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Editorial note

During the years 2006-2008 a regular publication of our periodical Cainozoic Research unfortunately was interrupted. With the appearance of CR 10 in August this year and volumes 11-13 in the present issue the shortfall is remedied and CR will regularly continue in 2014 with publication of volume 14. The present volumes 11-13 are published at the occasion of the 50th anniversary of the Dutch society Werkgroep voor Tertiaire en Kwartaire Geologie' (WTKG, established December 1963). Cainozoic Research is the successor periodical of two earlier serials published by WTKG, viz. 'Mededelingen van de WTKG' (1964-1989) and 'Contributions to Tertiary and Quaternary Geology' (1990-2000). Cainozoic Research, however, since its first appearance in 2001, is a joint publication of the Tertiary Research Group and WTKG. CR 11-13 contains just a single paper, realised by an international group of authors, describing the stratigraphically highly important Miocene gastropod fauna of the Karaman High Plain in Turkey. CR editors wish to express gratitude to the authors, and especially also to the unusual high number of reviewers world-wide, who's joint cooperation made it possible to have the large manuscript ready in printed form for distribution during the celebration of WTKG's 50th anniversary on December 14, 2013 in Leiden, The Netherlands.

Submitting dealine for CR 14 is March 2014.

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Systematics and palaeobiogeography of the gastropods of the middle Miocene (Serravallian) Karaman Basin, Turkey

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A systematic account of the middle Miocene late Serravallian gastropod assemblage found in the Karaman Basin of Turkey is given. In this work 437 species are recorded belonging to 252 genera, of which 60 were left in open nomenclature. Four new genera are proposed; *Erentoezia* nov. gen., *Janssenia* nov. gen., *Europhos* nov. gen. and *Nisosyrnola* nov. gen. Forty-one species are described as new; *Homalopoma laleensis* nov. sp., *Thericium ataturki* nov. sp., *Tiaracerithium eceae* nov. sp., *Gibborissoia angulosa* nov. sp., *Erentoezia akpinarensis* nov. sp., *Rhombostoma? meesi* nov. sp., *Rhombostoma? daani* nov. sp., *Elachisina rolani* nov. sp., *Elachisina gofasi* nov. sp., *Tornus karamanensis* nov. sp., *Solariorbis punctatocarinatus* nov. sp., *Dermomurex (Trialatella) kilikiensis* nov. sp., *Ocinebrina perparva* nov. sp., *Nassarius gilii* nov. sp., *Nassarius barbarossai* nov. sp., *Melongena jaapi* nov. sp., *Vexillum baluki* nov. sp., *Conomitra karamanensis* nov. sp., *Scalptia? problematica* nov. sp., *Clathurella pouweri* nov. sp., *Pleurotomoides isabelae* nov. sp., *Bela seyithasanensis* nov. sp., *Raphitoma spinosissima* nov. sp., *Raphitoma vandervoorti* nov. sp., *Cochlespira protomediterranea* nov. sp., *Clavatula labiolirata* nov. sp., *Clavatula seyithasanensis* nov. sp., *Perrona robustocarinifera* nov. sp., *Chrysallida majae* nov. sp., *Henrya wareni* nov. sp., *'Acteon' problematicus* nov. sp., *Philine seyithasanensis* nov. sp. and *Micratys fragilissimus* nov. sp.

The following taxonomic changes are made: type species are designated for the turritellid genera *Oligodia* Handmann, 1882 and *Helminthia* Handmann, 1882. *Trochus buchii* Dubois de Montpéreux, 1831 is suppressed in favour of the senior subjective synonym *Trochus catenularis* von Eichwald, 1830, *Turritella turris* var. *badensis* Sacco, 1896 is suppressed in favour of the senior subjective synonym *Turritella vindobonensis* Handmann, 1882, *Phorus gratteloupi* d'Orbigny, 1852 is suppressed in favour of the senior subjective synonym *Turritella vindobonensis* Handmann, 1882, *Phorus gratteloupi* d'Orbigny, 1852 is suppressed in favour of the senior subjective synonym *Turritella vindobonensis* Handmann, 1882, *Phorus gratteloupi* d'Orbigny, 1852 is suppressed in favour of the senior subjective synonym *Turritella vindobonensis* Handmann, 1882, *Phorus gratteloupi* d'Orbigny, 1852 is suppressed in favour of the senior subjective synonym *Turritella vindobonensis* Handmann, 1882, *Phorus gratteloupi* d'Orbigny, 1852 is suppressed in favour of the senior subjective synonym *Turritella vindobonensis* Handmann, 1882, *Phorus gratteloupi* d'Orbigny, 1852 is suppressed in favour of the senior subjective synonym *Turritella vindobonensis* hungarica Csepreghy Meznerics, 1950 and *Chrysallida interita* van der Linden & Eikenboom, 1992 is suppressed in favour of the senior subjective synonym *Parthenia* (*Pyrgisculus*) *longula* Boettger, 1906. *Mangilia hörnesi* Brusina, 1870 is considered a *nomen oblitum*. *Nassa explorata* Boettger 1906 is considered a *subjective* synonym of *Naytiopsis hypertropha* (Boettger, 1906), which is chosen as the valid name of the species. *Galeodes* (*Galeodes*) *thraciensis* Lebküchner, 1974, is considered a *nomen nudum*. *Raphitoma antonjanseni* Marquet, 1998 is corrected to *Raphitoma antonjansei*. Lectotypes are designated for *Conus subraristriatus* Pereira da Costa, 1866 and *Andonia transsylvanica* (Hoernes & Auinger, 1890).

The Karaman assemblages all correspond to soft bottom habitats. The fully marine layers at Seyithasan represent sandy bottom habitats, possibly with sea grass communities, deposited probably in the shallow sub-tidal zone. The clayey sediments at Akpınar correspond to shelf environments, and reflect slightly more open and deeper marine conditions than Seyithasan. Brackish deposits are also present in some localities, which probably represent lagoonal environments.

The importance of the assemblage is highlighted, as it is the only rich and diversified middle Miocene assemblage known from the Mediterranean region. The assemblage is compared with those found in the middle Miocene European Atlanto–Proto-Mediterranean and Paratethyan regions and a very close correlation (72.9%) is found between the Karaman fauna and that found in the slightly younger Badenian Paratethys, which is Langhian-early Serravallian in age. As might be expected, the correlation between the Karaman Basin assemblages and those along the eastern Atlantic frontage (Aquitaine, 28.8%; Loire, 20.9% and North Sea Basin, 14.6%) grows progressively weaker northwards.

The strong correlation between the Karaman and Paratethyan assemblages casts doubt on the model depicting the Badenian Paratethys as being highly endemic and suggests that the main connection between the Paratethys and the Proto-Mediterranean Sea via the Trans-Tethyan Trench corridor in Slovenia may still have been open during the late Badenian. However, the correlation between the Karaman assemblage and the coeval Sarmatian stage Karaman taxa occurring in the Paratethys, is very low (1.6 %). At that time the Paratethys was already disconnected from the Mediterranean and had developed a highly endemic gastropoda fauna. Therefore, the Karaman assemblage shows a high correlation with the slightly older Paratethyan fully marine Badenian assemblage, corresponding with the Langhian and early Serravallian, but not to the coeval Paratethyan late Serravallian/Sarmatian assemblage.

Özet (abstract in Turkish language)

Bu çalışmada, Türkiye'nin Karaman havzasında bulunmuş olan Orta Miyosen (Geç Serravaliyen) yaşlı gastropod topluluğunun sistematiği ele alınmaktadır. Çalışmada, toplam 252 cinse ait 437 tür kaydedilmiş, 60'ının ise sistematik adlandırma kurallarına göre isimleri "açık nomenklatür" olarak bırakılmıştır. Dört yeni cins *Erentoezia* nov. gen., *Janssenia* nov. gen., *Nisosyrnola* nov. gen. ve *Europhos* nov. gen. önerilmiş ve 41 yeni tür tanımlanmıştır. Yeni türlere ait isimler yukarıdaki ingilizce özette liste halinde verilmiştir.

Aşağıdaki taxonomik değişiklik yapılmış; turritellid cinsleri *Oligodia* Handmann, 1882 ve *Helminthia* Handmann, 1882 için tip türler belirlenmiştir. *Trochus buchii* Dubois de Montpéreux, 1831 daha kıdemli sinonim tür olan *Trochus catenularis* Eichwald, 1830'e dahil edilmiştir, *Turritella turris* var. *badensis* Sacco, 1896 daha kıdemli sinonim tür olan *Turritella vindobonensis* Handmann, 1882'e 'e dahil edilmiştir, *Phorus gratteloupi* d'Orbigny, 1852 daha kıdemli sinonim tür olan *Trochus conchyliophorus* var. *italica* Grateloup, 1845' dahil edilmiştir, *Melongena pseudobasilica* Strausz, 1966 daha kıdemli sinonim tür olan *Melongena hungarica* Csepreghy Meznerics, 1950'e dahil edilmiştir, ve *Chrysallida interita* van der Linden & Eikenboom, 1992 daha kıdemli sinonim tür olan *Parthenia (Pyrgisculus) longula* Boettger, 1906'e dahil edilmiştir. *Mangilia hörnesi* Brusina, 1870 *nomen oblitum*. *Nassarius schoenni* (Hoernes & Auinger, 1882) 'nin a *nomen protectum* ve *Nassa laevigata* Pusch, 1837 'nın ise a *nomen oblitum* olduğu düşünülmektedir. Geçerli tür isim olarak seçilen *Nassa explorata* Boettger 1906'nın *Naytiopsis hypertropha* (Boettger, 1906) ile eş anlamlı sinonim tür olduğu düşünülmektedir. *Galeodes* (*Galeodes*) *thraciensis* Lebküchner, 1974 a *nomen nudum* olarak kabul edilmiştir. *Raphitoma antonjanseni* Marquet, 1998 'a ait tür ismi, *Raphitoma antonjansei* olarak düzeltilmiştir. *Conus subraristriatus* Pereira da Costa, 1866 ve *Andonia transsylvanica* (Hoernes & Auinger, 1890) için lektotipler belirlenmiştir.

Karaman topluluklarının tümü yumuşak taban koşullarındaki bir yaşama işaret eder. Seyithasan'da tamamen denizel ortama ait seviyeler, olasılıkla deniz yosunutopluluklarını, ve muhtemelen sığ gelgit altı zonda çökelmiş olan kumlu taban habitatlarını temsil eder. Akpınar'daki killi sedimanlar şelf ortamına karşılık gelir ve Seyithasan'dakinden biraz daha derin olan açık deniz koşullarına işaret eder. Bazı lokalitelerde olasılıkla lagüner ortamları temsil eden brakiş çökeller de bulunur.

Özellikle vurgulamak gerekirse, Akdeniz Bölgesinde bilinen en zengin ve en çeşitli tek Orta Miyosen topluluğu olarak, Karaman gastropodları önemli bir topluluktur. Topluluk, Orta Miyosen Avrupa'sında Atlantik- Proto-Akdeniz ve Paratetis bölgelerinde bulunan diğer çoğu toplulukla karşılaştırılmış; ve Karaman faunası ile Paratetis bölgesinde Badeniyen'in (Langiyen – Erken Serravaliyen) biraz daha genç çökellerinde bulunan fauna arasında oldukça yakın bir korelasyon (72.9%) ilişkisinin bulunduğu saptanmıştır. Tahmin edilebileceği gibi, Karaman havzası toplulukları ile doğu Atlantik ön cephesi boyunca bulunanlar arasındaki korelasyon ise, kuzeye doğru gittikçe daha azalacak şekilde gelişim göstermektedir (Akitan, 28.8%; Loire, 20.9% ve Kuzey Denizi Havzası 14.6%).

Karaman ve Paratetis toplulukları arasındaki belirgin korelasyon, yüksek derecede endemik özelliğe sahip olduğu kabul edilen Badeniyen Paratetis'ini betimleyen modele karşı şüphe uyandırmakta olup, Paratetis'le Proto-Akdeniz arasındaki ana bağlantı yolu olan Slovenya'daki Trans- Tetis Trench koridorunun geç Badeniyen sırasında da halen açık olabileceğini düşündürmektedir. Bununla birlikte, Karaman topluluğu ile Paratetis'te oluşmuş eşyaşlı Sarmasiyen taxası arasındaki korelasyon oldukça düşüktür (1.6 %). Bu zaman sırasında Paratetis'in Akdenizle olan bağlantısı çoktan kesilmiş ve Paratetis'te oldukça yüksek düzeyde endemik gastropod faunası gelişmiştir. Bu yüzden, Karaman topluluğu, Paratetis'e ait eş yaşlı Geç Serravaliyen/Sarmasiyen topluluğu ile değil, biraz daha yaşlı ve tamamen denizel özellikte olan Paratetis Badeniyen topluluğu ile daha fazla benzerlik göstermektedir.

KEY WORDS: Middle Miocene, Serravallian, Karaman Basin, Turkey, Gastropoda, systematics, new genera, new species, palaeobiogeography. 1 Introduction, p. 6

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1 Introduction

For many years now, whilst working on European Neogene gastropod faunas, the authors came across references to fossil assemblages in the Karaman Basin of Turkey. The only comprehensive work available on these deposits was by Erünal-Erentöz (1956, 1958), who figured some beautifully preserved fossils, mostly identified as species found in the French Atlantic Miocene. The tantalising insight into these deposits offered by the Turkish palaeontologist was extremely important, but was at the same time frustrating, as the age of the deposits was somewhat vague and the variety of taxa illustrated raised the question of exactly how complete an account this was of the Karaman Basin fossil assemblages.

During a visit to the Naturalis Biodiversity Center (Leiden, The Netherlands) in 2009 molluscan researcher and curator Frank P. Wesselingh showed the senior author vast collections from the Miocene of Karaman assemblages collected decades ago by his predecessor, Arie W. Janssen, and by private collector Jaap van der Voort, now deposited at Naturalis. It was immediately clear from the material amassed that the assemblage described by Erünal-Erentöz (1956, 1958) was a huge underestimate of the true richness of the fauna. Further enquiries made by the senior author revealed the presence of similar collections in the Natural History Museum in Vienna, Austria. The importance of the Karaman assemblages for the understanding of the Atlanto-Mediterranean palaeobiogeography of Miocene gastropods and the need to further investigate them soon became clear. A proposal was made to resume studies on these assemblages with the help of Turkish colleague Doç. Dr. Yeşim İslamoğlu, who in fact is a great-niece of the pioneer Erünal-Erentöz, and with the logistic support of the MTA (Maden Tetkik ve Arama; the Mineral Research and Exploration General Directorate), in Ankara, Turkey. The aims of this research were:

- To verify the age determination of the fossil assemblages, based on nannoplankton and foraminifers.
- To describe and illustrate the palaeobiodiversity of the Miocene gastropod assemblages of the Karaman Basin as thoroughly as possible, using updated taxonomic concepts.
- To give either descriptions or further data on the shell morphology whenever existing details were considered inadequate, including, where possible, information on the protoconch and the original colour pattern.
- To give as complete a critical synonymy as possible for each species in order to ascertain their geographical and stratigraphical ranges.
- To offer a detailed discussion and comparison for each species.
- To discuss palaeobiogeographical implications of the gastropod fauna.

The present monograph is the results of this research.

1.1 A history of the study of the Karaman assemblages

The rich Turkish Miocene assemblages were first reported in the mid-19th century (Fischer *in* Tchihatcheff, 1866), but this was by no means the first time collections were made from the Karaman Basin. Excavations of Neolithic mounds at Çatalhöyük, some 50 km distance from the Karaman Basin, have found shells from the Karaman assemblages, such as *Athleta rarispina* (Fig. 1) in association with feasting activities. The significance of these fossil shells in the local Neolithic culture is conjectural, but proves that from an early age human settlers noticed and valued these fossils (Bar-Yosef Mayer *et al.*, 2010).



Figure 1. Miocene fossil gastropod *Athleta rarispina* (Lamarck, 1811) recovered from a Neolithic site (Karaman Archaeological Museum)

The first study of the assemblages was by Fischer *in* Tchihatcheff (1866), who reported and commented on 26 gastropod species from the Miocene of the Karaman area. No new taxa were introduced and the shells were considered to be conspecific with many well-known French Miocene and Italian Pliocene species.

Toula (1902) published a note on a small Turkish fossil collection in the Rijksmuseum van Geologie en Mineralogie (RGM) (now part of Naturalis Biodiversity Center in Leiden, The Netherlands). The Leiden specimens had originally been collected by Mr van Lennep, Vice-Consul of The Netherlands in Adrianopolis (nowadays Edirne) who handed them over to Mr van Uije Pieterse, Consul of The Netherlands in Istanbul (former Constantinople). In 1895 Mr van Uije Pieterse sent the fossils to Leiden, where Toula saw the collection during a study visit on an entirely different purpose. Professor Karl Martin, then

director of the museum, passed the fossils on to Toula on loan, for 'comparative research'. The small collection on which Toula (1901) based his publication was returned by him to Leiden and is still part of today's RGM collection. Although the collection was comparatively small, one new species and five 'new formae' were described by him based on a single specimen each. For the Gastropoda he included:

Turritella turris, Bast. – 2 specimens

- *Vermetus (Lementinia) arenarius* L. 1 specimen (fragment)
- Chenopus uttigerianus Risso var. peraneosa Sacco 2 specimens
- *Fusus anatolicus* n.f. 1 specimen (pictured on plate VIII as fig. 7a, b)
- Conus spec. ind. 1 specimen (internal mould)
- *Pleurotoma (Genota) Rudolfi* n.f. 1 specimen (pictured on plate VIII as fig. 8a, b)
- Pleurotoma (Clavatula) Theodori n.f. 1 specimen (pictured on plate VIII as fig. 9a, b)
- *Pleurotoma (Clavatula) Francisci* n.f. 1 specimen (pictured on plate VIII as fig. 10a, b)
- Pleurotoma (Clavatula) Ernesti n.f. 1 specimen (pictured on plate VIII as fig. 11a, b, in text on page 261 erroneously mentioned as 10a, b).

It is clear from the first couple of pages that Toula was unclear as to the provenance of this material. He combined indications of 'day marches', walking distances in hours, and terrain descriptions by Fischer *in* Tchihatcheff (1866) and quoted a letter sent by the Consul van Uije Pieterse: 'the locality where the fossils were found is in the neighbourhood of Larenda in Caramania, at a distance of 35 to 40 hours from the sea, 800-900 m. above sea level.' (Toula, 1901, p. 247), Larenda being the Greek name for Karaman before the Ottoman Empire.

In the spring and autumn of 1900, and again in the summer of 1901, Dr Franz Schaffer travelled through Anatolia, mainly to the area called Cilicia (southeastern Turkey from Anamur to Antakya, including large parts of the Taurus Mountains). Schaffer (1902a) gave an account of various localities and areas visited during his trips in 1900, and described and listed a number of fossils, including one new bivalve: Placuna taurica Schaffer, 1901. Schaffer (1902a, 1903) gave further accounts of his travels during the summer of 1901 and discussed the rich fossil assemblages of the area south-east of Karaman, specifically those around Gödet (today called Güldere) and the Gödet River valley, also mentioning a place called 'Aghin' which is now Gülkaya (situated at the western entrance of the small canyon leading to Akpınar, halfway to Gödet). He noted that the Gödet valley continued for about 25 km up to Fisandin (today called Dere Köy, but it is mentioned by its old name Fisandun by Erünal-Erentöz, 1956, 1958) and that fossils could be found in large numbers in almost every eroded rain gully.

Schaffer, with his excellent knowledge of the area, wrote a letter to the Kaiserlich-Königliche Geologische Reichsanstalt (date unknown but most probably early 1902, published in nr 3 of the 'Acta', the 'Verhandlungen der k.k. geologischen Reichsanstalt' for the session of 18th February 1902b), commenting on Toula's work. In this letter he corrected the locality data in Toula (1901) and concluded that the most probable origin of Toula's Leiden fossils was the area immediately south-east of Karaman. He recognised all Toula's new forms as occurring in the Gödet sediments. Further contributions were made by Daus (1915) and Papp (1949), who gave short faunal lists, adding to those given by previous authors, but without describing any new gastropod species.

The first comprehensive milestone paper was presented by Erünal-Erentöz (1958) and published as part of her doctoral thesis. Lütfiye Erünal-Erentöz (1912-2003) (Fig. 2) came from a family of Crimean Turks who immigrated to Istanbul following the First World War. Despite ill health during her childhood, including a year spent at a sanatorium to recover from tuberculosis, she graduated in geology at Istanbul University in 1938-39. Unfortunately, her PhD plans at the Sorbonne University in Paris were interrupted by the advent of the Second World War and she took a position in the newly formed MTA in Ankara. Her doctoral ambitions were finally realised at the Sorbonne in 1950. Her PhD on the Karaman area was defended in March 1953. Her thesis on the Karaman assemblages was published in two parts. The first part, "Mollusques du Néogène des Bassins de Karaman, Adana et Hatay" describing and illustrating a rich



Figure 2. Lütfiye Erünal-Erentöz collecting in the field (date and location unknown).

molluscan fauna predominantly from the Karaman area, was published in 1958. Strangely enough, the second part of her thesis, dealing with the stratigraphy of these Neogene basins, was published two years before part 1, in 1956. In this earlier publication, Erünal-Erentöz included maps with an accurate overview of the various fossiliferous localities, and also figured sections and profiles of outcrops with lists of the molluscan species occurring in them. The maps and additional information have been of immense value to subsequent collectors in localising the fossiliferous outcrops.

Lütfiye Erünal-Erentöz became known as the first macropalaeontologist in Turkey and is great-aunt to one of us (YI). She continued at the MTA and became a member of the Scientific Council in 1965, and founded the Natural History Museum of Mineral Research and Exploration 'Institution' (now General Directorate) in 1968. In the systematic portion of Erünal-Erentöz (1958), 141 gastropod species, subspecies and varieties are described, discussed and illustrated. Of these, 75 species were recorded from the Karaman assemblages. No type specimen allocations were made in her paper. It is not clear from her publication where this collection was housed, although some of it is in the Muséum National d'Histoire Naturelle in Paris, as can be seen through an internet search of the museum collections. These shells in the Paris collection are described as syntypes, which would suggest they are part of the original collection, but only seven of the 16 new species and varieties introduced by Erünal-Erentöz (1958) are present in Paris.

One of us (YI) succeeded in tracking down a further collection housed in the Geological Engineering Department of Ankara University, which we believe to be at least part of the Lütfiye Erünal-Erentöz collection used in her thesis and published in 1958. Most of the original labels are

New taxa in Erünal-Erentöz (1958)	Reported in this work as	Locality and age of assemblage
Turritella (Turritella) turris var. capriciosa	Ptychidia vindobonensis (Handmann, 1882)	Karaman (Serravallian, middle Miocene), Adana (Tortonian, late Miocene)
Turritella (Archimediella) bicarinata var. percingulata	Ptychidia vindobonensis (Handmann, 1882)	Adana (Tortonian, late Miocene)
Natica pachyopae var. curta	Cochlis curta (Erünal-Erentöz, 1958)	Karaman (Serravallian, middle Miocene)
Nassa (Amyclina) seyhanensis	-	Adana (Tortonian, late Miocene)
Nassa (Uzita) gayeae	<i>Nassarius elatus gayeae</i> Erünal- Erentöz, 1958	Karaman (Serravallian, middle Miocene)
Mitra (Cancilla) scrobiculata var. karamanensis	Cancilla planicostata (Bellardi, 1887)	Karaman (Serravallian, middle Miocene)
Clavatula (Clavatula) theodori var. calcaratiformis	Clavatula theodori (Toula, 1901)	Karaman (Serravallian, middle Miocene), Adana (Tortonian, late Miocene)
Clavatula (Clavatula) asperulata var. gracilis	Clavatula gracilis Erünal-Erentöz, 1958	Karaman (Serravallian, middle Miocene)
Conus (Lithoconus) planispira	<i>Monteiroconus daciae</i> (Hoernes & Auinger, 1879)	Karaman (Serravallian, middle Miocene)
Conus (Dendroconus) gulemani	juvenile Conus spp.	Karaman (Serravallian, middle Miocene)
Conus (Dendroconus) loczyi	_	Adana (Tortonian, late Miocene)
Conus (Dendroconus) pseudo-textilis var. pliocenica	_	Hatay (=Antakya) Basin (early Pliocene)
Conus (Chelyconus) pelagicus var. karamanensis	Varioconus pelagicus (Brocchi, 1814)	Karaman (Serravallian, middle Miocene)
Conus (Chelyconus) pelagicus var. inflatus	<i>Varioconus erunalerentoezae</i> nov. nom.	Karaman (Serravallian, middle Miocene)
Conus (Chelyconus) pyrula var. mucronata	_	Hatay (=Antakya) Basin (early Pliocene)
Conus (Chelyconus) curta	-	Hatay (=Antakya) Basin (early Pliocene)

Table 1. Taxa intruduced by Erünal-Erentöz (1958) and their revision in the present paper.

missing and the identifications have been rewritten by Prof. Guler Taner (now retired, but identified by her handwriting). The specimens had been wrapped in relatively new paper and replaced in their old boxes. Although collection numbers were written on the boxes, no record could be found of these numbers or their meaning. The specimens were therefore given new collection numbers by one of us (YI) and registered in the collection of the Geological Engineering Department, Ankara University. The old numbers and boxes were kept together with the specimens in case further information should be found subsequently.

The exact localities recorded in the monograph are not present on the new labels, which only mention basin names. The collection in Ankara University is very incomplete compared to the faunal list given by the Erünal-Erentöz. We (YI) managed to make a match between some of the shells in Ankara and plate illustrations in Erünal-Erentöz (1958), although most cannot be matched. This leads us to conclude that this Ankara collection is, at least in part, the collection on which the monograph was based and not a parallel collection.

In her work, Erünal-Erentöz (1958) formalised 16 new gastropod species and varieties. We have been able to revise all the forms from the Karaman assemblages, although taxa from the other basins await validation (Table 1).

No work dealing specifically with the Karaman benthic gastropods has been published subsequent to Erünal-Erentöz (1958). R. Janssen (1993) described a new turrid *Spirotropis karamanensis* in a review of the genus. An important contribution to the knowledge of the assemblage was made by A.W. Janssen (1999) in his monograph on the holoplanktonic molluscs of the Karaman Basin. Atabey *et al.* (2000) published a small list of gastropods collected from the newly described 'Tırtar Formation', while preparing the geological map of the area.

1.2 Geological setting

The Karaman Basin lies between the high plain of inner Anatolia and the central part of the central Taurus Mountains. It is surrounded by Neogene-Quaternary volcanic and lacustrine units in the north, and the Miocene Mut Basin, which is bordered by the Bolkar Mountains in the south.

The sediments of the Karaman Basin were formerly mapped as Mut Formation (Ulu & Balcı, 2009), named after the town of Mut, located about 45 km south of Karaman (Fig. 3). This formation, however, is now restricted to the Mut Basin and covers a stratigraphic interval from the Burdigalian to early Langhian, related to two third order sea-level cycles (Bassant *et al.*, 2005).

The gastropod assemblages described here come from moderately sorted, mollusc-rich clayey-silty rocks of the Tirtar Formation (Atabey *et al.*, 2000). Reefs and associated facies are present in spectacular outcrops revealing a complex internal architecture, with text-book examples of sequence stratigraphy (Gül & Eren, 2003; Mandic *et* *al.*, 2004; Bassant *et al.*, 2005), but not in the sampled localities. Towards the south, the Mut Basin is bordered by the Bolkar Mountains marking the transition with the high plain of the Karaman area. There, the Mut Formation is separated from the younger Tırtar Formation by a discordance and/or by terrestrial deposits, which were defined as Dağpazarı Formation by Atabey *et al.* (2000). The sedimentary facies of the Tırtar Formation are comparable to those of the Mut Formation and comprise clayey marls, marly sand, reefoid limestones and patch reefs (Ulu & Balcı, 2009).

Sampling locations were based on collecting localities given by Erünal-Erentöz (1956, 1958), and later numbered by Jaap van der Voort and Arie W. Janssen. They added further localities to those described by Erünal-Erentöz. Jaap van der Voort and Arie W. Janssen conducted extensive field work in the area, resulting in the collection of a significant part of the specimens used in the present monograph, now deposited in Naturalis (Leiden, the Netherlands) and the van der Voort private collection (see materials and methods). Nineteen collecting sites were allocated (Fig. 3):

- Locality 1 Oyster bank north-east of Dere Köy. A small outcrop along the roadside, mainly containing *Crassostrea gryphoides* (Schlotheim, 1813).
- Localities 2 and 3 Roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel.
- Locality 4 Ploughed fields at bend in Lale road planted with trees. On the eastern side of the Karaman-Mut main road (D715), at Localities 2 to 4, the fossiliferous occurrences are restricted to surface exposures in crop fields with almost no outcrops exposing the local stratigraphic sequence. At the junction of the local road to Lale village with the main Karaman-Mut road the stratigraphic sequence outcropping in the road cut is composed of a lower bed of pale grey clays with abundant turritellid fossils (1,5 m thick), overlain by fossiliferous, pale ochre, fine sandstones to clayey silts (>1,5 m). The crop fields along the eastern side of the Karaman-Mut road are mainly set on these upper clayey silts, becoming more grey and clayey towards the top of the slopes. Based on the altimetry of these slopes, in this area the complete stratigraphic sequence is around 30-40 m thick.
- Locality 5 Forest area south-west of Lale road bend. Wherever the eroded yellowish top soil is exposed between the trees, bivalves may be picked up (mainly *Chama, Ostrea* and fragments of Pectinidae). Only sporadic gastropod fossils.
- Locality 6 Hill slopes in forest west-northwest of Lale. In this forested area the top soil is hardly exposed between the trees, but in the gullies between the slopes, slightly eroded large-sized gastropods (Conidae, Muricidae) can be found.



Figure 3. Geography of the investigation area at different scales. The fossil collecting localities are marked with a star accompanied by the locality number.

Localities 7 and 8 – Akboğaz, slopes along Lale river and plains/hills north-east of Lale river valley (Fig. 4).

The fossil-bearing beds outcropping in the small valley 1 km SE of the old Lale village are part of a succession of clays silts and biogenic carbonates that form a cap over part of the outcrop, in which large scale low angle clinoforms were observed. No direct relationships were established between the fossil-bearing intervals and the carbonate bodies.

The fossil-bearing intervals contain the same facies as seen in Akpınar (locality 13). Facies (A) consists of siltstone with dispersed, but well-preserved marine molluscs. Very few paired bivalves were seen. The fauna is diverse and dominated by gastropods. Facies (B) resembles facies (A), but contains considerable numbers of the larger benthic foraminifer Operculina. Small molluscan species are more abundant in this facies then in facies (A) and include small Cardita species (often pairs) and small gastropod species. In one layer partially dissolved Operculina specimens with a diameter of approximately 4 cm were found. Facies (C) consists of beds and banks (typically decimetre thickness) of indurated carbonatebearing siltstone. In these beds partially or wholly decalcified shells were found, often dominated by paired Lucina s.lat, but also containing some venerid bivalves (mostly paired) and turritellids.

The three facies were found repeatedly in different

stratigraphical intervals and show lateral variation in thickness, continuity and e.g. rate of decalcification (and hence fossil preservation). By analogy to the Akpinar outcrop, the hard carbonate cap and low-angle clinoforms represent the topsets and foresets of a reef system. The mollusc-bearing intervals are mostly below the photic zone. Facies (A) that contains almost the entire fauna from the Lale River presumably represents the lower bound of the clinoforms (shelf environment). The paucity of paired bivalves and the mostly very good preservation suggests deeper depositional environments (possibly below storm wave base), but high bioturbation intensity. Facies (B) is within the (lower?) photic zone as witnessed by the obligate symbiont-bearing larger benthic foraminiferans. The common presence of paired bivalves indicates deposition below storm wave base. The common occurrence of in-situ lucinid bivalves in the indurated beds of facies (C) also indicates deposition below storm wave-base and relative oxygen-depleted sea-bed conditions.

Locality 9 – Tilkikaya, south of Başharman – slopes east of Gödet River (Fig. 5). This area of gentle slopes, on the right-hand side of the road leading from Başharman to locality 11, is characterised by outcrops of alternating yellow marls and grey clayey beds, in which *Turritella* and at one level *Petaloconchus* fossils are abundant.



Figure 4. Locality 7 & 8, Akboğaz, Tırtar Formation, slopes along Lale river and plains/hills north-east of Lale River valley (photo AWJ).



Figure 5. Locality 9. Tilkikaya, south of Başharman, Tırtar Formation, slopes east of Gödet River (photo JvdV).

- Locality 10 Hills/roadside near Tavşanlı. At this locality, 1,2 km west of the main Karaman-Mut road, after the turn to Tavşanlı, and 750 m west of the Lale junction (locality 2), to the south of the road the fossils occur in pale grey clays and ochre clayey silts 10-15 m thick, poorly exposed on the gentle slope of the hill above the crop fields. At this locality the exposures are extensively covered by vegetation and top-soil.
- Locality 11 Brackish assemblage, south-west bank of Gödet River across from Tilkikaya (Fig. 6). At the bottom of the steeply rising hillsides along the river valley, about 10 m above the river bed, and underlying the marine Miocene deposits, a grey to yellowbrownish gravel layer of about 1 m thickness was exposed on the south-west side of the narrow and dead-end dirt road along the river (Fig. 7). Decades ago, when this highly interesting fossiliferous locality was still accessible, a rich collection of brackish molluses could be amassed by sieving the sediment taken from the roadside. Due to the construction of the new Gödet River dam near Dere Köy, having an impact on the water level in the upstream river valley, we have to assume that this locality is no longer accessible. During recent visits by the senior author it could not be traced. Fortunately, material from this locality, collected by Arie W. Janssen and Jaap van der Voort before dam construction, was deposited in the RGM collection. It cannot be ruled out that during

extremely low water level periods this outcrop could be partly exposed again.

Locality 12 - Slopes east-northeast of Akpinar village.

Locality 13 - South of Akpınar-Pınarlar Yaylası (Fig. 8).

At Localities 12 and 13 (Akpınar), in the northeastern end of the Pınarlar Yaylası the stratigraphic sequence, subhorizontally exposed on the slopes of the gulches above the crop fields, is composed of a series of approximately 30 m of dark grey clays interbedded with 10-20 cm-thick beds of grey clayey marls, marls and, sporadically, marly limestones (Fig. 9).

The fossiliferous intervals in the outcrops north of Akpınar (Locality 13) represent mostly shelf deposits. The area is in need of detailed sedimentological and taphonomic study, but some initial observations are presented here. Thick (up to *c*. 30 m) indurated carbonate bodies are located on the south side of the outcrop zone. These carbonate bodies are composed of topsets and foresets (clinoforms). The clinoforms (height difference about 10 m) pinch out at the bottom and grade laterally into siltstone-dominated facies that in part contain the abundant, diverse, well-preserved marine molluscan fauna that is the subject of this study. Several siltstone intervals rich in well-preserved fossil molluscs are found and given their location laterally of the base of clinoforms these are considered to be shelf deposits (facies A). For



Figure 6. Locality 11, south-west bank of Gödet Creek near Tilkikaya, Tırtar Formation, brackish assemblage, position of outcrop (arrow) seen from the east (photo AWJ).



Figure 7. Locality 11, south-west bank of Gödet Creek near Tilkikaya, Tırtar Formation, brackish assemblage, outcropping shell bed along dirt road (photo AWJ).



Figure 8. Locality 13, south of Akpınar, Pinarlar Yaylası, Tırtar Formation, erosion slopes and valley. In the background entry of canyon leading towards Akpınar village (photo AWJ).



Figure 9. Locality 13, south of Akpınar, Pinarlar Yaylası, Tırtar Formation, grey clayey marls with *Sassia turrita* (Eichwald, 1830) *in situ* (photo CMS, May 2011).

the most part the fossil-bearing intervals were deposited below the photic zone, but an interval in Locality 13 with locally abundant larger benthic foraminiferans of the genus *Operculina* could be traced over approximately 300 m. This interval (Facies B) is relatively rich in smaller gastropod and bivalve species and unidentified biogenic carbonate clasts and includes *e.g.* common *Bittium* and other grazers that are rare or absent in the thicker Facies A intervals. Throughout the section, laterally traceable relatively thin (typically decimetres to half a metre) indurated and partially decalcified beds (Facies C) are found that contain some to common casts of mostly paired bivalves (including lucinid and venerid bivalves).

The observed location of the fossil-rich facies A siltstones at the lower margin of low-angle clinoforms indicates a shelf depositional environment. The partially very good preservation points to a position below storm wave-base, but the paucity of paired specimens implies intense bioturbation. The large benthic foraminiferans and occurrence of grazing molluscs in facies B implies its deposition within the photic zone. However, the commonness of paired small carditid bivalves implies deposition below storm wave base and hence a deep photic zone environment. The lateral discontinuity of this facies may represent local topographic highs on the sea-floor above the otherwise soft silty sea-floors of facies A. The thin, relatively well-bedded indurated siltstones of facies C with their casts of commonly paired bivalves represents deposition below storm wave base. The common

occurrence of lucinids implies oxygen depletion in the seafloor. These layers may represent distal conditions (to facies A) or maximum flooding intervals.

- Locality 14 Hills on south side of Gödet Creek, east of Akpınar. The fossil fauna of these hill slopes, composed of grey clayey marls, is very similar to the fauna described from localities 12 and 13.
- Locality 15 Steep slopes just before Gülkaya village on road to Akpınar.
- Locality 16 Basal conglomerate and oyster bed.
- Localities 17 and 17a Fields south of Seyithasan from outskirts of village for 2.4 km (Fig. 10), on the western side of the road to Ağaçyurdu.

Seyithasan is a complex of fields and small seasonal stream valley cuts. The area studied is approximately 1.4 km long and 500 m wide and covers the upper half of a large valley wall, about 1 km east of the village of Seyithasan. The abundance of mostly very well-preserved fossil molluscs is unparalleled. This locality requires intensive further study, and the observations and section presented here are provisional.

A single section was established through two stream valleys (Fig. 13a-c). Most layers were examined, but in some parts the steep walls made direct access impossible and lithology was 'estimated' from a distance combined with study of reworked sediment blocks downstream from the particular sections.

The section contains slightly over 110 m of varied deposits that include terrestrial and near shore conglomerates, red-bedded terrestrial silts, caliche soils, brackish water siltstones with locally abundant low-diversity mesohaline faunas, indurated siltstones and sandstones with occurring to abundant marine molluscan casts, intervals with partially decalcified corals (some in situ), fine-sand and silt intervals, some of which contain excessive numbers of very well preserved molluscs and claystones with variable numbers of molluscs. The section contains at least 11 terrestrial intervals.

The lower part of the section (c. 0-21 m) is dominated by conglomerate deposits intercalated with marine sandstone and siltstone beds. Fossil preservation is not very good, decalcification is common, but coral-bearing intervals were observed.

The overlying part (21 - *c*. 37 and possibly up to 45 m) is dominated by silts and clays with locally abundant brackish water taxa (*Granulolabium*, *Terebralia*, *Melanopsis*) (Locality 17a). Furthermore relatively thin, often indurated beds with partially decalficied marine faunas are found, including intervals rich in strongly diagenetically altered corals. Finally, thin terrestrial intervals are represented mostly by thin caliche-bearing clay layers.

The middle part of the section (37/45 - 80 m) is dominated by marine fine sandstone and siltstones and contains thin terrestrial red-clay intervals (locality 17). In the lower interval of this zone the fossils are mostly slightly decalcified, but halfway through this interval they are dominated by very well-preserved faunas. Two sets of extremely fossiliferous layers (a lower and an upper shelly interval) produce the greatest abundance of well-preserved fossils found in the adjacent fields. These two shelly intervals are each composed of several layers, including silt and fine sandstone with seagrass faunas (*Persistrombus* and very abundant *Agapilia/Smaragdia*), and seafloor faunas with partially in-situ paired bivalves. Below the top of this middle part a rich shell layer is found with more abraded and mixed faunas.

Satellite images of the outcrop zone show that the two shelly intervals described above can be traced laterally throughout the entire 1 km outcrop zone, and possibly beyond. The lack of wear, colour mixing and bioerosion implies relatively rapid deposition in sheltered environments. To the south end of the Seyithasan area, however, the shelly intervals contain increasingly abraded faunas suggesting lateral shallowing into the shallow subtidal zone.

In the upper part (c. 80-109 m) a succession occurs of red terrestrial clay intervals and greyish silty and fine sandy intervals with molluscan faunas dominated by small oysters, corbulids and turritellids. Many of the shelly intervals are slightly decalcified, but patches with well preserved and diverse marine faunas were observed that resemble the very well preserved interval of the part described above. In some parts of the upper part *Agapilia/Smaragdia* is abundant, implying sea grass environments. No indications of brackish water were found, other than possibly oligospecific oyster bearing intervals. The faunas point to relatively sediment-laden depositional conditions.

The top of the Seyithasan section (c. 109-112 m) consists of yellow biogenic fine sands with paired pectinid species and oysters. These represent deposition in low turbidity settings. The sands appear to transform into hard carbonate cap rock to the north of the exposure zone forming the cap of the valley wall.

The Seyithasan outcrop zone has a remarkable diversity of facies that can be studied in parallel section as well as traced laterally through the fields. Further study is very much recommended. We did not find layers with common larger benthic foraminiferans. The section contains a wide variety of depositional environments, but appears to have been in general close to the coast (and in part estuarine) and thus more proximal than either Lale or Akpinar.

- Locality 18 Hillsides east of Tarlaören. Eroded marly exposures mainly with bivalves, internal moulds of gastropods, and also occasional echinoids (*Clypeaster*).
- Locality 19 Road to Mut, 27 km south of Karaman. At a road-cut through a hill, grey clay was exposed on the eastern roadside, from which small and partly decalcified Naticidae and Nassariidae could be collected.



Figure 10. Seyithasan, locality 17. Tirtar Formation, approximately 25 meters of clays and silty clays, becoming marly in a few places and forming slightly protruding ridges 40 to 60 cm thick. The entire sequence is fossiliferous with the fossils concentrated in several beds (photo AWJ).



Figure 11. Seyithasan, locality 17. Tırtar Formation, clayey lower grey section with *Persististrombus inflexus* (Eichwald, 1830) *in situ* (photo CMS, May 2011).



Figure 12. Seyithasan, locality 17. Tırtar Formation, upper pale ochre to light brown section with *Cassis postmamillaris* Sacco, 1890 *in situ* (photo CMS, May 2011).



Figure 13a. Seyithasan, locality 17. Geographical position of stratigraphical section.



Figure 13b-c. Seyithasan, locality 17. Stratigraphic section. Colours are an exaggeration of the colours seen in the field (section prepared by Frank P. Wesselingh).



1.3 Age of Karaman assemblages

Until recently the age of these assemblages has been rather vague. Early authors considered the deposits to be Miocene in age without specifying further (Fischer *in* Tchihatcheff, 1866; Toula, 1901; Schaffer, 1902, 1903; Daus, 1915; Papp, 1949).

Erünal-Erentöz (1956, 1958) used the now outdated stratigraphic concept of the Helvetian stage (see Harzhauser *et* *al.*, 2003 for discussion). This historical stage comprised parts of the early Miocene Burdigalian stage and parts of the middle Miocene Langhian and Serravallian Stages, depending on region and author. Adding further to the complexity of the problem, the middle Miocene marine molluscan faunas of the Vienna Basin in Austria and other Paratethyan assemblages were at that time considered to be of Tortonian age by all authors, including Erünal-Erentöz (1956, 1958), which did not automatically imply



Figure 14. Miocene stratigraphy and biostratigraphy; modified from a chart produced with the Time Scale Creator program, provided by the International Commission on Stratigraphy (available at: http://www.stratigraphy.org/index.php/ics-chart-timescale). Pteropod zonations after Janssen (2012); shaded area in PZ 19 indicates the pteropod biozone proposed by Janssen (2012) for the Karaman high plain samples. Important mollusc bearing basins and regions are indicated for comparison [Aquitaine and Loire basins: Müller & Pujol (1979), Folliot *et al.* (1993), Cahuzac *et al.* (1995), Lozouet (1998), Bosellini & Perrin (2008); Mut Basin: Mandic *et al.* (2004), Bassant *et al.* (2005); Badenian of the Paratethys Basins: Harzhauser & Piller (2007)]. From Corić *et al.* (2012).

a late Miocene age as it does today. Therefore, the terms 'Miocène moyen' and 'Helvétien' as used by Erünal-Erentöz (1956, 1958) for the Karaman fossil assemblages are, by today's standards, ambiguous.

The first author to tackle this problem was A.W. Janssen (1999), who suggested a middle to late Serravallian age for the mollusc-bearing localities in the Karaman high plain based on holoplanktonic gastropods. Later, A.W. Janssen (2012) proposed a preliminary pteropod biozonation for the Neogene of the Mediterranean area and identified the pteropod assemblage from the Karaman high plain as Pteropod Zone 19-2 (see Fig. 14).

As part of the present project further samples were collected from the same locations as those mentioned by A.W. Janssen.

Samples collected during our second expedition to the Karaman Basin were processed at the Naturhistorisches Museum Wien (Austria). The aim was to provide independent age estimates for these deposits using nannopankton and planktonic foraminifers. These were recently published in Ćorić *et al.* (2012).

The planktonic foraminifers of the Akpınar deposits suggest a Serravallian age, based on the rare occurrence of *?Neogloboquadrina partimlabiata* (Ruggieri & Sprovieri, 1970), which is restricted to the Serravallian. This is supported by the absence of Tortonian marker species such as *Globigerina nepenthes* Todd, 1957 and *Neogloboquadrina acostaensis* Blow, 1959.

The nannoplankton assemblage is also indicative of the Serravallian Nannoplankton Zone NN6 *sensu* Martini (1971) based on the absence of *Discoaster kugleri* Martini & Bramlette, 1963 and the presence of *Cyclicargolithus floridanus* (Roth & Hay, 1967) Bukry, 1971. The last occurrence of *C. floridanus* (dated at 13.33 Ma by Lourens *et al.*, 2004) was used as an additional event to define the CN5a/CN5b boundary of Okada & Bukry (1980), which corresponds to the NN6/NN7 boundary of Martini (1971). The samples also contained *Coronocyclus nitescens* (Kamptner, 1963), which has its last occurrence slightly below the NN6/NN7 boundary (Young, 1998) at 12.12 Ma (Lourens *et al.*, 2004). As the NN6/NN7 boundary predates the Serravallian/Tortonian boundary, the samples can be dated clearly as Serravallian.

In an unpublished report, also part of this project, samples collected during the first Karaman expedition were processed by our colleague Mário Cachão (Universidade de Lisboa). This report mentioned the rare occurrence of *Discoaster kugleri* in some samples. This species was not found in the second set of samples analysed at the NHMW (Vienna, Austria), but its presence would suggest correlation of parts of the Tirtar Formation also with nannoplankton zone NN7 (Hilgen *et al.*, 2012).

These data confirmed the holoplanktonic-mollusc-based biostratigraphy of A.W. Janssen (1999, 2012), who proposed a middle to late Serravallian age (Fig. 14). Therefore, the rich Karaman molluscan fauna may partly correspond to late Badenian assemblages of the Paratethys Sea but is largely a time equivalent of the Sarmatian of the Paratethys. Coeval faunas along the eastern Atlantic coast are preserved in the Aquitaine Basin (*e.g.* Salles, Mios, Orthez-Le Paren; Cahuzac *et al.*, 1995; Lozouet, 1998; Cahuzac & Janssen, 2012) and the Loire Basin (Glibert, 1949; Bosellini & Perrin, 2008). Therefore, the molluscan fauna of the Karaman area provides an exceptional opportunity to cover the poorly resolved interval between the Langhian-early Serravallian faunas and Tortonian ones in the circum-Mediterranean area.

1.4 Material and methods

The material used here comes from:

- 1 Sampling campaigns carried out by the authors in the Karaman Basin in the period 2011-2013. Field sampling was conducted with the collaboration and field support of MTA, which kindly put its facilities at our disposal. The aim of the field work was to collect fresh material and microsamples, which are now housed in the MTA Museum and in the collection of one of the authors (YI), which is to be donated to Ankara University.
- Museum collections. Extensive collections are housed 2 in the Naturalis Biodiversity Center (RGM registration numbers) in Leiden, the Netherlands, and in the Jaap van der Voort (Ostercappeln-Venne, Germany) private collection (JvdV). Type and illustrated specimens from the latter have already been incorporated in the Naturalis collection, and the remaining complete JvdV collection will eventually also be deposited in the Leiden museum, and until that moment has not yet been allocated RGM numbers. Arie W. Janssen accompanied Jaap van der Voort on various trips and his material has been allocated RGM registration numbers. A further important collection is housed in the Naturhistorisches Museum in Vienna, Austria. The Vienna collection (NHMW registration numbers) is based on several collecting campaigns by Austrian geologists, starting with Franz X. Schaffer in the late 19th and early 20th century, and was enlarged by several later expeditions.

For detailed examination and description, illustration and SEM photography specimens from the RGM, JvdV and NHMW collections were chosen.

Nineteen locality numbers in the Karaman Basin were allocated (see above), corresponding to locality numbers originally used in the Jaap van der Voort and Arie W. Janssen collections. They have been adopted for all the other Turkish collections consulted and prepared. Although not all these localities yielded fossil gastropods, we have used the same locality numbers and descriptions so as to make the newly collected samples coherent with these important collections.

The classification of the Gastropoda adopted here is according to Bouchet & Rocroi (2005), taking into account recent modifications such as Tucker & Tenorio (2009) and Bouchet *et al.* (2011). For all species a comprehensive critical synonymy is provided, from literature concerning both Recent and fossil taxa, in order to determine the distribution of the species geographically and over geological time. In most cases only illustrated records have been included in the synonymy.

In text and references author names are applied as they appear in the publication referred to, e.g. Linnaeus (1758 (published as Caroli Linnaei = genitiv of Linnaeus), Linné (1767) (published as Caroli a Linné), and Mörch (1852), contrary to the often seen spelling of Mørch. Authors like 'van Aartsen', 'de Basterot', 'de Gregorio' etc. are listed in the References under A, B and G, respectively. In the synonymy the authors of the taxon are reproduced exactly as written in the publication (i.e. Brocchi may appear as Br., Brocc., Brocch., with or without a full stop). For species already discussed by the senior author and collaborators in the monographs covering the early Pliocene of Estepona, southern Spain (Landau et al. (2003, 2004a, b, 2006a, b, c, 2007, 2009b), Landau & Fehse (2004), Landau & Silva (2006), the synonymy is not repeated, but updated with new references when necessary. For the dates of publications by Sacco and Grateloup, we follow Marshall (1991) and Lesport et al. (2012), respectively.

For specific classification the Turkish shells were compared with specimens in the NHMW and RGM collections, as well as the historical literature. The number of Turkish shells present from each locality was annotated so the registration numbers convey: museum collection/ registration number/number of specimens.

Whenever possible the protoconch of the gastropod shells is described and illustrated. Protoconch whorls have been counted following the model suggested by Jablonski & Lutz (1980), and SEM photographs have been taken, whenever possible, following the proposals of Gili & Martinell (1992).

Teleoconchs were also examined under long-wave UV light and whenever a colour pattern became clearly visible, it was described and in most cases illustrated. The specimens were not bleached (see Merle *et al.*, 2008), as the colour pattern revealed itself readily without treatment. For the UV light photography, provided by Jaap van der Voort, the specimens were placed at the intersection of the beams of two UV lamps of the same wavelength arranged face to face at 90° to the shell axis. Finally, in order to get the best images, we have undertaken software processing (brightness and contrast adjustment). The photographed specimens are presented as imaged under UV light and not in negative view (see Pitt & Pitt, 1993).

Institutional abbreviation (or Museum/collections acronym):

- AÜ Lütfiye Erünal-Erentöz collection, Ankara University, Geology Department; Ankara, Turkey
- JvdV Jaap van der Voort collection, Ostercappeln-Venne, Germany.
- MTA Maden Tetkik ve Arama (The Mineral Research and Exploration General Directorate History of Nature Museum), Ankara, Turkey.
- NHMW Naturhistorisches Museum Wien, Austria.
- RGM Naturalis Biodiversity Center, Palaeontology Department, Leiden, The Netherlands, formerly Rijksmuseum van Geologie en Mineralogie.
- RM Robert Marquet collection, Antwerp, Belgium.
- YI Yeşim İslamoğlu collection, Ankara, Turkey.

Some individual observations or comments have been made by the authors that are accompanied by the authors initials (BL, MH, YI, CMS) respectively. Further contributions supplying photographs or specimens were made by Arie W. Janssen (AWJ) and Jaap van der Voort (JvdV).

Measurements taken with SEM photographs:

- dn = diameter first $\frac{1}{2}$ protoconch whorl.
- dp = diameter protoconch;
- dp/hp = diameter of protoconch/height;
- dp1 = diameter first protoconch whorl;
- hp = height protoconch.

2 Systematics

Class Gastropoda Cuvier, 1795 Subclass Eogastropoda Ponder & Lindberg, 1996 Clade Patellogastropoda Superfamily Lottioidea Gray, 1840 Family Acmaeidae Forbes, 1850 Subfamily Acmaeinae Forbes, 1850 Genus *Tectura* Gray, 1847a

Type species – Patella parva da Costa, 1778, by original designation. Recent, temperate Europe.

Tectura sp.

Plate 54, fig. 1

Dimensions and material – Maximum height 3.0 mm. Locality 17: NHMW 1847/0058/1435/27; JvdV/38, RGM 794 598/1 (ex JvdV), RGM 783 931/40, YI 225/4.

Discussion – A very small, thin-shelled *Tectura* species occurs in the Karaman assemblages with a maximum length of about 2 mm. The apex is placed at one-third distance from the posterior edge and the dorsal surface is devoid of sculpture, apart from a few poorly defined, subobsolete radial ribbing towards the edges.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Superfamily Scissurelloidea Gray, 1847a Family Scissurellidae Gray, 1847a Subfamily Scissurellinae Gray, 1847a Genus *Scissurella* d'Orbigny, 1824

Type species – Scissurella costata d'Orbigny, 1824, by original designation. Recent, Mediterranean.

Scissurella transylvanica Reuss, 1860 Plate 54, fig. 2

- *1860 *Scissurella transylvanica* m., Reuss, p. 266, pl. 7, fig. 6.
- 1860 Scissurella depressa m., Reuss, p. 266, pl. 7, fig. 7.
- 1875 Scissurella Lamellosa (Nobis), Benoist, p. 67, pl. 1, fig. 1.
- 1915 Scissurella falunica de Morgan, p. 232, fig. 15.
- 1917 Scissurella (Schismope) Terquemi (Deshayes) Cossmann & Peyrot, p. 70, no. 51, pl. 3, figs 10-14 [non Sukashitrochus terquemi (Deshayes, 1865)].
- 1938 Scissurella transylvanica Reuss Friedberg, p. 45, text-fig. 8.
- 1962 Scissurella terquemi (Deshayes) Kecskemétiné Körmendy, p. 83, pl. 9, figs 2-4 [non Sukashitrochus terquemi (Deshayes, 1865)].
- 1966 Scissurella costata transylvanica (Reuss, 1860) Strausz, p. 27, text-fig. 17.

- Scissurella terquemi (Deshayes) Kókay, p. 29,
 pl. 1, fig. 1 [non Sukashitrochus terquemi (Deshayes, 1865)].
- 1975 Scissurella (Scissurella) transylvanica Reuss Bałuk, p. 21, pl. 1, figs 1, 2.
- 1988 Scissurella cossmanni Depontaillier, 1881 Bandel, p. 11, pl. 2, figs 1-3.
- 1998 *Reusella depressa* (Reuss, 1860) Bandel, p. 44, pl. 14, fig. 8, pl. 15, figs 1-3.
- 2001a Scissurella lamellosa Benoist, 1875 Lozouet et al., p. 16, pl. 1, fig. 2; pl. 2, fig. 2.
- 2001a *Scissurella* cf. *transylvanica* (Reuss, 1860) [*sic*] Lozouet *et al.*, p. 16, pl. 1, fig. 4; pl. 2, fig. 3.
- 2012 Scissurella transylvanica (Reuss, 1860) Geiger, p. 363, figs 259-263.

Dimensions and material – Maximum diamater 1.6 mm. Localities 2 & 3: JvdV/1; locality 6: RGM 783 995/1; locality 13: JvdV/3; locality 17: RGM 794 597/1 (ex JvdV).

Discussion – The shells from Turkey are characterised by their sculpture of strong, close-set axial ribs. Geiger (2012) united four European Neogene nominal taxa under the name *Scissurella transylvanica* Reuss, 1860, considering *S. depressa* (Reuss, 1860), *S. lamellosa* Benoist, 1875 and *S. falunica* Morgan, 1915 all to be synonyms. For further discussion and comparisons see Geiger (2012).

Distribution – Late Oligocene: Aquitaine Basin, France (Bandel, 1988). Early Miocene: northeastern Atlantic (Aquitanian): Aquitaine Basin, France (Benoist, 1875; Lozouet *et al.*, 2001a). Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France (de Morgan, 1915); Paratethys (Langhian-Serravallian): Hungary (Kecskemétiné Körmendy, 1962; Kókay, 1966; Strausz, 1966), Poland (Friedberg, 1938; Bałuk, 1975), Romania (Reuss, 1860); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Superfamily Fissurelloidea Fleming, 1822 Family Fissurellidae Fleming, 1822 Subfamily Emarginulinae Children, 1834 Tribe Fissurellideini Pilsbry, 1890 Genus *Lucapinella* Pilsbry, 1890

Type species – Clypidella callomarginata Dall, 1871, by subsequent designation (Pilsbry, 1890). Recent, California.

Lucapinella clypeata (Grateloup, 1828)

Plate 1, fig. 1

- 1828a Fissurella depressa Nob., Grateloup, p. 79, no. 9 [non F. depressa Lamarck, 1822 (= F. crassa Lamarck, 1822)].
- *1828a Fissurella clypeata Nob., Grateloup, p. 79, no. 10.
- 1836 Fissurella depressa Nob. Grateloup, p. 276, pl.

1, fig. 22 [non F. depressa Lamarck, 1822 (= F. crassa Lamarck, 1822)].

- 1836 Fissurella clypeata Nob. Grateloup, p. 276, pl. 1, figs 23, 24.
- 1845 Fissurella depressa Grat. Grateloup, pl. 1, fig.
 22 [non F. depressa Lamarck, 1822 (= F. crassa Lamarck, 1822)].
- 1845 Fissurella clypeata Grat. Grateloup, pl. 1, figs 23, 24.
- 1852 *Fissurella aquensis* d'Orbigny, p. 92, no. 1722 (*nom. nov. pro F. depressa* Grateloup, 1828, *non* Lamarck, 1822).
- 1856 Fissurella clypeata Grat. Hörnes, p. 644, pl. 50, fig. 26.
- 1884 *Fissurella tapina* de Gregorio, p. 224 (*nom. nov. pro Fissurella clypeata* Grat. *in* Hörnes, 1856, *non* Grateloup, 1828).
- 1896d Fissurellidea clypeata (Grat.) Sacco, p. 12, pl. 1, fig. 48.
- 1896d *Fissurellidea clypeata* var. *tapina* (De Greg.) Sacco, p. 12, pl. 1, figs 49, 50.
- 1896d *Fissurellidea clypeata* var. *marginatella* Sacc., Sacco, p. 12, pl. 1, fig. 51.
- 1917 *Fissurellidea (Pupilia) clypeata* (Grateloup) Cossmann & Peyrot, no. 42, pl. 2, figs 67-73.
- 1917 Fissurellidea (Pupilia) clypeata mut. tapina de Gregorio – Cossmann & Peyrot, no. 43, pl. 2, figs 74, 75.
- 1949 *Fissurellidea clypeata* Grateloup, 1827 Glibert, p. 29, pl. 1, fig. 13.
- 1954 Fissurellidea (Papillaea) clypeata tapina De Greg. – Csepreghy-Meznerics, p. 11, pl. 1, fig. 11.
- 1954 Fissurellidea (Fissurellidea) clypeata Grat. Strausz, p. 7, pl. 9, fig. 185.
- 1960 Fissurellidea clypeata var. tapina (Gregorio 1884)
 Kojumdgieva & Strachimirov, p. 85, pl. 28, fig. 11.
- 1961 Fissurellidea (Papillaea) clypeata Grateloup Marinescu, p. 515, pl. 1, fig. 1.
- 1962 Fissurellidea (Fissurellidea) clypeata Grateloup Strausz, p. 158, pl. 76, figs 26-31.
- 1966 *Fissurellidea (Fissurellidea) clypeata* Grateloup, 1827 – Strausz, p. 28, pl. 76, figs 17-19.
- 1975 *Fissurellidea (Fissurellidea) clypeata* (Grateloup, 1827) Bałuk, p. 28, pl. 2, figs 12-16.
- 1981 *Fissurellidea clypeata* (Grateloup, 1827) Krach, p. 41, pl. 12, figs 13, 14.
- 1985 Fissurellidea (Fissurellidea) clypeata tapina (Gregorio, 1884) – Atanacković, p. 75, pl. 17, figs 6, 7.
- 2000 Fissurellidea (Fissurellidea) clypeata (Grateloup, 1827) – Popa & Ianoliu, p. 82, pl. 1, fig. 8.
- 2001a *Lucapinella clypeata* (Grateloup, 1828) Lozouet *et al.*, p. 17, pl. 3, fig. 3.

Dimensions and material – Maximum diameter 9.9 mm. Locality 17: NHMW 1874/0058/0924/1, 1874/0058/ 0925/6, JvdV/16, RGM 783 969/4, YI 206/3.

Discussion - Cossmann & Peyrot (1917) considered Fis-

surella depressa Grateloup, 1828 (*non* Lamarck, 1822, renamed *F. aquensis* by d'Orbigny, 1852) described from the early Oligocene Rupelian of Gaas, France, and specimens from the early Miocene Aquitanian-Burdigalian of the Aquitaine Basin, France, described as *Fissurella clypeata* Grateloup,1828 to represent a single highly variable species.

Distribution - Early Oligocene: northeastern Atlantic (Rupelian): Aquitaine Basin, France (Grateloup, 1828). Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1917; Lozouet et al., 2001a); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896d). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1917), Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856), Poland (Bałuk, 1975), Hungary (Csepreghy-Meznerics, 1954; Strausz, 1954, 1962, 1966), Bulgaria (Kojumdgieva & Strachimirov, 1960), Romania (Popa & Ianoliu, 2000), Bosnia (Atanacković, 1985); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (NHMW collection); Proto-Mediterranean Sea (Tortonian): Po valley, Italy (Sacco, 1896d).

Tribe Diodorini Odhner, 1932 Genus *Diodora* Gray, 1821

Type species – Patella apertura Montagu, 1803, by original designation. Recent, Mediterranean.

Diodora gibberula (Lamarck, 1822) Plate 1, fig. 2

*1822 Fissurella gibberula Lamarck, p. 15.

2003 *Diodora gibberula* (Lamarck, 1822) – Landau *et al.*, p. 25, pl. 4, fig. 3 (with additional synonyms).

Dimensions and material – Maximum diameter 10.3 mm. Locality 11: RGM 794 072/1 (ex JvdV); locality 17: NHMW 1874/0058/0926/2.

Discussion – Diodora gibberula (Lamarck, 1822) is characterised by its rather small shell and its more regular sculpture than most of its congeners. The apical aperture is also placed more posteriorly than in most Recent European *Diodora* species. *Diodora subcostaria* (d'Orbigny, 1852) from the Atlantic early Miocene Aquitaine Basin of France has a more central apical aperture and radial ribs of alternating strength (see Lozouet *et al.*, 2001a, pl. 3, fig. 2).

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896d). Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: western Mediterranean, Estepona Basin (Landau *et al.*, 2003). **Early-late Pliocene**: central Mediterranean, Italy (Sacco, 1896d). **Pleistocene**: western Mediterranean, Balearic Islands (Cuerda Barceló, 1987); central Mediterranean, Italy (Cerulli-Irelli, 1916; Malatesta, 1960; Ruggieri & Greco, 1965); Atlantic, Morocco (Lecointre, 1952). **Recent**: Atlantic, France to West Africa and the Canaries, Mediterranean, shallow water (Poppe & Goto, 1991).

Superfamily Trochoidea Rafinesque, 1815 Family Trochidae Rafinesque, 1815 Subfamily Trochinae Rafinesque, 1815 Tribe Trochini Rafinesque, 1815 Genus *Clanculus* de Montfort, 1810

Type species – Trochus pharaonius Linnaeus, 1758, by original designation. Recent, Red Sea.

Subgenus Clanculopsis Monterosato, 1880a

Type species – Trochus cruciatus Linnaeus, 1758, by subsequent designation (Sacco, 1896c). Recent, Mediterranean.

Clanculus (Clanculopsis) cruciatus (Linnaeus, 1758) Plate 1, fig. 3

- *1758 Trochus cruciatus Linnaeus, p. 757.
- 2003 Clanculus (Clanculopsis) cruciatus (Linnaeus, 1758) – Landau et al., p. 41, pl. 9, fig. 5 (with additional synonyms).
- 2004 *Clanculus cruciatus* (Linne, 1758) Chirli, p. 49, pl. 17, figs 1-6.
- non 1975 Clanculus (Clanculopsis) cf. cruciatus (Linnaeus, 1766 [sic]) – Bałuk, p. 42, pl. 5, fig. 8 [= Granulifera hoernesi (Doderlein, 1863)].

Dimensions and material – Height 12.2 mm. Localities 7 & 8: NHMW 1874/0058/0928/1, locality 17: NHMW 1874/0058/0927/2, RGM 794 088/1 (ex JvdV); locality 17a: NHMW 1847/0058/1591/2.

Discussion – This Clanculus species from the Karaman assemblages has very weak apertural dentition and a simple basal columellar tooth. These are the main characters of the subgenus Clanculopsis Monterosato, 1888. The inductural callus is also more weakly expanded over the base and the sculpture of beads is finer than in Clanculus (s. str.) de Montfort, 1810. Clanculus (Clanculopsis) baccatus (Defrance, 1824) from the Atlantic middle Miocene of France also has a non-bifid columellar tooth, but this is much more strongly developed than in C. (C.) cruciatus. Two further Clanculopsis species were described recently by Spadini (2006) from the Pliocene of Italy, C. (C.) landaui and C. (C.) marqueti, both differing from C. (C.) cruciatus in details of their surface sculpture and in having a far more strongly developed basal columella tooth. This Turkish record is probably the oldest one of *C. cruciatus*. Bałuk (1975, pl. 5, fig. 8) illustrated a very small shell in dorsal view as *C.* (*C.*) cf. *cruciatus*. This record was later corrected by the author (Bałuk, 2006, p. 182) to *Granulifera hoernesi* (Doderlein, 1863).

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Landau *et al.*, 2003), Morocco (Lecointre, 1952); central Mediterranean, Italy (Chirli, 2004), Tunisia (Fekih, 1975). Early-late Pliocene: central Mediterranean, Italy (Spadini, 1986; Cavallo & Repetto, 1992). Pleistocene: western Mediterranean, France (Glibert, 1962a), Balearic Islands (Cuerda Barceló, 1987); central Mediterranean, Sicily (Glibert, 1962a, Ruggieri & Greco, 1965); Tunisia (Glibert, 1962a); Cos (Glibert, 1962a); Cyprus (Glibert, 1962a), Italy (Malatesta, 1960). Recent: from southern Portugal into the Mediterranean, rocky bottoms from the intertidal zone to 60 m (Poppe & Goto, 1991).

Tribe Cantharidini Gray, 1857 Genus Jujubinus Monterosato, 1884

Type species – Trochus matoni Payraudeau, 1826, by subsequent designation (Pilsbry, 1889). Recent, Mediterranean.

Jujubinus celinae (Andrzejowski, 1833)

Plate 1, figs 4, 5

- 1831 Trochus turgidulus Brocchi Dubois de Montpéreux, p. 40, pl. 2, figs 29, 30 [non Jujubinus turgidulus (Brocchi, 1814)].
- *1833 *Trochus Celinae* Andrzejowski, p. 443, pl. 13, fig. 1.
- 1855 *Trochus Celinae* Andrz. Hörnes, p. 450, pl. 45, fig. 4.
- 1928 Calliostoma subturriculoides? Sinz. Friedberg, p. 503, pl. 31, fig. 21.
- 1928 Calliostoma Celinae Andrz. Friedberg, p. 508, pl. 32, fig. 8.
- 1956 *Calliostoma puberum* (Eichwald) Csepreghy-Meznerics, p. 377, pl. 1, figs 1, 2.
- 1966 *Calliostoma puberum* Eichwald, 1853 Strausz, p. 34, pl. 13, fig. 4.
- 1970 Calliostoma subturriculoides (Sinzow) Bałuk, p. 117, pl. 8, fig. 8.
- 1975 Jujubinus (Strigosella) celinae (Andrzejowski, 1833) – Bałuk, p. 41, pl. 4, figs 11-15.

Dimensions and material – Maximum height 12.5 mm. Locality 6: JvdV/1; localities 7 & 8: NHMW 1874/0058/0931/1, JvdV/1; locality 17: NHMW 1874/-0058/0929/1, 1874/0058/0930/26, JvdV/50+, RGM 783 924/6, YI 207/42.

Discussion – Bałuk (1975, p. 41) discussed the difficulty in identifying the small Paratethian *Jujubinus* species with a spire of variable height, weakly shouldered last whorl, spiral sculpture variably developed and an indistinct umbilicus. The specimens from Turkey are similar in size to those illustrated by Bałuk (1975, pl. 4, figs 11-15) from Poland as *Jujubinus celinae* (Andrzejowski, 1833), but with the spiral sculpture very indistinct or absent. Such smooth specimens were also illustrated by Hörnes (1855, pl. 45, fig. 4) from the Vienna Basin. The colour pattern of distinct rows of spiral dots or horizontal chevrons is clearly preserved in the shell illustrated (Pl. 1, fig. 4). The second specimen illustrated here as *J. celinae* (Pl. 1, fig. 5) is somewhat different, with a higher spire and weakly developed umbilical chink, but fits within the species variability as illustrated by Bałuk (1975).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1855), Poland (Friedberg, 1928; Bałuk, 1970, 1975), Hungary (Strausz, 1966; Csepreghy-Meznerics, 1956), Ukraine (Andrzejowski, 1833; Dubois de Montpéreux, 1831); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Jujubinus hoernesianus Sacco, 1896

Plate 1, fig. 6

- 1855 Trochus turricula Eichw. Hörnes, p. 451 (partim, pl. 45, fig. 6 only) [non Jujubinus turricula (Eichwald, 1851)].
- *1896c Jujubinus turricula var. hoernesiana Sacc., Sacco, p. 48.
- 1975 *Jujubinus (Jujubinus) turricula hoernesiana* Sacco, 1896 – Bałuk, p. 39, pl. 4, figs 2, 3.

Dimensions and material – Maximum height 5.5 mm. Locality 6: JvdV/1; localities 7 & 8: JvdV/2; locality 13: NHMW 1874/0058/0932/1, 1874/0058/0933/1, YI 208/1; locality 17: NHMW 1874/0058/0996/2, YI 209/4.

Discussion – Several extremely similar Jujubinus species have been described from the Paratethian Miocene: Jujubinus turricula (Eichwald, 1851) was separated from J. hoernesianus at subspecies level by Bałuk (1975), J. turricula having a slightly larger shell and a higher spire, and five spiral cords per whorl instead of the six present in J. hoernesianus. Both species occur together in the middle Miocene of Korytnica, Poland (Bałuk, 1975, p. 40) and therefore subspecies rank is not possible. Jujubinus vexans (Boettger, 1907) from the Romanian Paratethys is also small, slightly lower spired than the previous two species, and has eight spiral cords per whorl. Jujubinus kostejanus (Boettger, 1907), also from the Romanian deposits, is slightly broader-shelled, with more convex whorls, and the 8-9 spiral cords are not beaded as in all the previous species. In the French Miocene assemblages Jujubinus subturgidulus (d'Orbigny, 1852) from the early Miocene Aquitanian also has 6-7 spiral cords, but these are also not beaded. Jujubinus pseudoturricula (Dollfus & Dautzenberg, 1886) from the middle Miocene Langhian of the Loire Basin is high-spired, and similar in shape to *J. turricula*, but with only four spiral cords, which are more coarsely beaded.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1855) Poland (Bałuk, 1975); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Tribe Monodontini Gray, 1857 (=Gibbulinae Stolitzka, 1868) Genus *Gibbula* Risso, 1826

Type species – Trochus magus Linnaeus, 1758, by subsequent designation (Herrmannsen, 1847). Recent, Mediterranean Sea.

Note – Recent DNA barcoding work by Barco *et al.* (2013) does not support the use of subgenera within *Gibbula* in the way usually done in the literature (*e.g.* Cavallo & Repetto, 1992; Giannuzzi-Savelli *et al.*, 1994; Marquet, 1998; Landau *et al.*, 2003; Chirli, 2004).

Gibbula? sp. 1 Plate 2, fig. 2

Dimensions and material – Height 9.3 mm. Localities 7 & 8: NHMW 1874/0058/0934/1: locality 17: YI 67/2.

Discussion – A single small turbinifom shell from the Lale River deposits is characterised by its smooth whorls and a colour pattern consisting of spiral rows of dots. This pattern is typical of the genus *Turbo* Linnaeus, 1758 (type species *Turbo petholatus* Linnaeus, 1758), but members of this genus are not perforate. Some *Gibbula* species also have a similar colour pattern, such as the Recent Mediterranean *Gibbula ardens* (von Salis Marschlins, 1793) and *Gibbula nivosa* A. Adams, 1851, but most *Gibbula* species have some form of spiral sculpture, which is absent in the Turkish shell. Nevertheless, we provisionally place it in this genus.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Gibbula cf. sagus (Defrance, 1828)

Plate 2, figs 4, 5

- ? 1828 Trochus sagus Defrance, p. 478.
- ? 1917 Gibbula pseudomagus d'Orbigny Cossmann & Peyrot, p. 110, no. 68, pl. 3, figs 63-65 (non d'Orbigny, 1852).
- ? 1938 *Gibbula saga* Defrance Peyrot, p. 26, pl. 1, figs 22, 23.
- ? 1949 Gibbula sagus Defrance, 1828 Glibert, p. 50, pl. 3, fig. 4.
- ? 2003 Gibbula sagus Defrance, 1828 Lagarde, p. 50, figs 1, 2.

Dimensions and material – Maximum height 20.1 mm. Locality 11: JvdV/9, RGM 794 026/13; locality 13: YI 55/1; locality 17: NHMW 1874/0058/0940/1, 1874/0058/0941/1, 1874/0058/0942/5, JvdV/2, RGM 783 922/1 fragment; locality 17a: NHMW 1847/0058/1579/12.

Discussion – This species is related to a species group characterised by the wavy nodes on the sutural ramp and by strongly prosocline axial ribs between the spiral ribs, best developed along in the lower third of the whorls in most species. Shells belonging to this group were described by Sacco (1896c) from the Tortonian and Pliocene of Italy as variations of Gibbula magus (Linnaeus, 1758) and as G. semirotunda Sacco, 1896. The latter is reminiscent of the Turkish species, but differs in its depressed outline. A further member of this group is Gibbula sagus (Defrance, 1828), which has been recorded mainly from the middle Miocene of the Loire Basin. Glibert (1949) illustrated two shells indicating some variability in sculpture and outline. His fig. 4c displays weak sculpture, comparable to the Turkish species but with a narrower umbilicus. Therefore, doubts about the identification of the Turkish shell with G. sagus remain. Moreover, there is a strong difference in the spire height and strength of sculpture between the two specimens illustrated here. However, numerous intermediate shells can be found in the Turkish assemblages. Only a thorough revision of the various taxa, including the French early Miocene species G. pseudomagus (d'Orbigny, 1852), will allow a clear evaluation of the Turkish species. In the Karaman deposits it is most common in the brackish assemblages of localities 11 and 17a, although it occurs rarely elsewhere. This shell is also comparable with *Gibbula taurangulosa* (Sacco, 1896), from the early Miocene in Italy. The syntype illustrated in Ferrero Mortara et al. (1984) differs from the Karaman specimens in its more globular outline and its even more pronounced axial sculpture between the spiral ribs. The sculpture of the base with 8 spiral ribs crossed by raised growth lines is nearly identical. A clear difference is the partly closed umbilicus of the Italian species.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Gibbula catenularis (Eichwald, 1830)

Plate 1, fig. 7

- 1830 Trochus annulatus von Buch, p. 132 (non Trochus annulatus Gmelin, 1791).
- *1830 *Trochus catenularis* Eichwald, p. 221 (description in footnote).
- 1830 Trochus Puschi Andrzejowski, p. 99, pl. 5, fig. 1.
- 1831 *Trochus Buchi* Dubois de Montperreux, p. 39, pl. 3, figs 9-11.
- 1837 Trochus catenulatus [sic] Eichw. Bronn, p. 658.
- 1837 Trochus Buchii Dub. Bronn, p. 658.
- 1837 Trochus Buchii Dubois Pusch, p. 109.
- 1839 Tr. catenularis Eichwald, p. 11.

- 1852 *Trochus catenularis* Eichwald, p. 3, pl. 9, fig. 6a-c (atlas).
- 1853 Trochus catenularis mihi, Eichwald, p. 218.
- 1855 *Trochus fanulum* Gmel. Hörnes, p. 446, pl. 45, fig. 1 [*non Gibbula fanulum* (Gmelin, 1791)].
- 1882 *Trochus Buchii* Du Bois Hilber, p. 10, pl. 1, fig. 22.
- 1907 Gibbula (Forskalia) fanulum var. cingulifera Bronn
 Boettger, p. 182, no. 630.
- 1907 Gibbula (Forskalia) depressula Sacco Boettger,
 p. 183, no. 631 [non Gibbula depressula (Sacco, 1896)].
- 1928 Gibbula Buchi Dub. Friedberg, p. 480, pl. 30, figs 8-14.
- 1931 Gibbula Buchi Dub. Janoschek, p. 77.
- 1945 ? Gibbula buchi Dub. Sieber, p. 155.
- 1946 Gibbula (Forskalena) cf. buchi (Dub.) Sieber, p. 108.
- 1953 *Gibbula (Forskalena) buchi* (Dub.) Sieber, p. 185.
- 1954 Gibbula buchi Dub. Strausz, p. 8, pl. 6, fig. 137.
- 1954 *Gibbula (Forskalena) buchi* Dubois Csepreghy-Meznerics, p. 13, pl. 1, fig. 12.
- 1955 *G. (F.) buchi buchi* (Dub.) Sieber, p. 127.
- 1958a Gibbula (Forskalena) buchi buchi (Dub.) Sieber, p. 146.
- 1962 Gibbula buchi Dubois Strausz, p. 127, pl. 53, figs 4-9.
- 1966 Gibbula buchi Dubois, 1831 Strausz, p. 37, pl. 53, figs 4-9.
- 1968 *Gibbula buchi* (Dubois de Montpereux, 1831) Zelinskaya *et al.*, p. 107, pl. 29, fig. 6.
- 1975 *Gibbula (Gibbula) buchi* (Dubois, 1831) Bałuk, p. 32, pl. 4, figs 4, 5.
- 1993 *Gibbula (Gibbula) buchi* (Dubois, 1831) Iljina, p. 24, pl. 1, figs 15-18.
- 1998 Gibbula (Forskalena) buchi (Dubois) Schultz, p. 54, pl. 20, fig. 6.
- 1998 Gibbula buchi (Dubois) Anistratenko, p. 13.
- 2002 Gibbula buchi (Dubois) Harzhauser et al., p. 64.
- 2002 *Gibbula buchi* (Dubois, 1831) Harzhauser & Kowalke, p. 64, pl. 12, figs 7, 8, 13.
- 2002 Gibbula buchi (Dubois) Mandic et al., p. 200.
- 2004 *Gibbula buchi* (Dubois) Latal *et al.*, p. 161.
- 2005 *Gibbula buchi* (Dubois) Piller & Harzhauser, p. 452, fig. 4/8.
- 2006 Gibbula buchi Zuschin et al., p. 78.
- 2007 Gibbula buchi Zuschin et al., p. 289.
- 2007 Gibbula buchi Roetzel, p. 617.
- non 1961 Gibbula (Gibbula) buchi Dub. Florei, p. 681, pl. 6, figs 38, 39 (= Modulus basteroti Benoist, 1873).

Dimensions and material – Maximum height 20.5 mm. Locality 13: YI 56/1; locality 17: NHMW 1874/ 0058/0935/1, 1874/0058/0936/8, JvdV/4, RGM 783 979/1, YI 57/1; locality 17a: NHMW 1847/0058/1580/2.

Discussion – The genus *Forskalena* Iredale, 1918 has been used for this group of *Gibbula*-species with quite

characteristic scalate spires and a well-developed peripheral band delimited by a deep groove, as seen in the type species *Trochus fanulum* Gmelin, 1791. However, the use of this genus is not supported by the phylogeny produced by Barco *et al.* (2013) for Recent European *Gibbula* species, in which *T. fanulum* is on the same branch as *Trochus magus* Linnaeus, 1758, the type species of *Gibbula* Risso, 1826.

This species was first described by von Buch, 1830 as Trochus annulatus, referring to material collected by Dubois de Montpéreux at Bilozirka (= Bialazurka, Bialozurka), 50 km ENE of Ternopil (=Tarnopol) in Ukraine. This name, however, was preoccupied for a Recent species described by Gmelin (1791), and so Dubois de Montpéreux (1831) proposed Trochus Buchii as a new name for the same specimens from the same locality. Independently, Eichwald (1830) and Andrzejowski (1830) described the same species, more or less simultaneously, as Trochus catenularis Eichwald and Trochus Puschii Andrzejowski from Shushkivtsi (= Zukowce) and neighbouring villages about 2 km NW of Bilozirka (a map with the historical names of the localities was given by Dubois de Montpéreux, 1831). Hilber (1882) also described specimens from these Ukrainian localities, including Pidhirzi (= Podhorzec, Podhorce), about 60 km NW of Ternopil. Material with this provenance was also described by Friedberg (1928). Therefore, all these authors dealt with middle Miocene material from the same area in the Carpathian Foredeep.

Occurrences from the Pannonian basins complex were described later by Hörnes (1855), Boettger (1907), Csepreghy-Meznerics (1954) and Strausz (1966). *Gibbula catenularis* is one of the few species that are known also from the eastern Paratethys. Iljina (1993) reported occurrences from the Russian Tulsky in the northern Caucasus and from the Ustyurt Plateau between the Caspian and Aral seas in Kazakhstan. There it occurred during the Tarkhanian (= early Langhian) and Konkian (= Serravallian). The earliest occurrence of this species is documented from the Burdigalian of the Iranian Qom Basin (Harzhauser *et al.*, 2002).

Eichwald (1830) provided only a description of his Trochus catenularis in a footnote without illustration. In contrast Andrzejowski (1830) also published figures for his Trochus Puschii. In the preface to Eichwald (1830), the date of print is dated as January 10th 1830, whilst the Bulletin Société Imperiale des Naturalistes de Moscou, in which Andrzejowski (1830) was published, is dated as February 1st 1830. It seems, therefore, that Eichwald's species name has priority, as already stated by Eichwald (1839). In the case of this species it would be better to treat both names as nomina oblita, and to define the better-established name Trochus Buchii of Dubois de Montpéreux (1831) as nomen protectum. The ICZN gives clear rules for this procedure, requiring that the senior synonym or homonym not have been used as a valid name after 1899 (ICZN Art. 23.9.1.1), and that the junior synonym or homonym has been used as its presumed valid name in at least 25 works, published by at least 10 authors, in the immediately preceding 50 years and encompassing a span of not less than 10 years (23.9.1.2.). The first requirement seems to be fulfilled as we were not able to detect *Trochus catenularis* or *Trochus Puschii* used as valid names after 1896, when Sacco erroneously used *Forskalia* cf. *catenularis* for a Tortonian shell from Stazzano. The second requirement, however, is not met as we could only detect 13 papers mentioning *Gibbula buchi* between 1961 and 2011. Therefore, we propose to resurrect the earliest name for this species, *Trochus catenularis* Eichwald, 1830, and recombine it as *Gibbula catenularis* (Eichwald, 1830).

Gibbula catenularis has a highly variable shell. Specimens from the Carpathian Foredeep tend to have a more regularly conical spire, with less scalate whorls and finer rugose sculpture, whereas specimens from the Vienna Basin are more similar to our Turkish specimens with scalate spires, a more horizontal subsutural platform bearing coarsely rugose sculpture and two strongly elevated cords at the periphery. This species is closely similar to the Recent Mediterranean species *G. fanulum* (Gmelin, 1791), but this species has a different shell profile, with deeper sutures and a more sloping subsutural platform bearing weaker rugae. In *G. catenularis* the upper peripheral cord is delimited adapically by a groove, whereas in *G. fanulum* this upper peripheral cord is not clearly delimited from the subsutural platform.

Distribution – **Early Miocene**: Iran, Qom Basin (Harzhauser *et al.*, 2002). **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1855; Schultz, 1998), Poland (Friedberg, 1928; Bałuk, 1975), Romania (Boettger, 1907), Hungary (Csepreghy-Meznerics, 1954; Strausz, 1962, 1966), Ukraine (Eichwald, 1830; Andrzejowski, 1830; Dubois de Montpéreux, 1831; Hilber, 1882; Zelinskaya *et al.*, 1968), Russia (Iljina, 1993), (Sarmatian, late Serravallian): Eisenstadt-Sopron Basin, Austria (Harzhauser & Kowalke, 2002); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Paroxystele Schultz, 1969

Type species – Trochus patulus Brocchi, 1814, by original designation. Late Miocene-Pliocene, Mediterranean.

Paroxystele orientale (Cossmann & Peyrot, 1917) Plate 1, fig. 8

- 1831 Trochus patulus Brocch. Dubois de Montpéreux,
 p. 39, pl. 2, figs 31-33 [non Paroxystele patulum (Brocchi, 1814)].
- 1853 Trochus patulus Brocch. Eichwald, p. 216, pl. 9, fig. 5 [non Paroxystele patulum (Brocchi, 1814)].
- 1855 Trochus patulus Brocc. Hörnes, p. 458, pl. 45, fig. 14 [non Paroxystele patulum (Brocchi, 1814)].
- 1912 Trochus (Oxystele) Amadei Brong. Schaffer, p. 171, pl. 54, figs 36-39 [non Paroxystele amadei (Brongniart, 1823)].
- *1917 Oxystele orientalis Cossmann & Peyrot, p. 102.

- 1918 Oxystele orientalis Cossm. et Peyr. Cossmann, p. 213, pl. 8, figs 9, 10.
- 1928 Oxystele orientalis Cossm. et Peyr. Friedberg, p. 516, pl. 33, figs 4-7.
- 1955 *Oxystele orientalis* Cossmann et Peyrot, 1831 [*sic*] – Moisescu, p. 116, pl. 10, figs 1, 2.
- 1955 *Oxystele orientalis* Cossmann et Peyrot Korobkov, p. 98, pl. 4, figs 16-18.
- 1958 Monodonta (Oxystele) rostellaris (Michelotti) Erünal-Erentöz, p. 7, pl. 1, figs 1, 2 [non Paroxystele rostellaris (Michelotti, 1838)].
- 1958 Monodonta (Oxystele) patula (Brocchi) Erünal-Erentöz, p. 8, pl. 1, figs 3, 4 [non Paroxystele patulum (Brocchi, 1814)].
- 1960 Oxystele orientalis Cossmann et Peyrot 1917 Kojumdgieva & Strachimirov, p. 87, pl. 29, fig. 1.
- 1961 Oxystele orientalis Cosm. & Peyr. Florei, p. 680, pl. 6, fig. 36.
- 1962 Oxystele patula orientalis Cossmann & Peyrot Strausz, p. 126, fig. 150a.
- 1966 Oxystele patula orientalis Cossmann & Peyrot, 1917 – Strausz, p. 40, fig. 24.
- 1968 Oxystele orientalis Cossmann & Peyrot, 1917 Zelinskaya et al., p. 105, pl. 28, figs 15, 16.
- 1968 *Diloma (Oxystele) orientalis* (Cossmann & Peyrot) Hinculov, p. 119, pl. 27, figs 1-5.
- 1969 Oxystele orientalis Cossmann & Peyrot Atanacković, p. 191, pl. 8, fig. 1.
- 1970 Oxystele orientalis Cossmann & Peyrot Bałuk, p. 117, pl. 8, fig. 7.
- 1971 *Oxystele orientalis* Cossmann & Peyrot Eremija, p. 65, pl. 6, fig. 9.
- 1972 Oxystele patula orientalis Cossmann et Peyrot 1917 – Nicorici, p. 138, pl. 14, fig. 3.
- 1975 *Diloma (Paroxystele) orientalis* Cossmann & Peyrot Bałuk, p. 32, pl. 6, fig. 9.
- 1978 Diloma (Paroxystele) orientalis orientalis (Cossmann-Peyrot, 1916) – Steininger et al., p. 329, pl. 1, figs 3, 4.
- 1978 Diloma (Paroxystele) orientalis galiziensis Steininger et al., p. 329, pl. 1, figs 5, 6.
- 1981 *Diloma (Paroxystele) orientale* (Cossmann et Peyrot, 1917) Švagrovský, p. 104, pl. 32, figs 5-7.
- 1981 Oxystele orientalis Cossmann-Peyrot 1917 Krach, p. 45, pl. 13, figs 3, 4.
- 1985 Diloma (Oxystele) orientalis (Cossmann & Peyrot, 1917) Atanacković, p. 75, pl. 17, fig. 8.
- 1998 Diloma (Paroxystele) orientalis orientalis (Cossmann & Peyrot) – Schultz, p. 54, pl. 20, fig. 4.
- 2003 Diloma orientalis (Cossmann & Peyrot) Mikuž, p. 308, pl. 10, fig. 21.
- 2009 Diloma (Paroxystele) orientalis (Cossmann & Peyrot, 1916 [sic]) Mikuž, p. 8, pl. 1, fig. 1.

Dimensions and material – Maximum diameter 24.0 mm. Locality 6: JvdV/5; localities 7 & 8: NHMW 1874/-0058/0937/1, 1874/0058/0938/8, JvdV/7, YI 58/4; locality 11: RGM 794 027/1; locality 13 MTA 2013/001/5, YI 59/4; locality 17: NHMW 1874/0058/0939/24, JvdV/5, MTA 2013/002/4, YI 59/4.

Discussion – European members of the genus *Paroxystele* Schultz, 1969 have traditionally been placed in this group as a subgenus of *Diloma* Philippi, 1845 (González Delgado, 1985; Cavallo & Repetto, 1992; Bałuk, 1975; Schultz, 1998). However, these European shells have a completely different shape from the recent species *Diloma nigerrima* (Gmelin, 1791), the type species of *Diloma*, which is more globose, less depressed, and without an umbilicus (Lozouet *et al.*, 2001a, p. 18).

The genus *Paroxystele* seems to have been present in the European faunas from the late Oligocene (Lozouet, 1986) to the early Pleistocene (Cerulli-Irelli, 1916). The Pliocene and Pleistocene forms were discussed by Landau *et al.* (2003).

Most Miocene forms differ from those in the Pliocene in having a completely closed umbilicus and only few specimens have subsutural folds, which are usually present in the Plio-Pleistocene *Paroxystele patulum* (Brocchi, 1814). Moreover, *P. patulum* has a depressed scalate spire and the spiral sculpture is finely beaded. *Paroxystele orientale* (Cossmann & Peyrot, 1917) is characterised by having a relatively high spire made up of almost flat-sided whorls, the whorls are only slightly scalate, the spiral sculpture is composed of 10-12 non-beaded spiral cords of alternating strength and the umbilicus is not completely closed by callus.

Several other species were present in the European Miocene. In the French early Miocene, the Aquitanian to Burdigalian species Paroxystele burdigalensis (Cossmann & Peyrot, 1917) has a more depressed shell, with well-developed secondary spiral sculpture and the axial growth lines are more pronounced giving a beaded appearance to the spiral cords. The French Atlantic middle Miocene Langhian species Paroxystele turoniensis Glibert, 1949 is also lower-spired, the base is less rounded, subcarinate, the number of spiral cords is less than in *P*. orientale, without secondary sculpture, and the umbilical callus is broader and more closely adherent. In the French Serravallian and Burdigalian-Langhian Tethian Colli Torinesi of Italy, the species Paroxystele granellosa (Sacco, 1896) is characterised by its very granular sculpture and by having an umbilicus not completely closed by callus. Both P. amadei (Brongniart, 1823) from the Burdigalian-Langhian Tethian Colli Torinesi of Italy and Burdigalian Paratethys, and P. rotellaris (Michelotti, 1838) from the Atlantic Serravallian of France and Tethyan Tortonian of Italy are quite different, with a thick and extensive umbilical callus.

Distribution – Early Miocene: Paratethys (Aquitanian): Vienna Basin, Austria (Schaffer, 1912). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1855; Steininger *et al.*, 1978; Schultz, 1998), Poland (Friedberg, 1928; Bałuk, 1970), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1962, 1966), Romania (Moisescu, 1955), Slovenia (Mikuž, 2009), Bosnia (Atanacković, 1985), Ukraine (Zelinskaya *et al.*, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Superfamily Turbinoidea Rafinesque, 1815 Family Turbinidae Rafinesque, 1815 Genus *Bolma* Risso, 1826

Type species – Turbo rugosus Linné, 1767, by monotypy. Pliocene to Recent, Europe, Mediterranean.

Note – Williams *et al.* (2008) redefined the families Trochidae and Turbinidae, which together with Solariellidae Powell, 1951, Calliostomatidae Thiele, 1924 and Liotiidae Gray, 1850 make up the superfamily Trochoidea.

Bolma meynardi (Michelotti, 1847)

Plate 1, figs 9-12

- *1847 *Turbo Meynardi* mihi, Michelotti, p. 177, pl. 7, fig. 4.
- 1855 Turbo rugosus Linn. Hörnes, p. 432, pl. 44, fig.2 [non Bolma rugosa (Linné, 1767)].
- 1896c Bolma Meynardi (Micht.) Sacco, p. 11, pl. 1, fig. 23.
- 1896c Bolma taurinensis Sacc., Sacco, p. 12, pl. 1, fig. 24.
- 1896c Bolma taurinensis ? var. pseudaffinis Sacc., Sacco, p. 12, pl. 1, fig. 25.
- 1896c Bolma taurinensis ? var. percarinata Sacc., Sacco, p. 12, pl. 1, fig. 26.
- 1903 Turbo (Bolma) rugosa Linné Dollfus et al., p. 6, pl. 31, fig. 2 [non Bolma rugosa (Linné, 1767)].
- 1917 *Bolma Meynardi* (Michelotti) Cossmann & Peyrot, no. 107, pl. 5, figs 55-60.
- 1928 Bolma Meynardi Micht. Friedberg, p. 469, pl. 29, fig. 11.
- 1936 Astraea (Bolma) meynardi Michelotti Bogsch, p. 68, pl. 2, figs 10, 11.
- 1938 *Turbo Meynardii* Michelotti Stchepinsky, p. 53, pl. 5, fig. 1.
- 1958 Astraea (Bolma) rugosa (Linné) Erünal-Erentöz,
 p. 10, pl. 1, figs 7, 8 [non Bolma rugosa (Linné, 1767)].
- 1962 *Turbo (Bolma) rugosus meynardi* Michelotti Strausz, p. 128, text-fig. 153.
- 1966 Turbo (Bolma) rugosus meynardi Michelotti, 1847
 Strausz, p. 42, text-fig. 26.
- 1968 Bolma meynardi (Michelotti, 1847) Zelinskaya et al., p. 103, pl. 28, figs 7, 8.
- 1975 Astraea (Bolma) meynardi (Michelotti, 1847) Bałuk, p. 43, pl. 6, figs 5-7.
- 1984 *Bolma taurinensis* var. *percarinata* Sacco, 1896 Ferrero Mortara *et al.*, 259, pl. 45, fig. 6.
- 1998 Astraea (Bolma) tuberculata (Serres) Schultz,

p. 54, pl. 20, fig.7.

- 2003 Astraea (Bolma) rugosa (Linne 1766) İslamoğlu & Taner, p. 33, pl. 1, fig. 3.
- 2006 Astraea (Bolma) meynardi (Michelotti, 1847) Bałuk, p. 183, pl. 3, fig. 5.

Dimensions and material – Maximum diameter 64.9 mm. Localities 2 & 3: JvdV/5, YI 63/2; locality 6: JvdV/1; localities 7 & 8: JvdV/5, RGM 783 872/1; locality 9: JvdV/1; locality 13: NHMW 1847/0058/1042/1 operculum, 1847/0058/1043/1, JvdV/3, RGM 783 629/8, YI 62/3, YI 65/3 operculae; locality 17: NHMW 1847/0058/1044-1847/0058/1046/18, 14 operculae, JvdV/50+, RGM 783 323-326/44, RGM 783 981/4 juveniles, MTA 2013/003/22, MTA 2013/004/22 operculae, YI 61/66, YI 64/35 operculae; locality 18: JvdV/23. Exact locality unknown: AÜ-LE-K-201/1.

Discussion – In the literature on fossils, Miocene populations of 'Bolma rugosa' have been fairly consistently considered to be a species or subspecies distinct from the Pliocene to Recent species Bolma rugosa (Linné, 1767), identified as Bolma meynardi (Michelotti, 1847). Cossmann & Peyrot (1917) considered B. meynardi to differ from B. rugosa in having less stepped early teleoconch whorls, in having less nodular rugae, the rugae extending to the sutures, in having the four basal cords more closely spaced with more prominent secondary cords in the interspaces, and in B. rugosa the basal callus is less extensive than in B. meynardi, but more excavated by a central depression, which ends as a double denticle at the columellar abapical extremity, not present in B. meynardi. As can be seen when comparing Miocene forms (Fig. 15/1; Pl. 1, figs 9-12) and Pliocene to Recent forms (Figure 15/2-7), the basal callus is clearly significantly larger in the Miocene forms than in the Recent shells, with the Pliocene forms somewhere in between, but larger than that seen in Recent shells. The spire is squatter in the Miocene forms than in the Recent forms, with Pliocene forms having both types of spire. The rugae are not present or are very weak in the Recent shells and are strongly developed in most Miocene and Pliocene forms. However, the most important character in our opinion is the position of the suture on the second half of the last whorl. In all Miocene forms the position of the suture, when viewed aperturally, is between the base and mid-whorl height, whereas in all the Pliocene and Recent shells the suture is at or below the base. We therefore agree with previous authors in considering the Miocene forms to be a distinct species, B. meynardi. The Pliocene and Recent forms, although somewhat different, cannot be separated consistently.

Figure 15. 1. Bolma meynardi (Michelotti, 1847), NHMW 2012/0197/0001, ex BL collection, Cacela Velha, Algarve, Portugal, Tortonian, late Miocene; maximum diameter 66.4 mm. 2. Bolma rugosa (Linné, 1767), NHMW 2012/0197/0002, ex BL collection, Millas, Rousillon, France, Zanclean, early Pliocene; maximum diameter 46.2 mm. 3. Bolma rugosa (Linné, 1767), NHMW 2012/0197/0003, ex BL collection, Millas, Rousillon, France, Zanclean, early Pliocene; maximum diameter 48.1 mm. 4-7. Bolma rugosa (Linné, 1767), Recent; 4. Vrsar, Istra, Croatia, collected in the harbour, 55 mm, 5. Costa Brava, Spain, 46 mm, 6. Vrsar, Istra, Croatia, collected in the harbour, 45 mm, 7. Vrsar, Istra, Croatia, collected in the harbour, 47 mm (photos courtesy Axel Alf).





Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896c). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1917); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1855; Schultz, 1998), Poland (Friedberg, 1928, 1954; Bogsch, 1936; Bałuk, 1975, 2006), Hungary (Strausz, 1962, 1966), Ukraine (Zelinskaya *et al.*, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal, (Dollfus *et al.*, 1903); Proto-Mediterranean Sea (Tortonian): Po valley, Italy (Sacco, 1896c), Tunisia (Stchepinsky, 1938), Turkey (early Tortonian): Antalya Basin (İslamoğlu & Taner, 2003).

Genus Ormastralium Sacco, 1896

Type species – Trochus carinatus Borson, 1821, by original designation. Miocene-Pliocene, Europe.

Note – Beu & Ponder (1979) synonymised *Ormastralium* Sacco, 1896 with *Bolma* Risso, 1826. Landau *et al.* (2003) considered that the characters of *Ormastralium*, which are turbiniform with a strong angular peripheral carina and a second carina around a depressed base, warranted subgeneric separation. The protoconch is similar to that seen in species of *Bolma*. Following the more restricted generic concept adopted here of phylogenetically related groups, we elevate *Ormastralium* to full genus rank.

Ormastralium carinatum (Borson, 1821)

Plate 2, fig. 1

- *1821 *Trochus carinatus* nob., Borson, p. 330, pl. 2, fig. 2.
- 1823 Trochus carinatus Borson Brongniart, p. 56, pl. 4, fig. 5.
- 1840 Trochus carinatus Borson Bellardi & Michelotti, p. 160, pl. 7, figs 10, 11.
- 1855 *Turbo carinatus* Bors. Hörnes, p. 435, pl. 44, fig.
 6.
- 1896c Ormastralium carinatum Bors. Sacco, p. 17, pl. 2, fig. 15.
- 1896c Ormastralium carinatum var. prohenica Sacc., Sacco, p. 18, pl. 2, fig. 16.
- 1896c Ormastralium carinatum var. scalarata Sacc., Sacco, p. 18, pl. 2, fig. 17.
- 1896c Ormastralium carinatum var. elatissima Sacc., Sacco, p. 18, pl. 2, fig. 18.
- 1896c Ormastralium carinatum var. intercincta Sacc., Sacco, p. 18, pl. 2, fig. 19.
- 1896c Ormastralium carinatum var. perrotunda Sacc., Sacco, p. 18, pl. 2, fig. 20.
- 1896c Ormastralium carinatum var. rotundornata Sacc., Sacco, p. 18, pl. 2, fig. 21.
- 1896c Ormastralium carinatum var. bolmoides Sacc., Sacco, p. 18, pl. 2, fig. 22.

- 1917 Bolma (Ormastralium) carinata (Borson) Cossmann & Peyrot, no. 110, pl. 6, figs 5- 8.
- 1928 *Bolma carinata* Bors. Friedberg, p. 468, pl. 29, fig. 10.
- 1936 Astraea (Bolma) carinata Borson Bogsch, p. 69, pl. 2, fig. 12.
- 1956 Astraea (Astralium) carinata Bors. Csepreghy-Meznerics, p. 431, pl. 1, fig. 15.
- Bolma (Ormastralium) carinata Borson 1821 Kojumdgieva & Strachimirov, p. 88, pl. 29, fig. 7.
- 1962 Turbo (Bolma) carinatus Borson Strausz, p. 128, pl. 53, figs 10-12.
- 1966 *Turbo (Bolma?) carinatus* Borson, 1821 Strausz, p. 44, pl. 53, figs 10-12.
- 1968 Bolma carinata (Borson, 1821) Zelinskaya et al., p. 102, pl. 28, figs 5, 6.
- ?1975 Astraea (Ormastralium) carinata (Borson, 1821)
 Bałuk, p. 45, pl. 6, fig. 1.
- 1976 Astraea (Ormastralium) carinata (Borson, 1821) – Pavia, p. 152, pl. 1, figs 1, 3.
- 2006 Astraea (Ormastralium) carinata (Borson, 1821) - Bałuk, p. 184, pl. 2, fig. 5.

Dimensions and material – Maximum diameter 40.6 mm. Locality 10: YI 66/1; locality 12: JvdV/6, RGM 783 601/2; locality 13: NHMW 1874/0058/0943/1, 1874/0058/0944/1, 1847/0058/1685/1, JvdV/7, RGM 794 558/1 (ex JvdV), RGM 783 628/3.

Discussion – Ormastralium carinatum (Borson, 1821) is a very distinctive species, with its relatively smooth sculpture compared with its congeners, and its lack of spines. Despite this, the shells can be quite variable as illustrated by the many forms decribed by Sacco (1896c). In the Karaman Basin *Bolma meynardi* (Michelotti, 1847) occurs almost exclusively in the sandy deposits, whereas *O. carinatum* has been found only in the clayey outcrops around Akpinar.

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi & Michelotti, 1840; Sacco, 1896c; Pavia, 1976). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1917); Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1855), Poland (Friedberg, 1928; Bogsch, 1936; Bałuk, 1975, 2006), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Csepreghy-Meznerics, 1956; Strausz, 1962, 1966), Ukraine (Zelinskaya *et al.*, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Colloniidae Cossmann, 1917 Genus *Homalopoma* Carpenter, 1864

Type species – Turbo sanguineus Linnaeus, 1758, by original designation. Recent, Mediterranean.

Dimensions and type material – Holotype RGM 784 071, height 2.1 mm, width 2.5 mm; paratype 1 RGM 784 072, height 1.8 mm, width 2.0 mm, both locality 6; paratype 2 NHMW 1847/0058/1716, width 1.5 mm, locality 17.

Other material - Known only from type material.

Etymology – Reflecting the type locality of Lale village.

Locus typicus – Locality 6, hill slopes in forest westnorthwest of Lale, Karaman Basin, Turkey.

Stratum typicum – Tirtar Formation, Serravallian, middle Miocene.

Diagnosis – An extremely small *Homalopoma* species, with spiral sculpture on the last whorl restricted to the adapical third and a well-developed umbilicus with a crenulated edge.

Description – Shell very small, solid, turbiniform. Protoconch paucispiral, consisting of one whorl. Teleoconch of 3.5 moderately depressed convex whorls, with periphery at abapical suture. Suture impressed, linear. Spiral sculpture on spire whorls consisting of five cords, adapical two cords somewhat beaded, cords weakening and widening towards the abapical suture. Last whorl inflated, slightly concave in the adapical portion, strongly convex below, bearing spiral cords on the adapical third, smooth below. Aperture subcircular. Peristome complete, thickened, especially abapically. Umbilicus moderately wide, bordered by crenulated edge.

Discussion - Traditionally this small shell would have been placed in the genus Cirsochilus Cossmann, 1888. However, it is very similar to Delphinula granulosa Grateloup, 1828 from the Atlantic early Oligocene to early Miocene of the Aquitaine Basin, France, which Lozouet (1986) and Lozouet et al. (2001a) placed in the genus Homalopoma Carpenter, 1864. Homalopoma laleensis nov. sp. differs from H. granulosa in being much smaller and in having spiral sculpture restricted to the infrasutural area on the last whorl, whereas in H. granulosa the last whorl has prominent spiral cords throughout. Homalopoma degrangei (Cossmann & Peyrot, 1917), also from the early Miocene Aquitaine Basin of France has a more depressed shell with a wider umbilicus than either of the two preceding species. It is also separated from H. laleensis in having spiral cords around the entire width of the last whorl.

In the middle Miocene Paratethian assemblages of Romania, *Collonia (Cirsochilus) globuliformis* Boettger, 1902 (see Zilch, 1934, pl. 4, fig. 57) is probably a junior subjective synonym of *H. granulosa*. *Homalopoma unica* (Boettger, 1907) (see Zilch, 1934, pl. 4, fig. 58) differs from all the above species in being completely smooth. A species similar to *H. granulosa* with strong spiral cords throughout, with the adapical cords beaded, identified as *Craspedotus globulus* (Doderlein, 1863), occurs in the late Miocene Tortonian Proto-Mediterranean of Italy. Unfortunately, the specimen illustrated by Sacco (1896c, pl. 1, fig. 15) is too poor to be certain of its generic position.

Distribution – **Middle Miocene:** Proto-Mediterranean Sea (Serravallian) Karaman Basin, Turkey (this paper).

Subfamily Skeneinae W. Clark, 1851 Genus Akritogyra Warén, 1992

Type species –Akritogyra curvilineata Warén, 1992, by original designation. Recent, northeastern Atlantic.

Akritogyra cf. *conspicua* (Monterosato, 1880) Plate 54, fig. 5

- ? 1875 Cyclostrema conspicuum Monterosato, p. 23 (nomen nudum).
- ? 1878a Cyclostrema conspicuum Monterosato, p. 20 (nomen nudum).
- ? *1880b Cyclostrema conspicuum Monterosato, p. 66.
- ? ?1975 ?Skenea tenuis Bałuk, p. 50, pl. 2, figs 1, 2.
- ? 1986 Cyclostrema valvatoides Jeffreys, 1883 Di Geronimo & Bellagamba, pl. 2, figs 1, 2 [non Skenea valvatoides (Jeffreys, 1883)].
- ? 1992 Akritogyra conspicua (Monterosato, 1880) Warén, p. 163, figs 14C-D, 15D-F.
- ? 1994 Akritogyra conspicua (Monterosato, 1880) Giannuzzi-Savelli et al., p. 104, fig. 345.

Dimensions and material – Maximum diameter 1.3 mm. Locality 17: NHMW 1847/0058/1142/1, RGM 794 596/2 (ex JvdV), RGM 783 933/11.

Discussion - This minute shell conforms well to the description and illustrations of Akritogyra conspicua (Monterosato, 1880) given by Warén (1992, p. 163, fig. 14C-D, 15D-F). Our photographs were seen by A. Warén, who commented "Your Akritogyra conspicua is probably not far off. It is actually more or less impossible to be sure with some of the smooth skeneimorphs, where they belong and which are different species, unless one has soft parts, and the family classification, unless one has DNA" (personal communication, 2013). On the other hand B. Marshall wrote in his review of the chapter; "Judging from the illustration of the protoconch Akritogyra conspicua is most definitely not a vetigastropod and nor is it conspecific with the species so identified recorded by Warén. The species illustrated here is almost certainly a tornid (review 2013)". We therefore ascribe it to Akritogyra cf. conspicua (Monterosato, 1880).

The Karaman shells are fractionally smaller than the average size given for the Recent shells (1.4 mm; Warén, 1992) and the protoconch is also slightly smaller at 200 μ m vs. 250 μ m in the Recent shell. The shell described by Bałuk (1975, pl. 2, figs 1, 2) as *?Skenea tenuis* is probably

conspecific, but without a SEM illustration it is not possible to be certain of the identification. *Akritogyra similis* (Jeffreys, 1883) from the Recent northeastern Atlantic is very similar, but larger-shelled and taller-spired. Two similar skeneimorph species, *Cyclostrema* (*Daronia*) *deflexum* and *C*. (*D.*) *bifilosum*, were described by Boettger (1907) from the middle Miocene of Romania. Both differ from *A. conspicua* in having two spiral cords on the base.

Distribution – **Middle Miocene**: ?Paratethys (Langhian-Serravallian): Poland (Bałuk, 1975); Proto-Mediterranean Sea (Serravallian) Karaman Basin, Turkey (this paper). **Recent**: central and western Mediterranean (Warén, 1992).

Family Calliostomatidae Thiele, 1924 Subfamily Calliostomatinae Thiele, 1924 Genus *Calliostoma* Swainson, 1840 Subgenus *Calliostoma s. str.*

Type species – Trochus zizyphinus Linnaeus, 1758, by monotypy. Pliocene-Recent, Europe.

Calliostoma miliare (Brocchi, 1814)

Plate 2, fig. 3

- *1814 *Trochus miliaris* Nob., Brocchi, p. 353, pl. 6, fig. 1.
- 1855 *Trochus miliaris* Brocc. Hörnes, p. 454, pl. 45, fig. 9.
- 2003 Calliostoma (Calliostoma) miliaris (Brocchi, 1814) Landau et al., p. 55, pl. 14, fig. 3 (with additional synonyms).
- 2004 *Clelandella miliaris* (Brocchi, 1814) Chirli, p. 54, pl. 19, figs 7-12.
- 2011 *Calliostoma (Calliostoma) miliaris* (Brocchi, 1814) Landau *et al.*, p. 10, pl. 2, fig. 3 (with additional synonyms).
- non 1916 Calliostoma (Strigosella) cf. miliare (Brocchi) Cossmann & Peyrot, p. 313, no. 97, pl. 5, figs 8-12 [= Calliostoma tauromiliare (Sacco, 1896)].

Dimensions and material – Maximum height 11.7 mm. Locality 17: RGM 794 559/1 (ex JvdV), RGM 783 923/11 fragments.

Discussion – Calliostoma miliare (Brocchi, 1814) is placed by many authors in the genus Clelandella Winkworth 1932, which is said to have characteristics in between those of Calliostoma Swainson, 1840 and Jujubinus Monterosato, 1884. In size, shape and ornament C. miliare is much closer to Calliostoma than Jujubinus. Until further review, we consider Clelandella a junior synonym of Calliostoma. Calliostoma tauromiliare (Sacco, 1896) is the most similar species, but has fewer and stronger beaded spiral cords, a more developed abapical cord and a carinate periphery. For further discussion see Landau et al. (2003, p. 56). Distribution - Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896c). Middle Miocene: Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1855); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (Glibert, 1962); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896c). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González-Delgado, 1985; Ruiz Muñoz, 2007; Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (Landau et al, 2003), France (Glibert, 1962a); central Mediterranean, Italy (Anfossi et al., 1983; Cavallo & Repetto, 1992; Chirli, 2004). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1896c; Glibert, 1962a; Caprotti, 1976). Pleistocene: western Mediterranean, Balearic Islands (Cuerda Barceló, 1987); central Mediterranean, Italy (Cerulli-Irelli, 1916), Sicily (Di Geronimo, 1975). Recent: northeastern Atlantic, Norway to northern coast of West Africa, Mediterranean, various types of bottom from 35-800 m depth (Poppe & Goto, 1991).

Family Phasianellidae Swainson, 1840 Subfamily Tricoliinae Woodring, 1928 Genus *Tricolia* Risso, 1826

Type species – Turbo pullus Linnaeus, 1758, by subsequent designation (Gray, 1847). Recent, Mediterranean.

Tricolia eichwaldi (Hörnes, 1855)

Plate 2, fig. 6; Plate 54, fig. 6

- *1855 *Phasianella Eichwaldi* Hörnes, p. 430, pl. 44, fig. 1.
- 1928 *Phasianella Eichwaldi* Hoern. Friedberg, p. 475, pl. 30, figs 1, 2.
- 1949 *Tricolia eichwaldi* Hörnes, 1856 Glibert, p. 79, pl. 4, fig. 15.
- 1954 Phasianella (Tricolia) eichwaldi Hörn. Strausz,
 p. 89, pl. 6, fig. 128.
- 1955 *Phasianella (Tricolia) eichwaldi* Hoern. Korobkov, pl. 8, figs 6, 7.
- 1962 Phasianella (Tricolia) eichwaldi Hörnes Strausz, p. 113, pl. 47, figs 4-8.
- 1966 Phasianella (Tricolia) eichwaldi Hörnes, 1856 Strausz, p. 46, pl. 47, figs 4-8.
- 1968 *Phasianella (T.) eichwaldi* Hoern. Stancu & Andreescu, p. 461, pl. 3, fig. 23.
- 1975 Tricolia (Tricolia) eichwaldi (Hörnes, 1856) Bałuk, p. 57, pl. 7, figs 1-4.
- 2000 *Tricolia (Tricolia) eichwaldi* (Hoernes, 1856) Popa & Ianoliu, p. 83, pl. 2, fig. 1.

Dimensions and material – Maximum height 5.3 mm. Locality 17: NHMW 1847/0058/1282/1, 1847/0058/1283/10, JvdV/50+, RGM 794 582/2 (ex JvdV), RGM 783 921/35, YI 210/5.

Discussion - Tricolia eichwaldi (Hörnes, 1855) is characterised by its small size, its relatively expanded last whorl, by the presence of a concave subsutural collar, and by having a colour pattern of oblique parallel lines or zig-zags, well-preserved in the Karaman material. The colour pattern is similar to that of the Pliocene to Recent European species Tricolia pullus (Linnaeus, 1758), but this species is larger, higher-spired, with a proportionally less expanded last whorl and a smaller aperture, and lacks the subsutural depression. The protoconch of the Turkish shells is multispiral, consisting of just over three whorls, with a small nucleus (dp = 930 μ m, dp1 = 180 μ m, dn = 80 μ m; Pl. 54, fig. 6). Two spiral threads extend around the periphery of the second protoconch whorl. Tricolia millepunctata (Benoist, 1873) found in the Atlantic middle Miocene Serravallian Aquitaine and Loire basins of France (Cossmann & Peyrot, 1916; Glibert, 1949) and in the Langhian-Serravallian Paratethys of Hungary (Csepreghy-Meznerics, 1954) differs from T. eichwaldi in lacking the concave subsutural collar and in having a colour pattern consisting of small dots.

Distribution – Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1855), Poland (Friedberg, 1928; Bałuk, 1975), Hungary (Strausz, 1954, 1962, 1966), Romania (Popa & Ianoliu, 2000); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subclass Neritimorpha Golikov & Starobogatov, 1975 Order Cycloneritimorpha Frýda, 1998 Superfamily Neritoidea Rafinesque, 1815 Family Neritidae Rafinesque, 1815 Subfamily Neritinae Rafinesque, 1815 Genus *Nerita* Linnaeus, 1758

Type species – Nerita peloritana Linnaeus, 1758, by subsequent designation (de Montfort, 1810). Recent, Caribbean.

Nerita asperata (Dujardin, 1837)

Plate 2, figs 7, 8

- *1837 *Nerita asperata* Duj., Dujardin, p. 280, pl. 19, figs 15, 16.
- 1856 Nerita asperata Duj. Hörnes, p. 532, pl. 47, fig.12.
- 1883 Nerita asperata Duj. Benoist, p. 387, pl. 15, figs12, 13.
- 1917 Nerita asperata Dujardin Cossmann & Peyrot,
 p. 249, no. 143, pl. 7, figs 83, 84, pl. 10, fig. 37.
- 1949 Nerita (Theliostyla) asperata Dujardin, 1837 Glibert, p. 81, pl. 4, fig. 10.
- 1998 Nerita (Theliostyla) asperata Dujardin Schultz, p. 54, pl. 20, fig. 10a-b.

Dimensions and material - Maximum height 12.1 mm.

Locality 11: JvdV/15, RGM 794 519/1, RGM 794 520/1, RGM 794 028/5; locality 17a: NHMW 1847/0058/1578/7.

Discussion - Nerita asperata (Dujardin, 1837) is documented especially from the Langhian and Serravallian of the northeastern Atlantic and the Paratethys. It possibly had its roots in the early Miocene, during which morphologically very closely similar specimens were found in the Burdigalian of the Iranian Qom Formation (MH pers. observation). Further occurrences in the Burdigalian of the proto-Mediterranean Sea were mentioned from the Colli Torinesi by Vai (1996) in an unpublished thesis. Both occurrences, however, will need detailed taxonomic analyses. Nerita asperata? var. pliotransiens was described by Sacco (1896b, p. 50, pl. 5, fig. 50) from the Burdigalian Colli Torinesi, Italy. Sacco considered it to be somewhat intermediate between N. asperata, Nerita plutonis (de Basterot, 1825) and Nerita funata (Dujardin, 1837). Unfortunately the figure is too poor to make any firm conclusions, and this name has been excluded from the synonymy. In the Karaman assemblages this species is found exclusively in the brackish deposits at locality 11 and the brackish levels at Seyithasan (locality 17a).

Distribution – Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Benoist, 1883; Cossmann & Peyrot, 1917), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian): Austria, (Hörnes, 1856; Schultz, 1998); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Theodoxus de Montfort, 1810

Type species – Theodoxus lutetianus de Montfort, 1810, by original designation. Recent, Palearctic.

Theodoxus grateloupianus (Férussac, 1823) Plate 2, figs 9, 10

- *1823 Neritina Grateloupiana Férussac in Férussac & Deshayes, pl. 2, fig. 13.
- 1840 Neritina Grateloupeana [sic] Férussac Grateloup, p. 19, pl. 7, figs 6-8, 10-12.
- 1845 Neritina Grateloupeana [sic] Fér. Grateloup, pl. 5, figs 6-8, 10-12.
- 1856 Neritina Grateloupeana [sic] Ferussac Hörnes, p. 533, pl. 49, fig. 13.
- 1883 Neritina grateloupeana [sic] Ferussac Benoist, p. 384, pl. 15, figs 5, 6.
- 1896b Tripaloia? grateloupana [sic] (Fèr) [sic] Sacco, p. 52, pl. 5, fig. 61.
- 1896b *Tripaloia? grateloupana* [sic] var. dertonensis Sacc., Sacco, p. 53, pl. 5, fig. 62.
- 1917 Neritina Grateloupiana Férussac Cossmann & Peyrot, p. 258, no. 147, pl. 8, figs 15-20.
- 1954 Neritina grateloupiana Fér. Strausz, p. 9, 81, 90, pl. 9, fig. 160.
- 1962 Neritina grateloupiana Férussac Strausz, p. 118,

pl. 49, figs 21, 22.

- 1966 Neritina grateloupiana Férussac, 1825 [sic] Strausz, p. 59, pl. 49, figs 21, 22.
- 1974 Theodoxus fluviatilis (Linné) Magne & Vergneau-Saubade, p. 10 [non Theodoxus fluviatilis (Linnaeus, 1758)].
- 2001a *Theodoxus grateloupianus* (Férussac, 1823) Lozouet *et al.*, p. 20, pl. 5, fig. 3.
- 2001 *Theodoxus? grateloupianus* (Férussac, 1821) [*sic*] – Harzhauser & Kowalke, p. 355, fig. 2.1-2.

Dimensions and material – Maximum diameter 16.0 mm. Locality 11: JvdV/50+, RGM 794 050/1 (ex JvdV), RGM 794 051/1 (ex JvdV), RGM 783 946/9, RGM 794 029/22; locality 17a NHMW 1847/0058/1576/14, YI 360/1; locality 18: JvdV/10.

Discussion - Theodoxus grateloupianus (Férussac, 1823) was synonymised with the Recent European species Theodoxus fluviatilis (Linnaeus, 1758) by Magne & Vergneau-Saubade (1974). However, Lozouet et al. (2001a) argued that the late Oligocene and early Miocene shells from France differed from the Recent species by their larger size and in having teeth on the columella, whereas the Recent species has a smooth columella. This species is found in the Karaman assemblages exclusively in the brackish deposits at locality 11 and the brackish levels at Seyithasan (locality 17a). The shells attain a large maximum size, like the French fossil forms. The columella of most specimens bears teeth (Pl. 2, fig. 10), although some specimens have a smooth columella (Pl. 2, fig. 9). We follow Lozouet et al. (2001a) and Harzhauser & Kowalke (2001) in considering the fossil form to be a species separate from T. fluviatilis.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian-Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1917; Magne & Vergneau-Saubade, 1974; Lozouet *et al.*, 2001a); Proto-Mediterranean Sea (Aquitanian): Greece (Harzhauser & Kowalke, 2001). Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Benoist, 1883; Cossmann & Peyrot, 1917); Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1856), Hungary (Hörnes, 1856; Strausz, 1954, 1962, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896b).

Genus Agapilia Harzhauser & Kowalke, 2001

Type species –Neritina picta Férussac, 1823, by original designation. Miocene Aquitanian, France.

Agapilia picta (Férussac, 1823)

Plate 2, figs 11-14; Plate 54, fig. 7

*1823 *Neritina picta* Férussac *in* Férussac & Deshayes, pl. 2, figs 4-7.

- 1830 Neritina anomala m., Eichwald, p. 218.
- 1830 Neritina picta m., Eichwald, p. 218.
- 1831 *Neritina picta* Fér. Dubois de Montpéreux, p. 45, pl. 3, figs 45, 46.
- 1840 *Neritina picta* Féruss. Grateloup, p. 21, pl. 7, figs 13-17.
- 1840 Neritina duchasteli Desh. Grateloup, p. 24 pl. 7, fig. 24.
- 1845 Neritina picta Féruss. Grateloup, pl. 5, figs 13-17, 44.
- 1845 Neritina duchasteli Desh. Grateloup, pl. 5, fig. 24.
- 1850 Neritina Ferussaci Récluz, Récluz., p. 154.
- 1852 Nerita picta Eichwald, pl. 10, fig. 40.
- 1852 Nerita subglobosa Eichwald, pl. 10, fig. 41.
- 1853 Nerita picta m. [sic] Eichwald, p. 251.
- 1853 Nerita subglobosa m. Eichwald, p. 252.
- 1856 Nerita picta Fér. Hörnes, p. 535, pl. 47, fig. 14.
- 1875 *Cerithium pictum* Bast. var. Hoernes, p. 67, pl. 2, figs 8, 9.
- 1883 Nerita ferussaci Récluz Benoist, p. 382, pl. 15, figs 3, 4.
- 1896b *Puperita picta* var. *taurinensis* Sacc., Sacco, p. 51, pl. 5, fig. 52.
- 1896b *Puperita picta* var. *perzonata* Sacc., Sacco, p. 51, pl. 5, fig. 53.
- 1896b *Puperita picta var. azonata* Sacc., Sacco, p. 51, pl. 5, fig. 54.
- 1912 Neritina picta Fér. Schaffer, p. 170, pl. 54, fig. 33.
- 1917 Neritina picta Ferussac Cossmann & Peyrot, no. 146, pl. 8, figs 4-14.
- 1928 Neritina picta Fer. Friedberg, p. 463, pl. 28, figs 14-20.
- 1952 *Clithon (Vittoclithon) pictus pictus* (Férussac) Papp, p. 107, pl. 1, figs 1, 2, 5-8, 15-28.
- 1952 Clithon (Vittoclithon) pictus nivosus (Brusina) Papp, p. 107, pl. 1, figs 17-20.
- 1954 *Clithon (Vittoclithon) pictus pictus* (Férussac) Papp, p. 21, pl. 5, figs 1-3.
- 1955 Clithon (Vittoclithon) pictus pictus (Férussac) –
 Švagrovský, p. 204, pl. 4, figs 1-8.
- 1955 Clithon (Vittoclithon) pictus nivosus (Brusina) –
 Švagrovský, p. 206, pl. 5, figs 7-12.
- 1955 Neritina (Theodoxus) picta Moisescu, p. 195, pl. 19, figs 5, 6.
- 1958 Clithon pictus pictus Fer. Jovanović, p. 125, pl. 5, figs 1, 3.
- 1960 Clithon (Vittoclithon) pictus (Fér.) Švagrovský,p. 56, pl. 4, figs 6, 7.
- 1962 Neritina picta Férussac Strausz, p. 117, text-fig.
 138a, pl. 49, figs 13-17.
- 1967 Clithon (Vittoclithon) pictus cf. pictus (Férussac, 1825) Tejkal et al., p. 191, pl. 9B, figs 1, 2.
- 1966 Neritina picta Férussac, 1825 [sic] Strausz, p. 58, fig. 33, pl. 49, figs 13-17.
- 1966 Theodoxus pictus (Fér.) Kókay, p. 32, pl. 1, figs 14-16.
- 1966 Theodoxus pictus nivosus (Bruss.) Kókay, p. 32, pl. 1, fig. 17.
- 1968 Neritina picta Ferussac, 1825 [sic] Zelinskaya et al., p. 99, pl. 27, figs 10, 11.
- 1968 Theodoxus (Vittoclithon) pictus pictus (Férussac) – Hinculov, p. 120, pl. 27, figs 8-11.
- 1968 Theodoxus (Vittoclithon) pictus nivosus (Brusina) – Hinculov, p. 121, pl. 27, figs 12-14.
- 1969 Nerita (Theodoxus) picta (Férussac) Atanacković, p. 190, pl. 7, fig. 11.
- 1969 Clithon (Vittoclithon) pictus pictus (Férussac, 1825 [sic]) – Kojumdgieva, p. 59, pl. 22, figs 1-4.
- 1970 Neritina picta Férussac, 1825 [sic] Bałuk, p. 141, pl. 8, figs 9-13.
- 1971 *Clithon (Vittoclithon) pictus pictus* (Férussac) Stancu *et al.*, p. 125, pl. 6, fig. 3.
- 1971 Clithon (Vittoclithon) pictus pictus (Férussac, 1825 [sic]) Steininger, p. 368, pl. 2, figs 9, 10, pl. 3, figs 3, 4.
- 1971 *Clithon pictus* (Férussac) Švagrovský, p. 222, pl. 28, figs 3-5.
- 1974 *Clithon (Vittoclithon) pictus pictus* (Férussac) Papp, p. 331, pl. 2, figs 9-12.
- 1973 *Clithon (Vittoclithon) pictus* (Férussac, 1823) Steininger, p. 387, pl. 1, fig. 8.
- 1975 Neritina picta Férussac, 1825 [sic] Bałuk, p. 59, pl. 7, figs 7-10.
- 2001a *Vitta picta* (Férussac, 1823) Lozouet *et al.*, p. 20, pl. 5, figs 6-9.
- 2001 Agapilia picta (Férussac, 1825 [sic]) comb. nov. Harzhauser & Kowalke, p. 356, fig. 2.5-10.
- 2003 Neritina picta (Férussac 1825 [sic]) İslamoğlu & Taner, p. 33, pl. 1, fig. 4.
- 2008 Agapilia picta (Férussac, 1825 [sic]) İslamoğlu, p. 273, fig. 6A-C.

Dimensions and material – Maximum diameter 9.5 mm. Localities 2 & 3: JvdV/5, YI 70/4; locality 6: JvdV/6; localities 7 & 8: NHMW 1874/0058/0951/11, JvdV/3; locality 11: JvdV/50+, RGM 794 030/50+; locality 17: NHMW 1874/0058/0947-1874/0058/0950/4, 1874/0058/0951/50+, JvdV/50+, RGM 776 846/1 (ex JvdV), RGM 783 959/50+, RGM 783 960/50+, MTA 2013/005/50+, YI 68/50+, YI 69/50+; locality 17a: NHMW 1847/0058/1581/11; locality 18: JvdV/50+.

Discussion - Récluz (1850) erroneously considered Neritina picta Sowerby, 1833 to be a junior homonym of Neritina picta Férussac, 1823 and proposed Neritina ferussaci as a replacement name (see also Benoist, 1883). Other authors, such as d'Orbigny (1852) and Sacco (1896b) introduced new species or variatal names for certain morphologies but correctly accepted N. picta Férussac as the valid name. Although this name has obvious priority, Eichwald (1830) introduced exactly the same name for the same species without referring to Férussac (1823). Possibly, he really was not aware of Férussac's paper, while working in Vilnius (Lithuania) and the case is a striking coincidence [comparable to the case of the secondary homonym Cerithium bicinctum Eichwald 1852; see discussion for Granulolabium bicinctum (Brocchi, 1814)].

resent chronostratigraphically distinct Paratethyan offshoots. The character of the protoconch of *Agapilia picta* was discussed by Harzhauser & Kowalke (2001). It is comprised of about three whorls with a maximum diameter of 420-440 μ m. The protoconch of the Turkish shell we photographed has a protoconch of 2.25 whorls and is somewhat smaller (dp = 240 μ m; Pl. 54, fig. 6). It is possible that *A. picta* is a species group rather than a single taxon.

Distribution - Oligocene: Paratethys: Germany (Barthelt, 1989); Austria (Steininger, 1971, 1973; Harzhauser & Mandic, 2001); Slovakia (Seneš, 1858); Hungary (Baldi, 1973). ? Western Tethys: Iran (Harzhauser 2004b), Turkey (İslamoğlu, 2008). Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1917; Lozouet et al., 2001a); Proto-Mediterranean Sea: Colli Torinesi, Italy (Sacco, 1896b); Greece (Harzhauser & Kowalke, 2001), Turkey (İslamoğlu & Taner, 2003); Paratethys: Austria (Schaffer, 1912). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1917); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Papp, 1952, 1954; Tejkal et al., 1967); Ukraine (Friedberg, 1928; Bałuk, 1970, 1975), Hungary (Strausz, 1962, 1966), Bulgaria (Kojumdgieva, 1969), Slovakia (Švagrovský, 1960), Bosnia (Atanackovič, 1985).

This species occurs in the Paratethys also in deposits of the Sarmatian stage (late Serravallian): Austria (Papp, 1954); Slovakia (Švagrovský, 1971); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Phenacolepadidae Pilsbry, 1895a Genus *Phenacolepas* Pilsbry, 1891

Type species – Scutella crenulata Broderip, 1834, by subsequent designation (Thiele, 1909). Recent, Indo-West Pacific Region.

Note – The use of *Phenacolepas* Pilsbry, 1891 and *Plesiothyreus* Cossmann, 1888 is inconsistent. Christiaens (1989) suggested that the two names are synonyms, *Plesiothyreus* having priority. Zuschin *et al.* (2009) accepted this opinion with some doubts for their Red Sea species. Whilst *Phenacopelas* was based on the extant species *Scutella crenulata* Broderip, 1834, *Plesiothyreus* was based on an Eocene species from the Paris Basin. We are not aware of any SEM studies of its type species *Plesiothyreus parmophoroides* (Cossmann, 1885), which is not available to us. According to Y. Kano (personal communication, 2013) it "has a posterior deck (like in

Septaria) with minute denticles on its anterior margin" whilst "a vast majority of phenacolepadids" ... "lack the deck as the type species *P. crenulata* does". The protoconch and early teleoconch of species discussed herein clearly represent the morphology of the extant *Phenacolepas* as illustrated by Sasaki (1998). Therefore, we propose to place the Miocene to Holocene species treated previously in the literature as *Plesiothyreus* in in the genus *Phenacolepas*.

Phenacolepas ancyliformis (Grateloup, 1828) Plate 2, fig. 15, Plate 54, fig. 8

*1828a Pileopsis ancyliformis Grateloup, p. 81.

- 1836 *Pileopsis ancyliformis* N. Grateloup, p. 38, pl. 1, figs 40-43.
- 1845 *Pileopsis ancyliformis* Grat. Grateloup, pl. 1, figs 40-43.
- 1895b *Hyalosiria benoisti* Cossmann, p. 4, pl. 3, figs 7-9.
 1919 *Plesiothyreus ancyliformis* (Grateloup) Coss-
- mann & Peyrot, p. 515, no. 295, pl. 14, figs 35-37.
- 2001a *Pleisothyreus ancyliformis* (Grateloup, 1828) Lozouet *et al.*, p. 20, pl. 5, fig. 2.

Dimensions and material – Maximum diameter 5.0 mm. Locality 17: RGM 783 573-783 575/3

Discussion – The material from Turkey is poorly preserved and very fragile. The largest specimen (Pl. 2, fig. 15) is similar in size to that illustrated by Lozouet *et al.* (2001a, pl. 5, fig. 2) and has similar fine radial sculpture and even finer commarginal ribs. The protoconch (Pl. 54, fig. 8) is smooth and sharply delimited from the teleoconch. It is very similar to the protoconch of the Recent West African species *Phenacolepas fischeri* (Rochebrune, 1881) illustrated by Rolán (2005, pl. 2, fig. 23) and an unnamed Recent *Phenacolepas* species illustrated by Sasaki (1998, p. 124, fig. 86a-d).

Few species of the family Phenacolepadidae have been described so far from the European Neogene: *Phenacolepas taurina* (Michelotti, 1847) from the early Miocene of Italy is a poorly described species, which is possibly a junior synonym of *P. ancyliformis. Phenacolepas sacyi* (Cossmann & Peyrot, 1919) from the early Miocene Aquitanian of France differs in having much coarser sculpture. The early Miocene Italian species *Phenacolepas parvolaevis* (Sacco, 1896) has a strongly reduced sculpture and the Pliocene Mediterranean species *Phenacolepas pliocenicus* (Chirli, 2004) has a very low shell and reduced sculpture.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1919; Lozouet *et al.*, 2001a); ?Proto-Mediterranean: Colli Torinesi (Sacco, 1896). Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Superorder Caenogastropoda Cox, 1960 Superfamily Cerithioidea Fleming, 1822 Family Melanopsidae H. Adams & A. Adams, 1854 Genus *Melanopsis* Férussac, 1807

Type species – Murex praerosa Linnaeus, 1758, by original designation. Recent, Palearctic.

Melanopsis impressa Krauss, 1852

Plate 3, figs 1, 2

- *1852 Melanopsis impressa Krauss, p. 143, pl. 3, fig. 3.
 1856 Melanopsis impressa Krauss Hörnes, p. 596, pl.
- 49, fig. 10.
 1886 Melanopsis impressa Krauss Fontannes, p. 330.
- 1886 Melanopsis impressa Krauss Fontannes, p. 330, pl. 26, fig. 7.
- 1887 Melanopsis impressa Krauss Handmann, p. 22, pl. 3, figs 3-5.
- 1895b Melanopsis (Lyrcaea) impressa var. Bonellii (Sismd.) – Sacco, p. 10, pl. 1, fig. 10.
- 1896 Melanopsis (Lyrcea [sic]) impressa Krauss Penecke, p. 45, pl. 2, figs 2, 3.
- 1897 Melanopsis impressa Krauss Hoernes, p. 62, pl. 2, figs 1-10.
- 1912 Melanopsis impressa var. monregalensis Scc. Schaffer, p. 158, pl. 52, figs 10, 11.
- 1919 Melanopsis (Lyrcaea) impressa Krauss Cossmann & Peyrot, p. 694, no. 401, pl. 16, figs 88, 89.
- 1953 Melanopsis impressa impressa Krauss Papp, p. 130, pl. 9, figs 1-4.
- Melanopsis impressa Krauss Strausz, p. 100, pl. 40, figs 7-11.
- 1966 Melanopsis impressa Krauss, 1852 Strausz, p. 126, pl. 40, figs 7-11.
- Melanopsis (Lyrcaea) impressa impressa Krauss,
 1852 Tejkal et al., p. 197, pl. 9B, figs 10, 11.
- 1970 Melanopsis impressa impressa Krauss Schlickum, p. 148, pl. 10, fig. 5.
- 1971 Melanopsis impressa impressa Krauss, 1852 Steininger, p. 377, pl. 3, fig. 9.
- 1972 *Melanopsis impressa* Krauss Csepreghy-Meznerics, p. 27, pl. 9, fig. 3.
- 1973 Melanopsis impressa impressa Krauss, 1852 Steininger, p. 404, pl. 4, figs 6, 7.
- 1998 Melanopsis impressa impressa Krauss Schultz, p. 54, pl. 20, fig 14.
- 2001 Melanopsis impressa Krauss, 1852 Harzhauser & Kowalke, p. 360, fig. 3.6-8.
- 2002 *Melanopsis impressa* Krauss, 1852 Harzhauser, p. 71, pl. 3, figs 1, 2.
- 2007 Melanopsis impressa Krauss, 1852 Mandic & Ćorić, p. 392, pl. 2, fig. 3.
- 2008 *Melanopsis impressa* Krauss, 1852 İslamoğlu, p. 273, fig. 6 I, J.

Dimensions and material – Maximum height 25.7 mm. Localities 2 & 3: JvdV/1; locality 11: JvdV/50+, RGM 794 049/1 (ex JvdV), RGM 794 076/1 (ex JvdV), RGM 794 039/30; locality 17: JvdV/1; locality 17a NHMW 1847/0058/1577/11, YI 358/3; locality 18: JvdV/7.

Discussion – Melanopsis impressa Krauss, 1852 is characterised by its shouldered last whorl and more or less clearly developed axial folds on the last whorl. It is widespread in the circum-Mediterranean area throughout the early to middle Miocene. It is among the few gastropods that persist after the Badenian/Sarmatian boundary in the Paratethys and is the founder species of a spectacular radiation in Lake Pannon during the late Miocene and Pliocene strata, however, are doubtful and might rather represent convergences. In the Karaman assemblages it is found almost exclusively in the brackish deposits at locality 11 and the brackish levels at Seyithasan (locality 17a).

Distribution – This species or closely related species appear already during the Oligocene of the Western Tethys and the Paratethys (Harzhauser, 2004a; Baldi, 1973, Islamoğlu, 2008). **Early Miocene**: Proto-Mediterranean Sea (Aquitanian): Greece (Harzhauser & Kowalke, 2001); Paratethys (Burdigalian): Austria (Schaffer, 1912; Steininger, 1971, 1973; Harzhauser, 2002; Mandic & Ćorić, 2007). **Middle Miocene**: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1922); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856; Hoernes, 1897; Tejkal *et al.*, 1967; Schultz, 1998), Hungary (Strausz, 1962, 1966; Csepreghy-Meznerics, 1972).

This species occurs in the Paratethys also in deposits of the Sarmatian stage (late Serravallian): Austria (Papp, 1953); Slovakia (Švagrovský, 1971); Romania (Fontannes, 1886; Jekelius, 1944); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1895b).

Melanopsis glandicula Sandberger, 1870

Plate 3, fig. 3

- *1870 *Melanopsis glandicula* Sandb., Sandberger, pl. 8, fig. 4.
- 1920 *Melanopsis glandicula* Sandberger de Morgan, p. 325, fig. 20.
- 1949 *Melanopsis glandicula* Sandberger, 1870 Glibert, p. 430, pl. 8, fig. 4.

Dimensions and material – Maximum height 26.1 mm. Locality 11: JvdV/9, RGM 794 071/1 (ex JvdV), RGM 783 944/50+; locality 17: JvdV/1; locality 17a NHMW 1847/0058/1575/50+, YI 359/6; locality 18: JvdV/50+.

Discussion –The shells identified here as *Melanopsis* glandicula Sandberger, 1870 are very similar to those illustrated by de Morgan (1920) and Glibert (1949) from the Atlantic Langhian of the Loire Basin of France. The specimen illustrated here is complete with the outer lip extending beyond the siphonal canal, which gives it a

somewhat different profile to that illustrated by Glibert (1949, pl. 8, fig. 4), but most of the Turkish shells also have the outer lip damaged, making them more similar to the French illustration. In the Karaman assemblages it is found almost exclusively in the brackish deposits at locality 11 and the brackish levels at Seyithasan (locality 17a).

Distribution – **Middle Miocene**: northeastern Atlantic (Langhian): Loire Basin, France (de Morgan, 1920; Glibert, 1949); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Thiaridae Gill, 1871 Genus *Holandriana* Bourguignat, 1884

Type species – Melania holandrii Pfeiffer, 1828. Recent, Europe.

Holandriana patula (Bellardi & Michelotti, 1840) Plate 3, fig. 4

- [1827] *Melania patula* Bon. Bonelli, no. 2663 (unpublished).
- *1840 Melania patula Bon. Bellardi & Michelotti, p. 163, pl. 7, figs 8, 9.
- 1847 *Melania patula* Bonelli Michelotti, p. 188, pl. 6, fig. 14.
- 1895b Balanocochlis patula (Bon.) Sacco, p. 6, pl. 1, fig. 8.
- ?1895b Balanocochlis patula var. taurostriata Sacc., Sacco, p. 6, pl. 1, fig. 8.
- 1969b *Melania (Balanocochlis) incerta* Csepreghy-Meznerics, p. 70, pl. 1, figs 17, 18.

Dimensions and material – Maximum height 23.9 mm. Locality 11: JvdV/15, RGM 794 075/1 (ex JvdV), RGM 783 945/28, RGM 794 037/4; locality 17a NHMW 1847/0058/1574/22, YI 357/4; locality 18: JvdV/8.

Discussion – The middle Miocene Paratethyan species *Holandriana pecchiolii* (Hörnes, 1856) (spelled *pechiolii [sic]* in Hörnes, 1856, pl. 49) and the early Miocene Burdigalian species *Holandriana propatula* (Sacco, 1895) from the Proto-Mediterranean of Italy differ from *H. patula* in their shell shape. Both these species (which are possibly synonymous) have more fusiform shells, their spire whorls are less convex and the outer lip joins the last whorl at a rather acute angle, and is somewhat depressed adapically, whereas the outer lip in *Holandriana patula* (Bellardi & Michelotti, 1840) is more evenly rounded. In the Karaman assemblages it is found almost exclusively in the brackish deposits at locality 11 and the brackish levels at Seyithasan (locality 17a).

Distribution – **Early Miocene**: ?Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1895b). **Middle Miocene**: Paratethys (Langhian-Serravallian): Hungary (Csepreghy-Meznerics, 1969); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1895b).

Family Cerithiidae Fleming, 1822 Genus *Thericium* Monterosato, 1890

Type species – Cerithium vulgatum Bruguiere, 1792, by original designation. Recent, Europe.

Notes – Most workers have placed the Recent Atlantic and Mediterranean species of Cerithium in the subgenus Thericium Monterosato, 1890 (Cerulli-Irelli, 1912; Woodring, 1928; Malatesta, 1974; Houbrick, 1974; Pavia, 1975; Silva, 2001). However, this separation is not universally accepted and some authors consider the two synonymous (Strauz, 1966; Cavallo & Repetto, 1992; Giannuzzi-Savelli et al., 1997). The position taken by Cecalupo (2005, p. 12) in his revision of the family Cerithiidae is confusing, as he seems to recognise as valid both the subgenera Thericium Monterosato, 1890 and Vulgocerithium Cossmann, 1906, with Cerithium vulgatum Brugière, 1792 as the type species for both. True Cerithium (s. str.) species are Indo-Pacific taxa, characterised by a flaring outer lip, with a tooth-like extension projecting abapically over the anterior siphonal canal and a relatively longer siphonal canal. We therefore agree with Houbrick (1974, p. 39) in separating the Atlantic and Mediterranean forms from the larger Indo-Pacific species, and elevate Thericium to full generic rank, Thericium having priority over Vulgocerithium.

Thericium ataturki nov. sp.

Plate 3, figs 5, 6; Plate 54, fig. 9

2004 *Cerithium (Ptychocerithium) turritoplicatum* Sacco 1895 – İslamoğlu, p. 147, pl. 1, fig. 13 (*non* Sacco, 1895a).

Dimensions and material – Holotype NHMW 1874/-0058/0956, height 11.1 mm; paratype 1 RGM 783 934, height 12.7 mm; paratype 2 RGM 783 963, height 8.2 mm; paratype 3 NHMW 1874/0058/0957, height 12.2 mm; paratype 4 NHMW 1874/0058/0958, height 11.4 mm; paratype 5 RGM 784 076 (incomplete); paratype 6 RGM 784 098, height 13.1 mm; furthermore one specimen in YI 467, height 12.0 mm; all from the type locality.

Additional material— Maximum height 17.8 mm. Locality 13: YI 71/1; locality 17: NHMW 1874/0058/0959/11, RGM 783 977/10 fragments, YI 72/6.

Etymology- Named after president Mustafa Kemal Atatürk, founder of the Republic of Turkey.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene. *Diagnosis* – A small *Thericium* species, with evenly rounded whorls, nine axial ribs per whorl, of which 2-3 are varicose, the rest rather flattened, spiral sculpture very weak, except for two cords towards the base on the last whorl, and a rather small aperture.

Description – Shell small, cerithiiform. Protoconch poorly preserved. Teleoconch of about ten evenly convex whorls, with periphery just below mid-whorl. Suture superficial, linear. Axial sculpture of nine weakly elevated, slightly opisthocline ribs, subobsolete near the sutures, 2-3 ribs per whorl varicose. Spiral sculpture of very weak, narrow, irregular cords. Last whorl 42% of total height, convex, strongly constricted at the base, two spiral cords become more prominent on lower half of whorl, abapical cord delimiting base. Aperture small, 26% of total height, ovate, outer lip flared, labial varix weak, anal notch narrow, siphonal canal short, open. Columella regularly excavate, columellar callus narrow.

Discussion - This species differs from Cerithium distinctissimum Eichwald, 1853, from the middle Miocene of the Polish-Carpathian Foredeep, in its broader and more convex last whorl [see Eichwald (1852, pl. 7, fig. 19) and Friedberg (1914, pl. 16, fig. 10; non fig. 11)]. Its spire whorl profile displays a marked convexity close to the lower suture and a flat to slightly concave adsuturual anterior part of the whorls, resulting in a somewhat teardrop-shaped outline. In contrast, Cerithium distinctissimum develops weakly convex whorls with near-subparallel flanks and has broader axial ribs. The middle Miocene Paratethyan species Cerithium bronniforme Hilber, 1882 is based on few poorly preserved shells and it is doubtful whether Hilber's two illustrated specimens are conspecific. Both develop prominent axial sculpture and very strong spiral threads and lack the convexity around the lower suture of the Turkish shells.

Cerithium (Ptychocerithium) turritoplicatum Sacco 1895 differs from *T. ataturki* sp. nov. in having a more slender shell, with stronger spiral sculpture and in lacking the very prominent varices, expecially on the last whorl, placed at 180° to the aperture (see Sacco, 1895a, pl. 2, fig. 47; Ferrero Mortara *et al.*, 1984, pl. 35, fig. 4).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Langhian): Kasaba Basin, Turkey (İslamoğlu, 2004), (Serravallian): Karaman Basin, Turkey (this paper).

Thericium miocenicum (Vignal, 1911) Plate 3, fig.7

- *1911 Cerithium (Thericium) vulgatum Bruguière var. miocenica Vignal, p. 141, pl. 7, fig. 2.
- 1922 Cerithium (Vulgocerithium) vulgatum mut. miocaenicum [sic] Vignal – Cossmann & Peyrot, p. 188, no. 550, pl. 5, figs 33, 34.
- 1949 Cerithium (Vulgocerithium) vulgatum miocaenicum [sic] Vignal, 1910 – Glibert, p. 147, pl. 9, fig.
 12.

- 1958 Cerithium (Vulgocerithium) vulgatum var. miocenicum Vignal – Erünal-Erentöz, p. 30, pl. 3, figs 10, 11.
- 2003 Cerithium (Thericium) vulgatum miocenicum Vignal, 1910 – İslamoğlu & Taner, p. 44, pl. 2, fig. 12.

Dimensions and material – Maximum height 36.2 mm. Localities 7 & 8: JvdV/2; locality 11: JvdV/23; RGM 794 031/13; locality 13: YI 78/1; locality 17: NHMW 1874/0058/0960/1, 1874/0058/0961/34, JvdV/50+, RGM 783 737/8, MTA 2013/006/13, YI 73/36; locality 17a: NHMW 1847/0058/1586/9, YI 73/50+.

Discussion – Thericium miocenicum (Vignal, 1911) belongs to the *T. vulgatum* species group, differing from the Recent species in being smaller and in having less prominent tubercles and, most importantly, coarser spiral sculpture.

Bałuk (1975) considered this species to be a synonym of *Thericium europaeum* (Mayer, 1878). This decision cannot be followed as the stout species *Thericium europaeum* is characterised by an adsutural collar of granules, which are posteriorly swollen and fade out towards the middle of the whorls. These nodes may become very densely spaced, in which cases the collar appears as a band of axial furrows. This character is also developed, in a much less prominent way, in some specimens of *Thericium miospinosum* (Sacco, 1895) but is absent in *Thericium miocenicum*.

Thericium miocenicum is superficially similar to Thericium procrenatum (Sacco, 1895). This Burdigalian species is also slender and its early whorls are comparably convex. On later spire whorls it develops a posterior adsutural row of beads that is accompanied by a narrow concavity below, bearing spiral threads. The middle Miocene shells of Thericium procrenatum from the Paratethys differ even more strongly in their barrel-like outline of the whorls, the weaker sutures and their sculpture, which comprises several spiral rows of beads and squatty nodes, whilst the axial sculpture is subordinate (e.g. Hörnes, 1855; Sieber 1936/37; Atanackovíc, 1985). Already Sacco (1895a) recognised that the Paratethyan specimens illustrated by Hörnes (1855) might not fully correspond to his species Cerithium procrenatum and proposed the variatal names grundensis and pötzleinsdorfensis for the two Viennese shells. Therefore, we suggest treating the middle Miocene species as Thericium grundensis (Sacco, 1895).

Distribution – The distribution of this species is probably underestimated as it might have been identified frequently as *Thericium europaeum* (Mayer, 1878), *Thericium miospinosum* (Sacco, 1895) or as *Thericium vulgatum* (Bruguière, 1792). **Early Miocene**: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1922); Proto-Mediterranean (late Burdigalian): Antalya Basin, Turkey (İslamoğlu & Taner, 2003). **Middle Miocene**: northeastern Atlantic (Langhian) Aquitaine Basin, France (Cossmann & Peyrot, 1922); Loire Basin (Glibert, 1949); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Thericium miospinosum (Sacco, 1895) Plate 3, fig. 8

- 1837 Cerithium Zeuschneri m. V. adulta Pusch, p. 148 (partim, pl. 12, fig. 14 only) (non Cerithium zeuschneri Pusch 1837).
- 1855 Cerithium vulgatum Brug. var. Hörnes, p. 386, pl. 41, figs 1-4 [non Thericium vulgatum (Bruguière, 1792)].
- *1895a Cerithium vulgatum var. miospinosa Sacc., Sacco, p. 9.
- 1914 Cerithium vulgatum Brug. Friedberg, p. 253, pl.
 16, figs 1, 2 [non Thericium vulgatum (Bruguière, 1792)].
- 1914 *Cerithium vulgatum* var. *miospina* [*sic*] Sacco Friedberg, p. 254, pl. 16, fig. 2.
- 1936/37 Cerithium (Vulgocerithium) vulgatum var. miospina [sic] Sacco – Sieber, p. 495.
 - 1975 Cerithium (Thericium) vulgatum miospinosum Sacco, 1895 – Bałuk, p. 143, pl. 17, figs 13-16.
 - 1985 Cerithium (Thericium) vulgatum Bruguière, 1792
 Atanacković, p. 108, pl. 26, figs 4, 5 [non Thericium vulgatum (Bruguière, 1792)].
 - 1993 *Cerithium (Thericium) vulgatum* Bruguière, 1789 [*sic*] – Iljina, p. 78 (*partim*, pl. 10, fig. 1 only) [*non Thericium vulgatum* (Bruguière, 1792)].
 - 1998 Cerithium (Thericium) vulgatum miospinosum Sacco – Schultz, p. 58, pl. 22, fig. 4.
 - 2005 Cerithium vulgatum var. miospinosa Sacco, 1895
 Cecalupo, p. 144, pl. 35, figs 15, 16, pl. 37, fig. 7.

Dimensions and material – Maximum height 83.4 mm. Localities 2 & 3: JvdV/1, YI 74/1; locality 6: JvdV/2; localities 7 & 8: JvdV/3; locality 13: NHMW 1874/0058/097/1, JvdV/2; locality 17: NHMW 1874/0058/0962-1874/-0058/0969/8, 1874/0058/1641-1874/0058/1642/2, JvdV/29, RGM 783 808/8, MTA 2013/007/10, YI 75/14.

Discussion – Sacco (1895a) mentioned this species from the Tortonian of Stazzano in Italy and from various Pliocene localities in Italy without providing a description or illustration. When proposing the new name he referred to the specimens illustrated by Hörnes (1855) from Steinabrunn in the Vienna Basin. These are of late Langhian or early Serravallian age, and are considered herein as syntypes of *Cerithium miospinosum* Sacco 1895 (in Natural History Museum Vienna, NHMW 1846/0037/0354).

This species co-occurs with the much more widespread species *Cerithium europaeum* (Mayer, 1878), which is considerably smaller in size and has a narrower apical angle. The comparatively low diameter of the latest teleoconch whorls of *Thericium europaeum* results in a slightly elongate-ovoid outline, whilst *T. miospinosum* is broadly conical with a wide aperture.

In the Central Paratethys, Thericium miospinosum is a

moderately common species during the Langhian and early Serravallian. It is documented from the Pannonian basins complex and the Polish-Carpathian Foredeep. Iljina (1993) described it also from the Eastern Paratethys where it occurred during the Konkian (Serravallian) in the modern Ustyurt Plateau area. It is unclear whether the late Miocene and Pliocene shells from Italy, mentioned by Sacco (1895a) are conspecific, and as we have seen no further records of this species in Italy, it is excluded from the distribution data.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1855; Schultz, 1998), Poland (Friedberg, 1914; Bałuk, 1975, 2006), Bosnia (Atanackovíc, 1985), Romania (Tiţã, 2007); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Thericium longiuscatum (Sacco, 1895)

Plate 3, fig. 9

- 1855 Cerithium doliolum Brocc. Var. Hörnes, p. 392, pl. 41, figs 12, 13 only (non Murex doliolum Brocchi, 1814).
- *1895 Pithocerithium turonicum var. longiuscata Sacc., Sacco, p. 29.
- 1895 Pithocerithium turonicum var. dolioloconica Sacc., Sacco, p. 29.
- 1914 Cerithium exdoliolum Sacco Friedberg, p. 265, pl. 16, fig. 14. (non Pithocerithium turonicum var. exdoliolum Sacco, 1895).
- 1936/37 Cerithium (Pithocerithium) turonicum Mayer Sieber, p. 500, pl. 25, fig. E2 [non Thericium turonicum (Mayer, 1878)].
 - 1950 Cerithium (Vulgocerithium) exdoliolum Sacco
 Csepreghy-Meznerics, p. 31, pl. 2, fig. 4. (non Pithocerithium turonicum var. exdoliolum Sacco, 1895).
 - 1960 Cerithium (Vulgocerithium) exdoliolum Sacco 1895 – Kojumdgieva & Strachimirov, p. 106, pl. 31, fig. 8. (non Pithocerithium turonicum var. exdoliolum Sacco, 1895).
 - 1966 *Cerithium exdoliolum* Sacco 1895 Strausz, p. 131, pl. 9, figs 27, 28, pl. 10, fig. 2.
 - 1968 Cerithium (Thericium) turonicum Mayer Hinkulov, p. 132, pl. 31, figs 9-11 [non Thericium turonicum (Mayer, 1878)].
 - 1975 Cerithium (Thericium) turonicum Mayer, 1878 Bałuk, p. 148, pl. 17, figs 11, 12 only [non Thericium turonicum (Mayer, 1878)].

Dimensions and material – Height 15.5 mm. Locality 17: NHMW 1874/0058/1503/1, YI 365/2.

Discussion – The status of this species is quite obscure. Hörnes (1855) illustrated three shells as *Cerithium doliolum* (Brocchi, 1814) but considered two of them (Hörnes, 1855, figs 12, 13) to be varieties. His fig. 11 shows a specimen from Kleinebersdorf in Lower Austria of Burdigalian age whilst the two others are of Badenian age (fig. 12: Steinabrunn in Austria, fig 13: Mikulov in Czech Republic. Soon after, Mayer (1878) recognised that this identification is incorrect and considered Hörnes's figs 11 and 13 to be synonyms of Mayer's species Cerithium turonicum. Indeed, fig. 11 of Hörnes (1855) seems to be conspecific with Thericium turonicum (Mayer, 1878). For the same specimen, Sacco (1895) proposed the new varietal name exdoliolum and introduced the names longiuscata and dolioloconica for Hörnes's figs 12 and 13. The differences also induced Mathias Auinger, curator at the Natural History Museum in Vienna, to separate the two shells and to label them as Cerithium Zaliscense. This manuscript name was reported by Friedberg (1914), who preferred to use the name C. exdoliolum for this Badenian species. Later, Friedberg (1928) described Cerithium zalescense based on Sarmatian shells from Ukraine (correctly), without including the older shells from Steinabrunn and Mikulov.

Since then, the Badenian Paratethyan species was either treated as *C. turonicum* or as *C. exdoliolum*, both of which do not apply to this species in our opinion. As first revisers, we select *Thericium longiuscatum* (Sacco, 1895) as the name for this variable and widespread species and select the specimen from Steinabrunn in Austria (NHMW 1999/0098/0008) as the holotype. Consequently, the specimen in Hörnes (1855, fig. 11) is chosen as the holotype of *Thericium exdoliolum* (Sacco, 1895) (NHMW 1999/0098/0007). We note that Sieber (1936/37) also introduced *Cerithium (Pithocerithium) doliolum* Brocc. var. *imperfecta* as a name for this species.

Although it is very variable in its sculpture – in particular the nodes along the upper suture may range from nearly quadratic to round – *T. longiuscata* is separated from *Thericium turonicum* (Mayer, 1878), as illustrated by Mayer (1878) and Glibert (1949), which has a wider aperture, a more ovoid shape and a shorter base. We exclude shells described as *Cerithium exdoliolum* by Friedberg (1928, pl. 38, fig. 10) and Bałuk (1975, pl. 17, figs 9, 10) from the synonymy of *Thericium longiuscata* as they differ considerably in sculpture and shape and possibly are really conspecific with *Thericium exdoliolum* (Sacco, 1895).

The endemic Sarmatian species *Thericium rubiginosum* (Eichwald, 1830) is superficially similar to *T. longiusca-tum*, but differs especially in the numerous spiral threads between the rows of nodes.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1855), Poland (Bałuk, 1975), Ukraine (Friedberg, 1914); Hungary (Strausz, 1966), Romania (Csepreghy-Meznerics, 1950); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Thericium vulgatum (Bruguière, 1792) Plate 3, fig. 10

*1792 Cerithium vulgatum Nob., Bruguière, p. 481.

- 1895a *Cerithium vulgatum* var. *pergranulosa* Sacc., Sacco, p. 7, pl. 1, fig. 15.
- 1895a *Cerithium vulgatum* var. *pauciornata* Sacc., Sacco, p. 7, pl. 1, fig. 16.
- 1895a *Cerithium vulgatum* var. *spinosissima* Sacc., Sacco, p. 8, pl. 1, fig. 17.
- 1895a *Cerithium vulgatum* var. *totospinosa* Sacc., Sacco, p. 8, pl. 1, fig. 18.
- 1895a Cerithium vulgatum var. pseudoterebella Sacc., Sacco, p. 9, pl. 1, fig. 22.
- 1895a Cerithium vulgatum var. depressiornata Sacc., Sacco, p. 9, pl. 1, fig. 23.
- 1895a Cerithium vulgatum var. dertomutica Sacc., Sacco, p. 9, pl. 1, fig. 24.
- 1895a *Cerithium vulgatum* var. *pertorquata* Sacc., Sacco, p. 9, pl. 1, fig. 25.
- 1895a Cerithium vulgatum var. granosoligustica Sacc., Sacco, p. 10, pl. 1, fig. 26.
- 1895a *Cerithium vulgatum* var. *pergranosa* Sacc., Sacco, p. 10, pl. 1, fig. 27.
- 1895a *Cerithium vulgatum* var. *crassecingulata* Sacc., Sacco, p. 10, pl. 1, fig. 28.
- 1895a *Cerithium vulgatum* var. *subsimplex* Sacc., Sacco, p. 10, pl. 1, fig. 29.
- 1895a *Cerithium vulgatum* var. *persimplex* Sacc., Sacco, p. 10, pl. 1, fig. 30.
- 1895a Cerithium vulgatum var. dertopulchella Sacc., Sacco, p. 11, pl. 1, fig. 31.
- 1895a *Cerithium vulgatum* var. *dertornatulina* Sacc., Sacco, p. 11, pl. 1, fig. 32.
- 1895a *Cerithium vulgatum* var. *ventrosonana* Sacc., Sacco, p. 11, pl. 1, fig. 34.
- 1906 Vulgocerithium vulgatum Brug. Cossmann, p. 77, pl. 3, figs 13, 14.
- 1912 *Cerithium (Thericium) vulgatum* Brug. Cerulli-Irelli, p. 141, pl. 23, figs 1-7.
- 1938 Cerithium vulgatum Bruguière Stchepinsky, p. 65, pl. 7, fig. 2.
- 1960 *Thericium (Thericium) vulgatum* (Bruguière, 1792) Malatesta, p. 94, pl. 4, fig. 12.
- 1965 Cerithium (Thericium) vulgatum (Brug.) Ruggieri & Greco, p. 53, pl. 3, fig. 1.
- 1967 *Cerithium (Thericium) vulgatum* Bruguière, 1792 – Palla, p. 951, pl. 71, fig. 7.
- 1974 *Thericium (Thericium) vulgatum* (Bruguière, 1792) Malatesta, p. 205, pl. 15, fig. 6.
- 1975 *Cerithium (Vulgocerithium) vulgatum* var. *pergranulosa* Sacco – Fekih, p. 104, pl. 31, fig. 21.
- 1975 Cerithium (Vulgocerithium) vulgatum var. pauciornata Sacco – Fekih, p. 104, pl. 32, fig. 2.
- 1975 Cerithium (Vulgocerithium) vulgatum var. taurominor Sacco – Fekih, p. 104, pl. 31, fig. 19.
- 1975 Cerithium (Vulgocerithium) vulgatum var. granosoligustica Sacco – Fekih, p. 104, pl. 32, fig. 3.
- 1979 *Cerithium (Thericium) vulgatum* (Bruguière, 1792) Martinell, p. 99, pl. 1, figs 9, 10.
- 1984a *Cerithium (Thericium) vulgatum* Bruguière Martinell & Domènech, p. 7, pl. 1, fig. 5.

- 1987 *Thericium (Thericium) vulgatum* (Bruguière 1792) Cuerda Barceló, p. 230, pl. 18, fig. 14.
- 1988 Cerithium vulgatum (Bruguière, 1792) Chirli, p. 16, pl. 1, fig. 10.
- 1988 *Cerithium (Thericium) vulgatum* (Brug.) Brambilla *et al.*, pl. 7, fig. 3.
- 1991 Cerithium vulgatum (Bruguière, 1792) Poppe & Goto, p. 111, pl. 15, figs 4-7.
- 1992 *Cerithium vulgatum* Bruguière, 1792 Cavallo & Repetto, p. 56, fig. 053.
- 1997 *Cerithium vulgatum* Bruguière, 1792 Giannuzzi-Savelli *et al.*, p. 28, figs 12-48.
- 1998 Cerithium vulgatum Bruguière, 1792 Solsona, p. 63, pl. 2, figs 1-5.
- 2004a *Cerithium (Thericium) vulgatum* Bruguière, 1792 – Landau *et al.*, p. 8, pl. 1, figs 10, 11, ?12.
- 2006 *Cerithium vulgatum* (Bruguière, 1792) Chirli, p. 87, pl. 35, figs 7-15.
- 2008 *Cerithium vulgatum* Bruguière, 1792 Chirli & Richard, p. 19, pl. 2, fig. 6.
- 2010 *Cerithium vulgatum* Bruguière, 1792 Sosso & dell'Angelo, p. 20, unnumbered fig. p. 31 second row centre.
- non 1855 Cerithium vulgatum Brug. var. Hörnes, p. 386, pl. 41, figs 1-4 [= Thericium miospinosum (Sacco, 1895)].
- non 1914 Cerithium vulgatum Brug. Friedberg, p. 253, pl. 16, figs 1, 2 [= Thericium miospinosum (Sacco, 1895)].
- non 1985 Cerithium (Thericium) vulgatum Bruguière, 1792 – Atanacković, p. 108, pl. 26, figs 4, 5 [= Thericium miospinosum (Sacco, 1895)].
- non 1993 Cerithium (Thericium) vulgatum Bruguière, 1789 [sic] – Iljina, p. 78 (partim, pl. 10, fig. 1 only) [= Thericium miospinosum (Sacco, 1895)].

Dimensions and material – Maximum height 24.6 mm. Locality 11: JvdV/12, RGM 794 070/1 (ex JvdV); locality 17a: NHMW 1847/0058/1594/15, YI 364/4.

Discussion - Thericium vulgatum (Bruguière, 1792) has a highly variable shell, as can be deduced from the enormous number of varieties described by Sacco (1895a). The shells from Karaman represent a very early and rather stocky form of the species, not unlike the shell figured by Cossmann (1906, pl. 3, fig. 14) from the late Miocene Tortonian of Catalonia, Spain. The late Miocene forms from Italy illustrated by Sacco (1895a) are also rather smaller than the Pliocene-Recent forms. As far as we are aware, the present record is the earliest record of the species. The Atlantic early and middle Miocene and Paratethyan middle Miocene records refer to Thericium miocenicum (Vignal, 1911) or Thericium europaeum (Mayer, 1878). In the Karaman deposits T. vulgatum is found exclusively in the brackish-water assemblage at Gödet Creek (locality 11) and the brackish levels at Seyithasan (locality 17a).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Late Miocene: Proto-Mediterranean Sea (Tortonian): Spain (Cossmann, 1906; Solsona, 1998), Po Basin, Italy (Sacco, 1895a), Tunisia (Stchepinsky, 1938). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Landau et al., 2004a); northeastern Spain, (Martinell, 1979; Martinell & Domènech, 1984a); Roussillon, France (Fontannes, 1880; Chirli & Richard, 2008); central Mediterranean, Po valley, Italy (Sacco, 1895a; Palla, 1967; Malatesta, 1974; Chirli, 2006; Sosso & dell'Angelo, 2010), Tunisia (Fekih, 1975). Early-late Pliocene: Piacenzian, Atlantic, Mondego Basin, Portugal (Silva, 1993); central Mediterranean, Italy (Sacco, 1895a; Chirli, 1988; Cavallo & Repetto, 1992). Pleistocene: western Mediterranean, Balearic Islands (Cuerda Barceló, 1987), France (Glibert, 1962); central Mediterranean, Italy (Cerulli-Irelli, 1912; Malatesta, 1960; Brambilla et al., 1988), Sicily (Ruggieri & Greco, 1965), Cyprus, Tunisia (Glibert, 1962b). Recent: Mediterranean, shallow-waters on sandy and muddy bottoms (Poppe & Goto, 1991).

?Thericium sp.

Plate 3, fig. 11

Dimensions and material – Height 23.6 mm. Locality 13: RGM 783 844/1.

Discussion – A single incomplete cerithiid from the Akpinar deposits represents a very distinctive species with flat-sided whorls, strongly opisthocline ribs and rounded tubercles formed where the three primary spiral cords per whorl overrun the axial ribs. It also has a small varix on the last whorl opposite the labial varix. Unfortunately, the aperture and apex are missing, but the very straight spire, sculpture and varix are reminiscent of the tropical American genus *Ochetoclava* Woodring, 1928, which is so far unknown in the European Neogene. We provisionally place this shell in the genus *Thericium* with great reservation.

Distribution – **Middle Miocene:** Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Batillariidae Thiele, 1929 Genus *Batillaria* Benson, 1842

Type species – Cerithium zonale Bruguière, 1792, by monotypy. Recent, Japan.

Batillaria? pupaeformis (de Basterot, 1825) Plate 4, figs 1, 2

- *1825 *Cerithium pupaeforme* Nob., de Basterot, p. 58, pl. 3, fig. 18.
- 1911 *Cerithium (Semivergatus) pupaeforme* Basterot Vignal, p. 154, pl. 7, fig. 15.
- 1911 Cerithium (Semivergatus) partitum Vignal, p. 155, pl. 7, fig. 16.
- 1911 Cerithium (Semivergatus) partitum var. derivata

Vignal, p. 156, pl. 7, fig. 17.

- 1922 *Rhinoclavis (Semivergatus) pupaeforme* Basterot Cossmann & Peyrot, p. 221, no. 568, pl. 5, fig. 50.
- 1922 Rhinoclavis (Semivergatus) pupaeforme var. pergranulosa Cossmann & Peyrot, p. 223, no. 569, pl. 5, fig. 64.
- 1922 Rhinoclavis (Semivergatus) pupaeforme var. vasconiensis Cossmann & Peyrot, p. 223, no. 570, pl. 5, figs 55-57, 95.
- 1922 Rhinoclavis (Semivergatus) pupaeforme var. partita Vignal – Cossmann & Peyrot, p. 223, no. 571, pl. 5, figs 84, 86, 88.
- 1922 Rhinoclavis (Semivergatus) pupaeforme var. derivata Vignal – Cossmann & Peyrot, p. 224, no. 572, pl. 5, figs 68, 87.
- 2001a Batillaria? pupaeformis (Basterot, 1825) Lozouet et al., p. 27, pl. 8, fig. 5.
- 2005 *Rhinoclavis (Semivergatus) pupaefomris [sic]* Bast., *non* A. Adams in G.B. Sowerby II, 1853 – Cecalupo, p. 186, unnumbered figure.
- 2010 Batillaria pupaeformis (Basterot, 1825) Esu & Girotti, p. 158, pl. 6, figs 8-13.

Dimensions and material – Maximum height 11.3 mm. Locality 11: JvdV/33, RGM 794 067/1 (ex JvdV), RGM 794 032/13; locality 17: NHMW 1874/0058/0973/3, JvdV/2, RGM 783 990/1, YI 211/1; locality 17a NHMW 1847/0058/1651/1, 1847/0058/1582/50+.

Discussion - This species is either long-lived and polymorphic or represents an unresolved species complex. Early occurrences from the late Oligocene of southern Italy, described by Esu & Girotti (2010), differ from early Miocene shells in their wavy sutures and prominent axial sculpture. The early Miocene French type specimen of de Basterot (1825) agrees fully with the Turkish shells, whilst the early Miocene French shell illustrated by Lozouet et al. (2001a) has reduced sculpture. This variability makes it difficult to evaluate the status of most other middle and late Miocene taxa, which possibly also represent mere varieties of Batillaria? pupaeformis (de Basterot, 1825). The Tortonian Cerithium obliquistoma Seguenza, 1880 (p. 155, pl. 11, fig. 25) is broader than Batillaria? pupaeformis and its nodes are arranged in strict axial lines down the entire shell. The Tortonian shells identified by Robba (1968) as Cerithium (Thericium) obliquistoma Seguenza, 1880, however, are stout and ovoid with reduced sculpture and a prominent inner lip and differ clearly from the type material of Seguenza (1880). Similarly, some of the shells described by Sacco (1895a) as varieties of Pithocerithium obliquistoma (Seguenza, 1880) and Pithocerithium taurovatulum Sacco (1895a) possibly belong in this species-group but none of them fully corresponds to the Turkish shells in outline and sculpture.

Two taxa are described so far from the middle Miocene of the Paratethys: *Cerithium (Pithocerithium) attritum* Boettger, 1907 from Romania represents an exceptionally smooth or juvenile form (see Zilch, 1934, p. 221, pl. 8, fig. 30 for illustration). *Pithocerithium pseudobliquistoma*

Szalai, 1926, from Hungary, resembles of Batillaria? obliquistoma Seguenza, 1880. The illustrations in Szalai (1926, p. 343, text-figs 2-4) show stout conical shells with three rows of prominent nodes and a wide aperture. Shells from the type locality illustrated and described by Strausz (1954, p. 16, pl. 3, fig. 50a-d) are more ovoid, develop somewhat spinose sculpture on rather widelyspaced axial ribs and have a narrower aperture. Thus, for the time being it is difficult to define which species are distinct. Although, we tentatively consider them as synonyms of Batillaria? pupaeformis, we refrain from listing them in the synonymy. In the Karaman assemblages this species is found almost exclusively in the brackish deposits at locality 11 and the brackish levels at Seyithasan (locality 17a). Many specimens from the latter locality have a colour pattern preserved well, consisting of reddish spiral bands between the spiral rows of tubercles (Pl. 4, fig. 1).

Distribution – Early Miocene: northeastern Atlantic (Aquitanian-Burdigalian): Aquitaine Basin, France (Vignal, 1911; Cossmann & Peyrot, 1922; Lozouet *et al.*, 2001a). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1922; Lozouet *et al.*, 2001a); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Granulolabium Cossmann, 1889

Type species – Cerithium plicatum Bruguière, 1792. Early Miocene, France.

Granulolabium bicinctum (Brocchi, 1814)

Plate 4, figs 3, 4

- *1814 *Murex bicinctus* nob., Brocchi, p. 446, pl. 9, fig. 13.
- 1825 *C. pictum* Nob., de Basterot, p. 57, pl. 3, fig. 6.
- 1830 C. mitrale m., Eichwald, p. 224.
- 1832 Cerithium pictum De Bast. Grateloup, p. 274.
- 1845 C. pictum De Bast. Grateloup, pl. 18, fig. 8.
- 1852 *Cerithium mitrale*, Eichwald, pl. 7, fig. 10a-c (explanation to plates only).
- 1852 *Cerithium trijugum,* Eichwald, pl. 7, fig. 11a-c (explanation to plates only).
- 1852 la même en variété, Eichwald, pl. 7, fig. 13a-c (explanation to plates only).
- 1852 *Cerithium bijugum*, Eichwald, pl. 7, fig. 14a-c (explanation to plates only).
- 1852 *Cerithium bicinctum*, Eichwald, pl. 7, fig. 15a-c (explanation to plates only).
- 1853 Cerith. mitrale m., Eichwald, p. 153.
- 1853 Cerithium trijugum m. Eichwald, p. 155.
- 1853 Cerithium bijugum m., Eichwald, p. 155.
- 1853 Cerithium bicinctum m., Eichwald, p. 155.
- 1855 Cerithium pictum Bast. Hörnes, p. 394, pl. 41, figs 15, 17.
- 1866 Cerithium pictum Bast. Pereira da Costa, p. 249, pl. 28, fig. 13.

- 1886 Cerithium pictum Basterot Fontannes, p. 329, pl. 26, figs 2, 3.
- 1879 *Cerithium Florianum* Hilb., Hilber, p. 435, pl. 3, figs 8-10.
- 1879 *Cerithium Noricum* Hilb., Hilber, p. 442, pl. 4, fig. 7a-c.
- 1895a Tiarapirenella bicincta (Br.) Sacco, p. 60, pl. 3, fig. 52.
- 1906 Potamides (Pirenella) bicinctum (Brocchi) Cossmann, p. 116, pl. 12, fig. 52.
- 1911 Potamides (Pirenella) pictus Defrance Vignal, p. 177, pl. 9, fig. 36.
- 1912 Cerithium (Potamides) mitrale Eichw. Schaffer, p. 157, pl. 51, figs 30-32.
- 1914 Potamides mitralis Eichw. Friedberg, p. 271, pl. 17, figs 1-7.
- 1914 *Potamides mitralis* Eichw. var. *ascalarata* Friedberg, Friedberg, p. 275, pl. 17, fig. 8.
- 1914 Potamides costatus Eichw. Friedberg, p. 276, pl. 17, figs 9, 10.
- 1922 Pirenella picta (Defrance in Basterot) Cossmann & Peyrot, p. 273, pl. 6, figs 17-20, pl. 7, fig. 9.
- 1935 *Cerithium mitreolum* Eichw. Kolesnikov, p. 223, pl. 28, figs 9-13.
- 1935 *Cerithium bijugum* Eichw. Kolesnikov, p. 224, pl. 28, figs 6-8.
- 1936/37 *Pirenella bicincta* Brocc. var. *turritogracilis* Sacco – Sieber, p. 482, pl. 24, figs A3, 5, 6.
- 1936/37 *Pirenella picta* (Defrance in Basterot) Sieber, p. 484, pl. 24, fig. D3.
- 1936/37 *Pirenella picta* Defr. var. *mitralis* Eichwald Sieber, p. 485, pl. 24, figs C5-6.
- 1936/37 *Pirenella picta* Defr. var. *melanopsiformis* Auinger in coll. – Sieber, p. 486, pl. 24, figs D1-2.
- 1936/37 *Pirenella picta* Defr. var. *bicostata* Eichw. Sieber, p. 486, pl. 24, figs C3-4.
- 1936/37 *Pirenella picta* Defr. var. *nympha* Eichw. Sieber, p. 486, pl. 24, figs C1-2.
 - 1950 *Potamides mitralis* Eichwald Csepreghy-Meznerics, p. 26, pl. 1, fig. 10.
 - 1950 Potamides mitralis florianus Hilber Csepreghy-Meznerics, p. 27, pl. 1, fig. 11.
 - 1950 *Potamides bicostatus* Eichwald Csepreghy-Meznerics, p. 27, pl. 1, fig. 15.
 - 1954 *Pirenella picta picta* (Defrance) Papp, p. 39, pl. 6, figs 1-12.
 - 1954 *Pirenella picta* cf. *melanopsiformis* (Auinger in coll.) Friedberg Papp, p. 40, pl. 6, figs 13-15.
 - 1954 *Pirenella picta mitralis* (Eichwald) Papp, p. 40, pl. 6, figs 16-18.
 - 1954 *Pirenella picta bicostata* (Eichwald) Papp, p. 41, pl. 6, figs 19-21.
 - 1954 *Pirenella picta nympha* (Eichwald) Papp, p. 41, pl. 6, figs 22-24.
 - 1954 *Pirenella picta* (Defrance in Basterot) Švagrovský, p. 9, pl. 1, figs 34-37.
 - 1954 *Pirenella picta* (Defr.) var. *melanopsiformis* Auing. (in coll.) – Švagrovský, p. 12, pl. 1, figs 44-49, 52-53.
 - 1954 Pirenella mitralis (Eichwald) Švagrovský, p. 14,

pl. 1, figs 38-43, 50-51.

- 1954 Pirenella mitralis (Eichw.) var. ascalarata Friedberg – Švagrovský, p. 18, pl. 2, figs 1-6.
- 1954 *Pirenella bicostata* (Eichwald) Švagrovský, p. 19, pl. 2, figs 7-27.
- 1954 *Pirenella bijuga* (Eichwald) Švagrovský, p. 21,
 pl. 2, figs 28-35, pl. 3, figs 1, 2.
- 1955 *Pirenella bicincta* (Brocchi) 1814 Rossi Ronchetti, p. 125, fig. 60.
- 1955 Potamides (Pirenella mitralis) [sic] Eichw. 1830 Moisescu, p. 120, pl. 10, fig. 8.
- 1955 Pirenella picta mitralis Eichwald, 1830/1853 Strausz, p. 161, pl. 4, fig. 29.
- 1955 *Pirenella picta pseudogamlitzensis*, Strausz, p. 167, pl. 4, figs 31, 32.
- 1958 *Pirenella picta* (Defrance in Basterot) Erünal-Erentöz, p. 24, pl. 2, figs 25-29.
- 1960 Pirenella picta var. bicostata (Eichwald 1853) Kojumdgieva & Strachimirov, p. 108, pl. 31, figs 15, 17.
- 1962 *Potamides (Pirenella) pictus* Defrance (in Basterot) Strausz, p. 40, pl. 8, fig. 15.
- 1962 Potamides (Pirenella) pictus mitralis Eichwald Strausz, p. 41, pl. 8, figs 16-18.
- 1962 *Potamides (Pirenella) pictus bicostatus* Eichwald Strausz, p. 41, pl. 8, fig. 19.
- 1962 Potamides (Pirenella) pictus melanopsiformis Auinger (in Friedberg) – Strausz, p. 41, pl. 8, fig. 20.
- 1963 *Pirenella bicincta* (Br.) Venzo & Pelosio, p. 68, pl. 33, figs 40-44.
- 1966 *Pirenella picta floriana* (Hilb.) Kókay, p. 41, pl. 4, figs 1-4.
- 1966 *Potamides (Pirenella) pictus* Defrance (*in* Basterot) 1825 Strausz, p. 145, pl. 8, fig. 15.
- 1966 *Potamides (Pirenella) pictus mitralis* Eichwald, 1830 – Strausz, p. 145, pl. 8, figs 16-18.
- 1966 Potamides (Pirenella) pictus bicostatus Eichwald,
 1853 Strausz, p. 146, pl. 8, fig. 19.
- 1966 Potamides (Pirenella) pictus melanopsiformis Auiniger (in Friedberg), 1928 – Strausz, p. 146, pl. 8, fig. 20.
- 1967 *Pirenella bicincta turritogracilis* (Sacco, 1895) Tejkal *et al.*, p. 194, pl. 9B, figs 15-21.
- 1968 *Pirenella bicincta* (Brocchi, 1814) Robba, p. 514, pl. 39, fig. 14a-b.
- 1970 Potamides (Pirenella) pictus bicostatus (Eichwald) Bałuk, p. 117, pl. 10, fig. 4.
- 1970 Potamides (Pirenella) pictus mitralis (Eichwald) – Bałuk, p. 117, pl. 10, fig. 6.
- 1971 *Pirenella picta picta* (Basterot, 1825) Švagrovský, p. 326, pl. 56, figs 1-5.
- 1971 *Pirenella picta mitralis* (Eichwald, 1830) Švagrovský, p. 330, pl. 56, figs 5-11.
- 1971 *Pirenella picta mitralis* (Eichwald, 1830) Steininger, p. 378, pl. 3, fig. 2.
- 1973 *Pirenella picta mitralis* (Eichwald) 1853 Bohn-Havas, p. 1045, pl. 3, figs 20, 21.
- 1974 *Pirenella picta picta* (Defrance) Papp, p. 343, pl. 6, figs 1-12.

- 1975 *Pirenella picta mitralis* (Eichwald, 1850) Bałuk, p. 131, pl. 15, fig. 8.
- 1993 Potamides (Pirenella) pictus mitralis (Eichwald, 1830) Iljina, p. 75, pl. 9, figs 17, 18.
- 1982 Pirenella picta mitralis (Eichwald, 1853) Švagrovský, p. 21, pl. 6, fig. 1.
- 2002 *Granulolabium bicinctum* (Brocchi, 1814) Harzhauser, p. 74, pl. 1, figs 13-16.
- 2002 *Granulolabium bicinctum* (Brocchi, 1814) Harzhauser & Kowalke, p. 66, pl. 11, figs 1-8.
- 2011 Granulolabium bicinctum (Brocchi, 1814) Harzhauser et al., p. 173, fig. 3/7.
- 2012 *Granulolabium bicinctum* (Brocchi 1814) d'Amico *et al.*, p. 162, pl. 1, fig. 11, pl. 2, figs 12-16.

Dimensions and material – Maximum height 19.9 mm. Locality 11: JvdV/50+, RGM 794 073/1 (ex JvdV), RGM 794 074/1 (ex JvdV), RGM 794 033/50+; locality 17a: NHMW 1847/0058/1593/50+, YI 362/50+.

Discussion – According to Lozouet (1986), this species developed during the early Miocene, probably anagenetically, from Granulolabium plicatum (Bruguiére, 1792). The two species coexist at least since the early Burdigalian (Eggenburgian; Schaffer, 1912). Especially, in late Burdigalian and early Langhian (Karpatian/Badenian) deposits of the Paratethys it is often difficult to assign certain specimens to either of these species (e.g. Harzhauser, 2002). During the late Langhian and Serravallian, G. bicinctum was fully established and becomes an ubiquitous and extraordinarily polymorphic species. This led many authors to produce numerous species, subspecies and variatal names. Aside from numerous synonyms, the species-rank name *bicinctum* was erroneously proposed again as primary homonym by Eichwald (1830), who obviously was not aware that Brocchi (1814) had already used this name for the same species. Lozouet (1986) demonstrated that Tiarapirenella Sacco 1895a, of which *Murex bicinctus* Brocchi, 1814 is the type species, is a synonym of Granulolabium Cossmann, 1889. Among several other taxa, Lozouet (1986) treated especially the frequently used names Cerithium pictum de Basterot, 1825 and C. mitrale Eichwald 1830 as synonyms of Granulolabium bicinctum.

Granulolabium bicinctum is among the few species that survived the Badenian/Sarmatian extinction event in the Paratethys and is widespread in Sarmatian deposits. Due to its variability and copious occurrence, it was described in hundreds of papers and a full synonymy list would be endless. Therefore, we list only some selected references with the most important synonyms and focus on significant geographic and stratigraphic occurrences. In the Karaman assemblages *G. bicinctum* is found exclusively in the brackish deposits at locality 11 and the brackish levels at Seyithasan (locality 17a).

Distribution – Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Vignal, 1911; Cossmann & Peyrot, 1922), Paratethys: Austria (Schaffer, 1912; Steininger, 1971; Harzhauser, 2002). **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1855; Papp, 1954; Tejkal *et al.*, 1967; Schultz, 1998), Poland (Bałuk, 1970, 1975), Ukraine (Friedberg, 1914; Slovakia (Švagrovský, 1954), Romania (Fontannes, 1886; Moisescu, 1955; coll. NHMW), Hungary (Csepreghy-Meznerics, 1950; Strausz, 1962, 1966; Bohn-Havas, 1973), Bulgaria (Kojumdgieva & Strachimirov), Eastern Paratethys (Kolesnikov, 1935; Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian and Messinian): Italy (Robba, 1968; Sacco, 1895b; Venzo & Pelosio, 1963; d'Amico *et al.*, 2012). Early Pliocene: Italy (Sacco, 1895b).

Genus Tiaracerithium Sacco, 1985a

Type species – Cerithium pseudotiarella d'Orbigny, 1852 (*= Cerithium thiarella* Grateloup, 1832). Early Miocene, France.

Tiaracerithium eceae nov. sp.

Plate 4, figs 5, 6; Plate 54, fig. 10

Dimensions and material – Holotype RGM 783 998 (ex JvdV), height 16.3 mm; paratype 1 RGM 784 077 (incomplete); paratype 2 RGM 974 521, height 16.3 mm; paratype 3 RGM 974 522, height 14.6 mm; paratype 4 RGM 974 523, height 18.2 mm; paratype 5 RGM 974 524, height 14.7 mm; paratype 6 NHMW 1847/0058/1652, height 18.2 mm; paratype 7 NHMW 1847/0058/1653, height 19.0 mm; paratype 8 NHMW 1847/0058/1654, height 17.4 mm; furthermore two specimens in YI 471, height 16,2 mm; and YI 472, height 19.1 mm.

Additional material – Maximum height 20.2 mm. Locality 11: JvdV/50+, RGM 794 035/21; locality 17: JvdV/1; locality 17a: NHMW 1847/0058/1597/50+; YI 361/50+.

Etymology – Named after Ece İslamoğlu, daughter of one of the authors.

Locus typicus – Southwest bank of Gödet Creek near Tilkikaya, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Tiaracerithium* species, in which the early teleoconch whorls are strongly carinate and the later spire whorls are barrel-shaped, bearing two broad spiral bands, four on the last whorl, with secondary cords covering the entire whorl surface.

Description – Shell medium-sized, cerithiiform. Protoconch paucispiral, of about two convex whorls, nucleus medium-sized. Teleoconch of about eleven whorls. Suture superficial, linear. First two teleoconch whorls bearing sharp, strong carina mid-whorl. Two cords appear above carina of third whorl, carina becoming closer to abapical suture. Fourth whorl carina placed immediately above abapical suture, with three cords above, whorl profile concave. Seventh whorl surface covered with narrow, irregular, close set cords, carina weakens, whorl profile irregular. On eighth and ninth whorl two raised spiral bands develop, upper broader, placed immediately below adapical suture, second band narrower, centrally placed, carina no longer present. Last whorl 46% of total height, barrel-shaped to lower cord, concave on base, bearing four rounded primary spiral bands, adapical band just below suture widest, adapical band delimiting base; surface covered with narrow irregular secondary cords. Aperture small, 23% of total height; outer lip simple, siphonal canal short, open.

Discussion - Despite the superficial similarity to Granulolabium bicinctum, Tiaracerithium eceae nov. sp. differs distinctly in the keeled early spire whorls and their median concavity. It also develops faint spiral threads, which are most prominent in the interspaces between the beaded primary ribs. Tiaracerithium thiarella (Grateloup, 1837a), as described by Cossmann & Peyrot (1922) and Lozouet et al. (2001a) from the early Miocene of France, lacks the keel of the early spire whorls but agrees in shell shape. Erroneously, d'Orbigny (1852) introduced Cerithium pseudotiarella as replacement name for Grateloup's species (see Lozouet et al., 2001a for discussion). Therefore, Sacco (1895a) treated this species as Tiaracerithium pseudotiarella and proposed several varietal names for shells from the Burdigalian of Italy. All these shells develop comparably barrel-shaped late spire whorls but lack the characteristic keel of the Turkish species.

Seguenza (1879) described a comparable shell from the Tortonian of Reggiano in Italy as *Cerithium articula-tum* O.G. Costa, 1855. We have not been able to find the original description of this species in Costa (1850-1856) or Costa 1838-1873), although Cecalupo (2005) lists this species as *Cerithium articulatum* (O.G. Costa 1855). In any case, it would probably be a junior homonym of *Cerithium articulatum* A. Adams & Reeve, 1850.

Tiaracerithium eceae nov. sp. is found almost exclusively in the brackish deposits at locality 11 and the brackish levels at Seyithasan (locality 17a) of the Karaman assemblages.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey.

Family Scaliolidae Jousseaume, 1912 Genus *Sandbergeria* Bosquet, 1861

Type species – Sandbergeria cancellata Nyst, 1836, by monotypy. Early Oligocene, Belgium.

Sandbergeria perpusilla (Grateloup, 1827) Plate 54, figs 11-14

- *1827 Rissoa perpusilla Nob., Grateloup, p. 133.
- 1830 Rissoa striatula Eichwald, p. 218 (partim).
- 1831 *Melania reticulata* Dubois de Montpéreux, p. 47, pl. 3, figs 24-25.
- 1838 *Rissoa perpusilla* Nob., Grateloup, p. 202, pl. 5, figs 40, 41.
- 1847 *Rissoa perpusilla* Grat. Grateloup, pl. 4, figs 40, 41.
- 1852 Rissoa striatula Eichwald, pl. 10, fig. 11.
- 1853 *Rissoa striatula* mihi, Eichwald, p. 269 (*partim*, pl. 10, fig. 11 only).
- 1856 Cemnitzia perpusilla Grat. Hörnes, p. 540, pl. 43, fig. 19.
- 1895a Sandbergeria perpusilla (Grat.) Sacco, p. 76, pl. 2, fig. 125.
- 1895a Sandbergeria perpusilla var. sulcatior Sacc., Sacco, p. 76, pl. 2, fig. 127.
- 1895a Sandbergeria perpusilla var. strictisuturata Sacc., Sacco, p. 76, pl. 2, fig. 128.
- 1895a Sandbergeria perpusilla var. undatocosticillata Sacc., Sacco, p. 76, pl. 2, fig. 126.
- 1902 Sandbergeria cylindrata Boettger, p. 134, no. 416.
- 1914 Sandbergeria perpusilla Grat. Friedberg, p. 319, pl. 19, fig. 6.
- 1914 Sandbergeria striatula Eichw. Friedberg, p. 322, pl. 19, fig. 10.
- 1922 *Sandbergeria perpusilla* Grateloup Cossmann & Peyrot, n. 643, pl. 6, figs 21-24.
- 1922 Sandbergeria perpusilla mut. clathratula Cossmann & Peyrot, n. 643, pl. 7, figs 81, 82.
- 1934 Sandbergeria cylindrata Boettger Zilch, p. 227, pl. 9, fig. 64.
- 1949 Sandbergeria perpusilla Grateloup, sp. 1827 Glibert, p. 131, pl. 9, fig. 1.
- 1956 Sandbergeria perpusilla (Grat.) Csepreghy-Meznerics, p. 387, pl. 1, figs 36-39.
- 1960 Sandbergeria perpusilla Grateloup Švagrovský, p. 89, pl. 8, figs 10, 11.
- 1964 Sandbergeria perpusilla (Grat.) Švagrovský, p. 80, pl. 16, fig. 8.
- 1962 Sandbergeria perpusilla Grateloup Strausz, p. 27, pl. 4, figs 7, 8.
- 1966 Sandbergeria perpusilla Grateloup (1827) 1838 Strausz, p. 173, pl. 4, figs 7, 8.
- 1968 Sandbergeria perpusilla (Grateloup, 1827) Zelinskaya et al., p. 167, pl. 40, figs 24, 25.
- 1970 Sandbergeria perpusilla (Grateloup) Bałuk, p. 117, pl. 9, fig. 7.
- 1970 Sandbergeria cylindrata Boettg. Rado & Mutiu, p. 148, pl. 5, figs 14, 19.
- 1975 Sandbergeria perpusilla (Grateloup, 1838) Bałuk, p. 136, pl. 15, fig. 2.
- 1985 Sandbergeria perpusilla (Grateloup, 1827) Atanacković, p. 101, pl. 24, figs 11, 12.

Dimensions and material – Maximum height 4.0 mm. Localities 2 & 3: JvdV/12, RGM 783 947/2; locality 6: JvdV/3, RGM 783 991/2; locality 13: JvdV/50+; locality 17: JvdV/22, RGM 784 605/3, RGM 783 932/50+, YI 212/50+.

Discussion – Sandbergeria perpusilla (Grateloup, 1827) is a very common, widespread species in the middle Miocene of the Paratethys, where it is an important constituent of some asemblages (Zuschin *et al.*, 2004a, 2005, 2006). It is extremely variable in sculpture and convexity of the whorls but is clearly separable from *Sandbergeria spiralissima* (Dubois de Montpéreux, 1831), which has a much higher number of delicate spiral grooves.

Lozouet *et al.* (2001a) treated this species as synonym of the Oligocene species *Sandbergeria turrita* (Grateloup, 1827). No material of this species is availabe to us and no illustration seems to exist since the poor drawings in Grateloup (1847). The Oligocene North Sea specimen illustrated by R. Janssen (1978) [as *Sandbergeria secalina* (Philippi, 1843)] seems to differ from *S. perpusilla* in its beaded sculpture. Therefore, we prefer to keep both these taxa separate until better information on the Oligocene species is available.

The protoconch in the Turkish material is dome-shaped, consisting of just over three smooth convex whorls with a small nucleus (dp = $200 \,\mu$ m, hp = $210 \,\mu$ m, dp/hp = 0.95, dp1 = $95 \,\mu$ m, dn = $50 \,\mu$ m; Pl. 54, fig. 14b, c). The junction with the teleoconch is clearly delimited by the beginning of the spiral sculpture.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian-Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1922); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1895a). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1922), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856), Poland (Friedberg, 1914; Bałuk, 1970, 1975), Hungary (Strausz, 1962, 1966; Csepreghy-Meznerics, 1956), Romania (Zilch, 1934), Ukraine (Zelinskaya *et al.*, 1968), Slovakia (Švagrovský, 1960), Bosnia (Atanacković, 1985); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Dialidae Kay, 1979 Genus *Gibborissoia* Cossmann in Sacco, 1895

Type species – Bulimus costellatus Grateloup, 1828, by original designation. Early Miocene, France.

Note – Sacco (1895b) referred to a letter by Cossmann when introducing the genus name. He used *Gibborissoia* in the text (p. 34), in the index (Sacco, 1895b, p. 48) as well as in the index of his 1904 monograph. Thus, there is no reason to emend the name to *Gibborissoa* (*e.g.* Cossmann, 1921; Lozouet *et al.*, 2001a) as this case does not fulfill the requirements of ICZN 32.5 (spellings that must be corrected).

Gibborissoia angulosa nov. sp. Plate 4, figs 7, 8; Plate 55, fig. 1

Dimensions and material–Holotype RGM 783 974, height 8.7 mm; paratype 1 NHMW 1847/0058/1696, height 8.3 mm; paratype 2 RGM 783 975, height 7.0 mm; paratype 3 RGM 783 976, height 5.9 mm; paratype 4 RGM 784 077 (juvenile); paratype 5 NHMW 1847/0058/1697, height 7.7 mm; paratype 6 NHMW 1847/0058/1698, height 8.8 mm; furthermore two specimens in YI 468, height 7.9 mm, and YI 469, height 6.0 mm. All from the type locality.

Additional material – Localities 2 & 3: JvdV/30; localities 7 & 8; JvdV/1, locality 17: NHMW 1874/0058/0997/15, JvdV/30, RGM 783 935/30 juveniles + fragments, YI 470/3.

Etymology – Reflecting the shape of the angular last whorl.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum –Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Gibborissoia* species, with a protoconch consisting of about two smooth whorls, devoid of sculpture or varices, with a tall spire composed of convex whorls, becoming increasingly angular abapically, and a roundly angular last whorl.

Description – Shell small, fragile, tall-spired. Protoconch of just fewer than two smooth whorls, delimited from teleoconch by prosocline scar. Teleoconch of nine whorls, devoid of sculpture or varices, initially rounded, abapically increasingly angular, with periphery below mid-whorl. Suture superficial, linear. Last whorl 45-50% total height, roundly angled at periphery. Aperture 35% of total height, ovate, outer lip simple, somewhat flared abapically. Columella smooth, excavated in mid-portion. Columellar callus not developed. Colour pattern of vertical reddish flammules preserved on some specimens.

Discussion – Both Bałuk (1975) and Lozouet *et al.* (2001a) noted that the traditional placement of these shells with a smooth paucispiral protoconch in the genus *Alaba* H. Adams & A. Adams, 1853 was unlikely, as *Alaba* is characterised by species with richly sculptured multispiral protoconchs. We ascribe this new species to the genus *Gibborissoia*, erected by Cossmann *in* Sacco (1895b) for *Bulimus costellatus* Grateloup, 1828 (considered to be a junior subjective synonym of *Rissoa varicosa* de Basterot, 1825; see Lozouet *et al.*, 2001a).

Gibborissoia varicosa, widespread in the Miocene northeastern Atlantic, Paratethys and Proto-Mediterranean, is a very variable species, but all the various forms and varieties described have some form of weak spiral sculpture and prominent axial varices. *Gibborissoia angulosa* nov. sp. is common in the Karaman assemblages. None of the specimens examined has any hint of axial or spiral sculpture. Moreover, as the name suggests, *G. angulosa* has angular late teleoconch whorls, quite different in profile from those of *G. varicosa*.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Gibborissoia varicosa (de Basterot, 1825)

Plate 4, fig. 9

- *1825 *Rissoa varicosa* Nob., de Basterot, p. 37, pl. 1, fig. 2.
- 1825 *Phasianella prevostina* Nob., de Basterot, p. 38, pl. 1, fig. 18.
- 1838 *Rissoa costellata* Nob., Grateloup, p. 199, pl. 5, figs 29-31.
- 1847 *Rissoa costellata* Grat. Grateloup, pl. 4, figs 29-31.
- 1852 Rissoa anomala Eichwald, pl. 10, fig. 14.
- 1853 Rissoa anomala m., Eichwald, p. 271.
- 1856 *Rissoa costellata* Grat. Hörnes, p. 575, pl. 48, fig. 21.
- 1895b Alaba costellata (Grat.) Sacco, p. 34, pl. 1, fig. 95.
- 1895b Alaba costellata var. triangularis Sacc., Sacco, p. 34, pl. 1, fig. 96.
- 1902 Alaba paucivaricosa Boettger, p. 148, no. 454.
- 1919 *Alaba costellata* (Grateloup) Cossmann & Peyrot, p. 570, no. 327, pl. 17, figs 26, 27.
- 1919 Alaba costellata var. varicosa (Basterot) Cossmann & Peyrot, p. 573, no. 328, pl. 17, figs 1, 2.
- 1919 Alaba costellata var. ventripotens Cossmann & Peyrot, p. 574, no. 329, pl. 16, figs 117, 118.
- 1919 Alaba costellata var. ecostata Cossmann & Peyrot, p. 574, no. 330, pl. 16, figs 94, 95.
- 1921 Gibborissoa costellata (Grat.) Cossmann, p. 53, pl. 2, figs 87-90.
- 1923 Alaba costellata var. anomala Eichw. Friedberg, p. 362, pl. 21, figs 5, 6.
- 1934 Alaba (Gibborissoa) paucivaricosa (Boettger) Zilch, p. 220, pl. 8, fig. 28.
- 1956 *Alaba costellata anomala* (Eichwald) Csepreghy-Meznerics, p. 386, pl. 3, figs 10, 11.
- 1957 Alaba costellata Grat. Pavlovsky, p. 53, pl. 1, fig. 1.
- 1960 Alaba costellata anomala (Eichwald) Švagrovský, p. 70, pl. 6, figs 7-10.
- 1966 *Alaba costellata anomala* Eichwald, 1853 Strausz, p. 128, pl. 13, fig. 3, pl. 45, fig. 19.
- 1966 Alaba paucivaricosa Boettger Kókay, p. 44, pl. 4, fig. 15.
- 1968 Alaba (Alaba) costellata anomala (Eichwald) Hinculov, p. 130, pl. 30, figs 19, 20.
- 1969 Alaba costellata anomala (Eichwald) Atanacković, p. 195, pl. 8, figs 14, 15.
- 1970 Alaba costellata anomala Eichwald) Bałuk, p. 117, pl. 9, figs 1, 2.
- 1975 Alaba costellata anomala (Eichwald, 1850 [sic]) -

Bałuk, p. 138, pl. 16, figs 1-4.

- 1985 *Alaba costellata anomala* (Eichwald) Atanacković, p. 102, pl. 24, figs 18, 19.
- 2001a Gibborissoa varicosa (Basterot, 1825) Lozouet et al., p. 25, pl. 6, figs 8, 9.

Dimensions and material – Maximum height 6.7 mm. Locality 6: JvdV/22; locality 17: JvdV/1, RGM 783 939/1; locality 17: NHMW 1847/0058/1708/1.

Discussion - The generic placement of this species was discussed by Lozouet et al. (2001a, p. 25). Gibborissoia varicosa (de Basterot, 1825) has an extremely variable shell, in which the shell shape ranges from from relatively slender to elongated and squatter with a greatly inflated last whorl, the development of the characteristic rounded varices is variable and the spiral sculpture is fine to subobsolete. Extreme forms are well illustrated by the varieties described by Cossmann & Peyrot (1919). For example, their variety ecostata (1919, pl. 16, figs 94, 95) is tall and slender, with only the labral varix developed and almost no spiral sculpture, quite different from the more 'typical' form illustrated by Lozouet et al. (2001a, pl. 6, figs 8, 9). Therefore, the grounds on which to separate the Paratethyan forms under the subspecies anomala Eichwald, 1853 based on weaker spiral sculpture (Strausz, 1966, p. 128) is in our opinion insufficient.

The Turkish shells also vary considerably in slenderness and the strength and number of varices. In the Karaman assemblages *G. varicosa* is far less common than *Gibborissoia angulosa* nov. sp. (for comparison, see above).

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1919; Cossmann, 1921; Lozouet *et al.*, 2001a); Proto-Mediterranean Sea (Burdigalian): Italy (Sacco, 1895b). Middle Miocene: Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1856), Czech Republic (Hörnes, 1856), Poland (Friedberg, 1923; Bałuk, 1970, 1975), Hungary (Hörnes, 1856; Csepreghy-Meznerics, 1956; Strausz, 1966), Romania (Boettger, 1902; Zilch, 1934), Bosnia (Atanacković, 1969); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Gibborissoia cf. denudata (Hilber, 1879)

Fig. 16/1; Pl. 4, fig. 10

cf. *1879 *Rissoa (Alaba) denudata* Hilb., Hilber, p. 448, pl. 5, fig. 6.

Dimensions and material – Height 9.5 mm. Locality 17: NHMW 1874/0058/0998/1.

Discussion – We provisionally place this single specimen from the Seyithasan deposits in the genus *Gibborissoia* Cossmann *in* Sacco, 1895. The shell is much more solid and larger than the congeners discussed above. The aperture is large and the outer lip greatly flared abapically. There is a weak varix on the last whorl on the ventral side, which is difficult to see in the photographs. At first glance this shell is similar to that described from the middle Miocene Paratethys of Romania by Boettger (1902) as *Alaba paucivaricosa* (see Zilch, 1934, pl. 8, fig. 28; Figure 16/2), which was probably correctly synonymised with the polymorphic *Gibborissoia varicosa* (de Basterot, 1825) by Bałuk (1975). However, the spire of the Turkish shell is higher and the spire whorls flatter. It is possible that this single shell is an extreme gerontic specimen of *G. varicosa*, but until more material becomes available we prefer to keep it distinct.



Figure 16. 1. *Gibborissoia* cf. *denudata* (Hilber, 1879), NHMW 1874/0058/0998, locality 17, Seyithasan, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene; height 9.5 mm. 2. *Gibborissoia denudata* (Hilber, 1879). Syntype, Universalmuseum Graz (Austria), Inv.Nr. 5247 (specimen figured by Hilber, 1879, pl. 5, fig. 6), Pöls (Styria, Austria), Badenian, middle Miocene, height 8.3 mm.

The Turkish shell is highly reminiscent of the extremely rare *Gibborissoia denudata* (Hilber, 1879), which is known so far only from the Langhian of the Styrian Basin in Austria. The type of this species, stored in the Universalmuseum Graz (Austria), differs slightly in its broader early teleoconch whorls, the stronger convexity of the spire whorls and the somewhat more slender last whorl (which lacks the aperture). As the variability of this species is unknown, it is difficult to decide if these differences are sufficient to separate the Turkish specimen at the species level.

AnothercomparablespecieswasdescribedbyŠvagrovský (1960) from the Badenian of Slovakia (erroneously

identified as *Alaba pangymna* Cossmann). Švagrovský's specimens differ from the Turkish and Styrian shells in their stockier outline and the greater convexity of the whorls, but might also be stocky morphs of *G. denuda-ta. Alaba pangymna* was originally described from the Badenian of Poland by Friedberg (1923). The name was proposed by Cossmann in a personal correspondence with Friedberg and the authorship has to be attributed to Friedberg (1923). This Polish species, however, has strongly convex whorls with deep sutures and is definitely not related to any of the species discussed above.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Potamididae H. Adams & A. Adams, 1854 Genus *Terebralia* Swainson, 1840

Type species – Strombus palustris Linnaeus, 1758, by subsequent designation (Sacco, 1895b). Recent, Indo-West Pacific.

Terebralia lignitarum (Eichwald, 1830) Plate 4, fig. 11

- 1821 *Cerithium lineatum* nob., Borson, p. 326, pl. 1, fig. 21 (*non Cerithium lineatum* Lamarck, 1822]).
- *1830 C. lignitarum m., Eichwald, p. 224.
- 1832 *Cerithium bidentatum* Defrance Grateloup, p. 271, nr. 277.
- 1845 C. *bidentatum* Defr. Grateloup, pl. 17, fig. 15, pl. 48, fig. 1.
- 1852 *Cerithium lignitarum* Eichwald, p. 2, pl. 7, fig. 20a-b.
- 1853 Cerithium lignitarum m. Eichwald, p. 146.
- 1855 Cerithium lignitarum Eichw. Hörnes, p. 398, pl. 42, figs 1-3.
- 1867 Cerithium lignitarum Eichw. Pereira da Costa, p. 250, pl. 28, fig. 11.
- 1888 Potamides lignitarum var. sulfurea Sacc., Sacco, p. 92, pl. 4, figs 10-12.
- 1888 *Potamides lignitarum* var. *cingulatior* Sacc., Sacco, p. 93, pl. 4, fig. 13.
- 1888 *Potamides lignitarum* var. *planulata* Sacc., Sacco, p. 94, pl. 4, figs 14-17.
- 1888 *Potamides colligens* Sacc., Sacco, p. 97, pl. 5, fig. 12.
- 1888 Potamides colligens var. fasciculata Sacc., Sacco, p. 97, pl. 5, fig. 13.
- 1895a Terebralia colligens (Sacc.) Sacco, p. 53, pl. 3, fig. 30.
- 1895a *Terebralia bidentata* var. *cingulatior* Sacc., Sacco, p. 53, pl. 3, fig. 31.
- 1895a var. margaritifera Sacc., Sacco, p. 53.
- 1899 Clava bidendata (Defrance) Grateloup Dollfus & Dautzenberg, 199, pl. 9, figs 1, 2.
- ?1906 Terebralia vignali Cossmann Cossmann, p. 125, pl. 10, fig. 14.
- 1912 Cerithium (Clava) bidentatum var. fusiformis

Schaffer, p. 155, pl. 52, figs 4, 5.

- 1914 Terebralia bidentata Defr. Friedberg, p. 295 text-figs 65, 66b (c), pl. 18, figs 5, 6.
- 1922 Terebralia bidentata (Defrance in Grateloup) Cossmann & Peyrot, p. 262, nr. 600, pl. 6, figs 4, 5.
- 1949 Terebralia bidentata Defrance Glibert, p. 139, pl. 9, fig. 5.
- 1950 Terebralia bidentata (Defr. in Grat.) margaritifera
 Sacco Csepreghy-Meznerics, p. 29, pl. 1, fig. 17.
- 1954 Terebralia bidendata Grat. Strausz, p. 16, pl. 1, fig. 21a-b.
- 1955 *Terebralia bidentata margaritifera* Sacco, 1895 Strausz, p. 153, pl. 3, figs 27, 28.
- 1955 *Terebralia lignitarum* Eichwald 1830 Moisescu, p. 121, pl. 10, figs 6, 7.
- 1958 *Terebralia bidentata* (Defrance) Erünal-Erentöz, p. 26, pl. 2, fig. 31.
- 1958 *Terebralia bidentata* var. *vignali* Cossmann Erünal-Erentöz, p. 27, pl. 3, figs 3-5.
- 1960 Terebralia (Terebralia) bidentata var. lignitarum (Eichwald 1853) – Kojumdgieva & Strachimirov, p. 109, pl. 31, fig. 22a-b.
- 1962 *Potamides (Terebralia) bidentatus lignitarum* Eichwald – Strausz, p. 34, pl. 6, figs 3-9.
- 1962 Potamides (Terebralia) bidentatus margaritifer Sacco – Strausz, p. 35, pl. 6, figs 10-14.
- 1966 Potamides (Terebralia) bidentatus margaritifer Sacco, 1895 – Strausz, p. 160, pl. 6, figs 10-14.
- 1966 Potamides (Terebralia) bidentatus lignitarum Eichwald, (1830) 1853 – Strausz, p. 162, pl. 6, figs 3, 5.
- 1967 *Terebralia bidentata bidentata* (Grateloup, 1832) – Tejkal *et al.*, p. 195, pl. 9B, fig. 13.
- 1968 Terebralia lignitarum lignitarum (Eichwald) Hinculov, p. 128, pl. 30, figs 12, 13.
- 1970 Terebralia bidentata (Defrance) Bałuk, p. 117, pl. 10, figs 2, 3.
- 1971 *Terebralia bidentata fusiformis* (Schaffer, 1912) Steininger, p. 380, pl. 6, fig. 4.
- 1972 Potamides (Terebralia) bidentatus lignitarum Eichwald (1830) 1853 – Nicorici, p. 139, pl. 15, figs 6, 7.
- 1973 Terebralia bidentata margaritifera Sacco, 1895 Bohn-Havas, p. 1044, pl. 4, figs 3, 4.
- 1974 *Terebralia lignitarum* (Eichwald) Papp, p. 345, pl. 8, figs 1, 2.
- 1975 *Terebralia bidentata* Defrance, 1840 Báldi & Steininger, p. 344, pl. 9, fig. 3.
- 1975 *Terebralia bidentata* (Defrance *in* Grateloup) Bałuk, p. 133, pl. 15, figs 16, 17.
- 1993 *Terebralia bidentata* (Defrance *in* Grateloup, 1840) Iljina, p. 76, pl. 9, figs 21, 22.
- 1998 *Terebralia bidentata bidentata* (Defrance) Schultz, p. 54, pl. 20, fig. 17.
- 2001a *Terebralia bidentata* (Defrance *in* Grateloup, 1832) Lozouet *et al.* p. 26, pl. 9, fig. 11.
- 2001 *Terebralia bidentata* (Defrance *in* Grateloup, 1840) Harzhauser & Kowalke, p. 364, figs 5.1-6.
- 2002 Terebralia bidentata (Defrance in Grateloup,

1840) – Harzhauser, p. 75, pl. 2, fig. 1.

- 2007 Terebralia lignitarum (Eichwald, 1830) Vazzana & Cecalupo, p. 186, pl. 4, figs a-d.
- 2008 *Terebralia bidentata* (Defrance *in* Grateloup, 1840) İslamoğlu, p. 273, fig. 6K.
- 2012 *Terebralia lignitarum* (Eichwald 1830) d'Amico *et al.*, p. 161, pl. 1, figs 6-7.

Dimensions and material – Maximum height 52.0 mm. Localities 7 & 8: JvdV/1; locality 11: RGM 783 941/50+, JvdV/50+; locality 17: NHMW 1874/0058/0980/1, 1874/-0058/0981/9, JvdV/3; locality 18: JvdV/1; locality 17a: NHMW 1847/0058/1595/1, YI 79/19.

Discussion – Some authors, such as Hörnes (1855), Friedberg (1936) and Bałuk (1975), already agreed about the synonymy of *Cerithium lignitarum* Eichwald, 1830 and *Cerithium bidentatum* Defrance *in* Grateloup, 1832. Nevertheless, *C. bidentatum* has usually been considered to be the first available valid name based on the fact that Grateloup illustrated his shell in 1847 whilst Eichwald's atlas was not published before 1852. However, according to the ICZN Code, *C. lignitarum* has priority, as Eichwald (1830) provided a Latin description in the footnote on page 224. Friedberg (1936) clarified the type locality, which is Zaleśce Gorge at Zhabiak in Ukraine (see Lukeneder *et al.*, 2011 for geological setting). There, the shells were found in lignite deposits of Langhian (= Badenian) age.

Cecalupo (2005) treated this species as member of *Pseu-dovergatus* Vignal, 1904 based on superficial convergences in apertural characters. Species of this cerithiid genus are fully marine animals that occur in sublittoral settings. Moreover, they differ completely in shell sculpture and the outline of the early whorls and there is no reason to place the Miocene species into *Pseudovergatus*. Cecalupo (2005) referred to Houbrick (1978) when discussing his decision but overlooked the fact that Houbrick (1991) placed *C. lignitarum* within *Terebralia* as well, when discussing the evolution and ecology of that genus. Recently, Reid *et al.* (2008) confirmed this placement.

The shell illustrated by Eichwald (1852) represents a broad conical robust type with broad varices. This widespread species attained considerable size up to 10 cm in height, and is characterised by its broad conical outline with slightly to moderately convex whorls and a tall, ovoid last whorl. Most previous authors were aware of the presence of a second morphological form represented by smaller, more slender shells with low but numerous whorls with nearly flat flanks, few and weak varices and a short last whorl, which contracts rapidly into a short base and canal. Hörnes (1855) proposed Cerithium Duboisi as the name for this form. Although it may be questionable whether this slender type represents a separate species, it is always easily distinguished from the broad, bulky shells of Terebralia lignitarum. Later, Dollfus & Dautzenberg (1899) and Cossmann & Peyrot (1922) caused some confusion about the status of these taxa as they used the name Terebralia lignitarum (Eichwald) for the slender type to distinguish it from their Terebralia bidentata. This mistake was perpetuated throughout the next decades (e.g. Glibert, 1949; Erünal-Erentöz, 1958, Schultz, 1998) resulting in combinations, such as Potamides (Terebralia) bidentatus lignitarum Eichwald in Strausz (1966) for shells that represent the slender Terebralia duboisi (Hörnes, 1855). The enormous number of available species and variatal names proposed by Sacco (1888), Hoernes (1901), Schaffer (1912), Friedberg (1914), Cossmann & Peyrot (1922), Glibert (1949) and many others and their quite arbitrary usage caused further confusion. For example, Terebralia bidentata var. margaritifera was introduced by Sacco (1895a) as a new name for the specimen illustrated by Hörnes (1855, pl. 42, fig. 1), which derives from Grund in Lower Austria (early Langhian). This shell is identical with typical shells of *T. bidentata* or *lignitarum* from other European sections, and Glibert (1949) correctly stated that Sacco's name has to be treated as synonym of T. bidentata. Later, Strausz (1966) applied the name T. margaritifera to very stout shells from the Langhian of Hungary, although Glibert (1949) had proposed the subspecies name Terebralia bidentata occidentalis for these morphologies. We consider all these shells to represent probably only varieties of a rather polymorphic species but the example documents the confused usages of the various names. Thus, we prefer to refer only to some few selected references and abandon many other references until a thorough revision of this group is available.

The species appeared already during the Oligocene and persisted in the Proto-Mediterranean Sea until the Tortonian and then virtually became extinct at the end of the Miocene. It is generally a good indicator for coastal mudflats and mangroves (Harzhauser & Kowalke, 2001). At several Paratethyan localities, such as the Oligocene locality of Máriahalom in Hungary (Chattian, Egerian) and the Burdigalian locality of Teiritzberg in Austria it co-occurs with ellobiids such as *Ellobium* and *Melampus* along with *Tympanotonos* (own observations MH; Binder, 2002). Also its stable isotope signature indicates that it occupied coastal settings exclusively, where it could cope with strongly fluctuating salinity (Latal *et al.*, 2006).

In the Karaman assemblages *Terebralia lignitarum* is found most commonly in the brackish deposits at locality 11 and the brackish levels at Seyithasan (locality 17a).

Distribution – Late Oligocene: Paratethys Sea: Hungary (Báldi & Steininger, 1975; Janssen, 1984c); Proto-Mediterranean Sea (late Rupelian- early Chattian): Denizli Basin, Turkey (İslamoğlu, 2008). Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1922; Lozouet *et al.*, 2001a); Paratethys (Burdigalian): Austria, (Schaffer, 1912; Steininger, 1971; Harzhauser & Kowalke, 2001; Harzhauser, 2002); Proto-Mediterranean Sea (Burdigalian): Italy (Sacco, 1895a), Greece (Harzhauser & Kowalke, 2001); Erzincan and Sivas basins in Turkey (Stchepinsky, 1946). Early Indian Ocean: several shells from the Burdigalian of Pakistan illustrated in Vredenburg (1928) may be closely related and fit well within the range of this group. Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1922), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1855; Schultz, 1998), Poland (Bałuk, 1970, 1975), Ukraine (Friedberg, 1914, Zelinskaya et al., 1968), Hungary (Csepreghy-Meznerics, 1950; Strausz, 1954, 1962, 1966; Bohn-Havas, 1973), Slovenia (Hoernes, 1901, Mikuž, 2009), Romania (Nicorici, 1972), Bulgaria (Kojumdgieva & Strachimirov, 1960); Eastern Paratethys, Chokrakian, Konkian (= Langhian) and late Serravallian (Iljina 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian) Cacela Basin, Portugal (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1895a, 1888; Davoli, 1990; Vazzana & Cecalupo, 2007; d'Amico et al., 2012).

Terebralia duboisi (Hörnes, 1855)

Plate 4, fig. 12

- *1855 *Cerithium Duboisi* Hörn., Hörnes, p. 399, pl. 42, figs 4, 5.
- ?1888 Potamides monregalensis Sacc., Sacco, p. 95, pl. 5, figs 2-9.
- ?1888 Potamides Melii Sacc., Sacco, p. 95, pl. 4, fig. 18, 19.
- ?1895a Terebralia monregalensis (Sacc.) Sacco, p. 54, pl. 3, fig. 35.
- 1899 *Tympanotomus lignitarum* Eichwald Dollfus & Dautzenberg, 201, pl. 9, figs 3, 4.
- 1901 *Tympanotomus Duboisi* M. Hoern. R. Hoernes, p. 344, unnumbered pl., fig. 7.
- 1912 Cerithium (Clava) bidentatum var. abbreviata Schaffer, p. 156, pl. 52, fig. 7.
- 1914 Terebralia Duboisi Hoern. Friedberg, p. 299, text-fig. 67, pl. 18, fig. 8.
- ?1914 Terebralia Andrzejowskii Friedberg, p. 301, pl. 18, fig. 9.
- 1922 Terebralia lignitarum (Eichwald) Cossmann & Peyrot, p. 265, nr. 603, pl. 6, fig. 59, pl. 7, figs 9, 10.
- 1949 Terebralia lignitarum (Eichwald) Glibert, p. 140, pl. 9, fig. 7.
- 1950 *Terebralia lignitarum* (Eichwald) Csepreghy-Meznerics, p. 28, pl. 1, fig. 18.
- 1954 *Terebralia bidendata lignitarum* Eichw. Strausz, p. 17, pl. 1, fig. 22a-b.
- 1954 Terebralia lignitarum (Eichw.) Švagrovský, p. 49, pl. 3, figs 3-21.
- 1955 *Terebralia bidentata lignitarum* Eichwald, 1830/1853 – Strausz, p. 37, pl. 3, figs 25, 26.
- 1955 Terebralia lignitarum Eichwald 1830 Moisescu, p. 121, pl. 10, figs 6, 7.
- 1958 *Terebralia bidentata* var. *cingulatior* Sacco Erünal-Erentöz, p. 27, pl. 3, figs 1, 2.

- 1958 *Terebralia lignitarum* (Eichwald) Erünal-Erentöz, p. 28, pl. 3, figs 6, 7.
- 1968 *Terebralia bidentata lignitarum* (Eichwald) Hinculov, p. 128, pl. 30, fig. 14a-b.
- 1968 Terebralia bidentata cingulatior Sacco Hinculov, p. 129, pl. 30, figs 15, 16.
- 1973 *Terebralia lignitarum* (Eichwald) Bohn-Havas, p. 1044, pl. 4, fig. 5.
- 1975 *Terebralia duboisi* (Hörnes. 1856) Bałuk, p. 135, pl. 15, fig. 4.
- 1982 Terebralia lignitarum (Eichwald, 1830) Švagrovský, p. 24, pl. 6, figs 5, 6.
- 1993 *Terebralia lignitara* [*sic*] (Eichwald, 1830) Iljina, p. 76, pl. 9, figs 19, 20.
- 1998 Terebralia bidentata lignitarum (Eichwald) Schultz, p. 54, pl. 20, fig. 18.
- 2002 *Terebralia bidentata* (Defrance *in* Grateloup, 1840) Harzhauser, p. 75, pl. 2, fig. 2.
- 2004 *Terebralia lignitara* (Eichwald 1830) İslamoğlu & Taner, p. 40, pl. 2, fig. 2.
- 2004 *Terebralia lignitara lignitara* (Eichwald 1853) İslamoğlu & Taner, p. 40, pl. 2, fig. 3.
- 2007 *Cerithium duboisi* Hörnes, 1856 Vazzana & Cecalupo, p. 189, pl. 4, figs f-g, l.

Dimensions and material – Maximum height 48.4 mm. Localities 2 & 3: JvdV/1; locality 6: JvdV/1; locality 11: RGM 783 942-943/50+, JvdV/50+; locality 17: NHMW 1874/0058/0982/1, 1874/0058/0983/14, JvdV/13, RGM 783 738/5, MTA 2013/008/4; locality 17a: NHMW 1847/-0058/1596/5, YI 80/50+; locality 18: JvdV/1.

Discussion – As discussed above, this species has frequently been confused with *Terebralia lignitarum*. Harzhauser (2002) synonymised the two taxa, but we treat them here as distinct species. This seems a sensible decision, as the two forms coexist at most localities. We agree with Glibert (1949) that they are relatively easy to distinguish; most specimens of *T. duboisi* have a more elongate shell, shorter spire whorls, above all the last whorl, and weaker varices than specimens of *T. lignitarium*.

Terebralia andrzejowskii Friedberg, 1914 seems to be a specimen with an aberrantly inflated last whorl but otherwise corresponds well to *T. duboisi*. Similarly, most of the shells described by Sacco (1888) as *Potamides monregalensis* Sacco, 1888 from the Burdigalian of Italy probably represent *Terebralia duboisi*. Some of the shells described as *Terebralia bidentata* from the early Miocene of the Erzincan and Sivas Basins in Turkey by Stchepinsky (1939, 1941, 1946) also represent *Terebralia duboisi* (e.g. 1941, pl. 5, fig. 7).

Whilst *Terebralia lignitarum* vanished from the Paratethys during the middle Badenian, *T. duboisi* survived even the Badenian-Sarmatian extinction event in the Paratethys and appeared in Sarmatian strata as rather small, conical shell with delicate, very regular sculpture of small beads. Some of these shells are slightly reminiscent of *Tympanotonos margaritaceus* due to their broad shell and narrow suture [*e.g.* Slovakian shells illustrated in Švagrovský (1971)]. Hoernes (1875) proposed *Cerithium* *pauli* as a name for the Sarmatian shells and already discussed the close relationship to *Terebralia duboisi*. In the Eastern Paratethys the species-group survived even up to the Bessarabian (= latest Serravallian and early Tortonian) when it was represented by more slender shells, treated as *Terebralia menestrieri* (d'Orbigny, 1844) by Kolesnikov (1935).

In the Karaman assemblages *T. duboisi* is found most commonly in the brackish deposits at locality 11 and the brackish levels at Seyithasan (locality 17a).

Distribution - Early Miocene: northeastern Atlantic (Aquitanian-Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1922), Paratethys: Austria (Schaffer, 1912; Harzhauser, 2002); Proto-Mediterranean Sea (Burdigalian): Italy (Sacco, 1895a), Sivas Basin, Turkey (Stchepinsky, 1946), Antalya Basin (late Burdigalian): Turkey (İslamoğlu & Taner, 2004), Iranian Qom Basin (own observation MH). Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1922), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1855; Schultz, 1998), Slovakia (Švagrovský, 1954), Hungary (Csepreghy-Meznerics, 1950; Strausz, 1966; Bohn-Havas, 1973), Romania (Moisescu, 1955; Hinculov, 1968), Poland (Bałuk, 1975), Ukraine (Friedberg, 1914), Eastern Paratethys: Konkian and Sarmatian (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1895a; Vazzana & Cecalupo, 2007).

Genus Potamides Brongniart, 1810

Type species – Cerithium lamarcki Brongniart, 1810. Oligocene, France.

Potamides nodosoplicatus (Hörnes, 1855)

Plate 4, figs 13, 14

- *1855 *Cerithium nodoso-plicatum* Hörn., Hörnes, p. 397, pl. 41, figs 19, 20.
- 1879 *Cerithium biquadratum* Hilb.,Hilber, p. 441, pl. 4, fig. 6.
- 1882 *Cerithium Schaueri* Hilber, Hilber, p. 7, pl. 1, figs 14, 15.
- 1912 Cerithium nodosoplicatum Hoern. Schaffer, p. 157, pl. 51, figs 33, 34.
- 1914 Potamides nodosoplicatus Hoern. Friedberg, p. 280, pl. 17, fig. 14a-b.
- 1914 Potamides Schaueri Hilb. Friedberg, p. 284 (pars), pl. 17, fig. 18 (non fig. 19).
- 1914 Potamides biseriatus Friedb., Friedberg, p. 293, pl. 18, fig. 2a-b.
- 1935 *Cerithium nodosiplicatum* Hoernes Kolesnikov, p. 227, pl. 28, figs 22-24.
- 1836/37 *Pirenella biseriata* Friedberg Sieber, p. 480, pl. 25, figs D2-3.

- 1940 *Cerithium nodosoplicatum* Hoernes Simionescu & Barbu, p. 91, pl. 2, fig. 22.
- 1954 *Pirenella nodosoplicata* (M. Hoernes) Papp, p. 41, pl. 6, figs 25, 26.
- 1954 Pirenella nodosoplicata (M. Hörnes) Švagrovský, p. 5, pl. 1, figs 1-13.
- 1955 *Pirenella nodosoplicata biquadrata* Hilber Strausz, p. 64, pl. 4, fig. 40.
- 1960 Pirenella nodosoplicata nodosoplicata (M. Hoernes) Švagrovský, p. 139, pl. 8, figs 1-3.
- 1960 Pirenella nodosoplicata biseriata (Friedberg) Švagrovský, p. 140, pl. 8, figs 4-6.
- 1962 Potamides (Pirenella) nodosoplicatus biquadratus Hilber – Strausz, p. 38, pl. 7, fig. 22.
- 1966 Potamides (Pirenella) nodosoplicatus biquadratus Hilber, 1879 – Strausz, p. 153, pl. 7, fig. 22.
- 1971 Pirenella nodosoplicata nodosoplicata (M. Hoernes, 1856) Švagrovský, p. 337, pl. 57, figs 8-15.
- 1974 *Pirenella nodosoplicata nodosoplicata* (M. Hoernes) Papp, p. 344, pl. 6, figs 25-29.
- 1998 Pirenella nodosoplicata nodosoplicata (Hörnes) Schultz, p. 130, pl. 59, fig. 8a-d.
- 1993 *Potamides (Pirenella) cicur* (Zhizhchenko, 1934) – Iljina, p., pl. 9, figs 4, 5.
- 2002 *Granulolabium nodosoplicatum* (Hörnes, 1856) Harzhauser & Kowalke, p. 66, pl. 13, figs 6, 7, 11.
- 2003 Pirenella gamlitzensis gamlitzensis (Hilber 1879)
 İslamoğlu & Taner, p. 38, pl. 1, figs 1, ?13.
- ?non 1950 Potamides nodosoplicatus (Hörn.) Csepreghy-Meznerics, p. 27, pl. 1, fig. 12.
- non 1955 Pirenella nodosoplicata Hörn. Strausz, p. 57, pl. 4, fig. 38.
- non 1955 Pirenella nodosoplicata petersi Auing. Friedb. Strausz, p. 64, pl. 4, fig. 37.
- non 1960 Pirenella nodosoplicata (Hörnes, 1856) Kojumdgieva & Strachimirov, p. 108, pl. 31, fig. 16.
- non 1966 Potamides (Pirenella) nodosoplicatus Hörnes, 1856 – Strausz, p. 151, pl. 7, fig. 20.
- ?non 1973 Pirenella nodosoplicata (Hörnes) 1856 Bohn-Havas, p. 1045, pl. 4, fig. 7.

Dimensions and material – Maximum height 14.7 mm. Locality 6: JvdV/1; locality 11: JvdV/50+, RGM 794 068/1 (ex JvdV), RGM 794069/1 (ex JvdV), RGM 794 034/19; locality 17a: YI 363/21.

Discussion – The generic placement of this species is not fully resolved. Harzhauser & Kowalke (2002) treated it as a species of *Granulolabium* based on similarities in protoconch architecture, whilst Lozouet (1986) included it in *Potamides* (only fig. 20 of Hörnes, 1855). According to Reid *et al.* (2008), the middle to late Miocene species group of *Potamides theodiscus*, in which *P. nodosoplicatus* belongs, represents *Potamides*, whilst the extant *Pirenella conica* (= *Cerithideopsilla conica*) is a descendant of a Miocene immigrant from the Indo-West Pacific Region that is unrelated to the European lineage. Therefore, we prefer to retain this species within *Potamides*.

A lot of confusion exists concerning this species in the

literature. Many authors, such as Friedberg (1914) and Strausz (1955, 1966) confused it with specimens of *Granulolabium bicinctum* or other taxa and included also very slender, high-spired shells. Moreover, the separation from the middle Miocene *Cerithium gamlitzensis* Hilber, 1879, which is also very inconsistently used in the literature, is vague. Typical representatives of *Potamides nodosoplicatus* are rather small with a slightly cyrtoconoid spire, resulting in an elongate pupoid outline. The illustrated Turkish shell has somewhat reduced sculpture but is otherwise very close to the Sarmatian Paratethyan shells described by Švagrovský (1971) and Harzhauser & Kowalke (2002). These shells are coeval with the Turkish ones, agree in outline and develop a comparably wide and excavated aperture.

Cecalupo (2005) considered the Paratethyan Miocene shells to be conspecific with the Pliocene-Recent species Cerithideopsilla conica (de Blainville, 1829). However, it is not completely clear what Cecalupo's (2005) intentions were, as he synonymised C. nodosoplicatus with P. conica on page 152, and then on page 153 referred to pl. 20, fig. 1a, a copy of Hörnes's (1855, pl. 42, fig. 6) figure of Cerithium plicatum Bruguière, 1792, which is on the correct page with other illustrations of Granulolabium plicatum. Most specimens of both P. nodosoplicata and *P. conica* have sculpture composed of two rows of strong tubercles below the suture, but as can be predicted by the numerous varieties decribed for both of these species, their sculpture is highly variable. However, after examining many Recent specimens we do not believe them to be conspecific. Pirenella conica differs from P. nodosoplicata in having a shell with a wider apical angle and most importantly the recent shells are larger and have a far more flattened base.

Potamides etruscus (Mayer-Eymar, 1864), from the Pliocene of Siena, Italy, is a very similar species in size, shell outline and aperture (see de Stefani & Pantanelli, 1878, p. 158; de Stefani, 1888/89, p. 47, pl. 11, figs 29-31). Although it may be a closely related species, *P. etruscus* differs distinctly in the presence of three spiral rows of nodes of equal strength.

Distribution – This species was unknown so far outside the Paratethys, where it appears during the early Burdigalian (Eggenburgian) and persists up the late Serravallian (Sarmatian). **Early Miocene**: Paratethys (Burdigalian): Austria (Schaffer, 1912); Proto-Mediterranean (late Burdigalian): Antalya Basin (İslamoğlu & Taner, 2003). **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1855; Papp, 1954; Schultz, 1998), Slovakia (Švagrovský, 1971), Ukraine (Friedberg, 1914), Hungary (Strausz, 1962, 1966), Romania (Simionescu & Barbu, 1940), Moldavia (Kolesnikov, 1935), Eastern Paratethys (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subfamily Bittiinae Cossmann, 1906 Genus *Bittium* Gray, 1847

Type species – Strombiformis reticulatum da Costa, 1778,

by subsequent designation (Gray, 1847). Recent, Europe.

Bittium reticulatum (da Costa, 1778) Plate 5, figs 1-4; Plate 55, figs 2, 3

- *1778 Strombiformis reticulatum da Costa, p. 117, pl. 8, fig. 13.
- 1855 Cerithium scabrum Olivi Hörnes, p. 410, pl. 42, figs 16, 17 [non Bittium scabrum (Olivi, 1972)].
- 1872 Strombiformis reticulatus Da Costa S.V. Wood, p. 50, pl. 5, fig. 22.
- 1914 Bittium reticulatum Da Costa Friedberg, p. 302, pl. 18, figs 10, 11.
- 1918 Bittium reticulatum (Da Costa) Harmer, p. 414, pl. 41, figs 1-3.
- 1922 Bittium reticulatum var. exferrugineum Sacco Cossmann & Peyrot, p. 282, no. 614, pl. 7, figs 51, 52.
- 1936-37 Bittium reticulatum Costa Sieber, p. 489, pl. 25, figs A1, 3.
 - 1954 *Bittium reticulatum* Costa Strausz, p. 18, 58, 97, pl. 2, fig. 28.
 - 1954 *Bittium reticulatum* (Da Costa, 1778) Csepreghy-Meznerics, p. 21, pl. 3, fig. 8.
 - 1954 *Bittium reticulatum* (Da Costa, 1778) Strausz, p. 18, pl. 2, fig. 28.
 - 1955 Bittium reticulatum (Da Costa, 1778) Strausz, p. 201, pl. 9, figs 154-174.
 - Bittium reticulatum (Da Costa, 1778) Strausz, p. 35, pl. 6, figs 17-21.
 - 1966 Bittium reticulatum (Da Costa, 1778) Strausz, p. 140, pl. 6, figs 17-21.
 - 1973 Bittium reticulatum (Costa) 1779 [sic] Bohn-Havas, p. 1046, pl. 4, fig. 6.
 - 2000 Bittium (Bittium) reticulatum (Da Costa, 1779 [sic]) Popa & Ianoliu, p. 85, pl. 3, fig. 1.
 - 2002 Bittium reticulatum (Da Costa, 1779 [sic]) Harzhauser, p. 72, pl. 2, fig. 9.
 - 2004a *Bittium reticulatum* (Da Costa, 1778) Landau *et al.*, p. 12, pl. 2, figs 4, 5 (with additional synonyms).
 - 2011 *Bittium reticulatum* (Da Costa, 1778) Landau *et al.*, p. 10, pl. 2, fig. 5.
 - 2012 Bittium reticulatum (Da Costa, 1778) Wesselingh et al., p. 38, figs 3-5.

Dimensions and material – Maximum height 11.9 mm. Localities 2 & 3: JvdV/30, RGM 783 950/10 fragments, YI 82/7; locality 6: JvdV/20; localities 7 & 8: NHMW 1874/0058/0991/4; locality 10: YI 84/23; locality 13: NHMW 1874/0058/0985-1874/0058/0988/4, 1874/0058/0989/50+, JvdV/23, RGM 784 039/3, RGM 783 631/1, YI 83/50+; locality 17: NHMW 1874/0058/0990/30, JvdV/50+, RGM 783 579/1, RGM 783 982/28, MTA 2013/009/7, YI 81/50+.

Discussion – Bittium reticulatum (da Costa, 1778) belongs to the group of European *Bittium* species with convex rather than flat-sided whorls (this group include

B. latreillii Payraudeau, 1826 and *B. lacteum* Philippi, 1836). *Bittium scabrum* (Olivi, 1792) is distinguished by having only three spiral cords. *Bittium jadertinum* (Brusina, 1865) also has four cords, but they are equidistant as opposed to the first and second being more closely spaced as in *B. reticulatum*. Furthermore, *B. jadertinum* does not have any varices, or they are present only on the last 1¹/₂ whorls.

The shells from Turkey fit within the range of variability of *B. reticulatum*. The protoconch is somewhat worn, but in both shells illustrated (Pl. 55, figs 2c, 3) it is multispiral, consisting of about three whorls, similar to that illustrated for the Recent shells (van der Linden & Wagner, 1990, fig. 2). For further discussion see Landau *et al.* (2004a, p. 12).

Distribution - Early Miocene: Paratethys (Aquitanian-Burdigalian): Austria, (Harzhauser, 2002). Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitain Basin, France (Cossmann & Peyrot, 1922), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys, (Langhian-Serravallian): Austria (Hörnes, 1855), Poland (Friedberg, 1914; Bałuk, 1975), Hungary (Strausz, 1954, 1955, 1962, 1966; Bohn-Havas, 1973), Romania (Popa & Ianoliu, 2000); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1986; Landau et al., 2011); western Mediterranean, Estepona Basin, Spain, (Landau et al., 2004a), northeastern Spain (Martinell, 1979; Martinell & Domènech, 1984a; Llop, 1990), France (Martinell & Domènech, 1984b); central Mediterranean, Italy (Caprotti, 1974; Anfossi et al., 1983); Tunisia (Fekih, 1974). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); central Mediterranean, Italy (Malatesta, 1974; Cavallo & Repetto, 1992). Late Pliocene: northeastern Atlantic, British Isles (S.V. Wood, 1872). Pleistocene: western Mediterranean, Balearic Islands (Cuerda Barceló, 1987); central Mediterranean, Italy (Brambilla et al., 1988; Taviani et al., 1998). Recent: northeastern Atlantic, British Isles (Harmer, 1918); northeastern Atlantic, northern Spain southwards to the Canaries, Mediterranean (Verduin, 1976). From the intertidal zone down to about 250 m depth. Lives on seaweeds (Zostera, Posidonia, Cystoseira) or on rocks (Poppe & Goto, 1991).

Bittium sp.

Plate 5, figs 5-7; Plate 55, figs 4, 5

Dimensions and material – Maximum height 9.5 mm. Localities 2 & 3: YI 87/1; locality 13: JvdV/8, RGM 783 631/1, YI 86/5; locality 17: NHMW 1874/0058/0992-1874/0058/0994/3, 1874/0058/0995/50+, JvdV/50+, RGM 783 577/1, RGM 783 578/1, RGM 783 983/18, YI 85/50+.

Discussion – A second *Bittium* species coexists with *Bittium reticulatum* (da Costa, 1778) in the Seyithasan deposits, but differs from this species in being smaller

and much more slender. This smaller species has more strongly convex whorls and the varices are more strongly developed, deforming the regular shape of the spire. The last whorl and aperture are slightly shorter than in *B. re-ticulatum* and the last whorl is more strongly constricted at the base. The protoconch is also multispiral (Pl. 55, figs 4b, 5), but is taller than in *B. reticulatum*, consisting of at least four whorls.

This species has a superficial similarity to the middle Miocene Paratethyan species *Bittium spina* (Hörnes, 1855) in the slenderness and convexity of the whorls. They differ constantly in the regular shape, the pointed nodes and the development of only two sharp spiral ribs on early teleoconch whorls in *B. spina*. A species with comparably irregular growth is the early Miocene *Bittium larrieyense* Vignal, 1911 from France. Its weakly convex whorl outline and the "*Terebralia*-like" nodes, however, allow a very clear separation of the two species.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Cerithidium Monterosato, 1884

Type species – Cerithium submamillatum de Rayneval & Ponzi, 1854, by monotypy. Recent, Mediterranean Sea.

Cerithidium? schwartzi (Hörnes, 1856) Plate 55, fig. 6

- *1856 Cerithium Schwartzi Hörn., Hörnes, p. 412, pl. 42, fig. 18.
- 1914 Seila Schwartzi Hoern. Friedberg, p. 313, pl. 18, fig. 26
- 1936/37 Seila (Seila) Schwartzi (Hörn. M.) Sieber, p. 506, pl. 25, fig. B3.
 - 1966 *Seila schwartzi* Hörnes, 1856 Strausz, p. 168, pl. 5, fig. 25
 - 1976 *Bittium (Cerithidium) schwartzi* (Hoernes, 1856) – Gründel, p. 52, text-fig. 12, pl. 1, figs 7, 8.
- non 1970 Seila schwartzi Hörnes Bałuk, p. 118, pl. 9, fig. 9 [= Cerithidium? turritella (Eichwald, 1853)].

Dimensions and material – Maximum height 4.0 mm. Locality 17: RGM 783 576/2.

Discussion – The generic placement of this species in the literature has been quite unstable. It was originally described by Hörnes (1856) in *Cerithium*, and considered to be a species of *Bittium* by Boettger (1906). Later it was frequently placed in the cerithiopsid genus *Seila* (Sieber, 1936-37; Strausz, 1966). Gründel (1976) proved the relation with Bittiinae based on protoconch and sculptural characters and placed this species in *Cerithidium* Monterosato, 1884 (as a subgenus of *Bittium*), despite the rather atypical reduction of the axial sculpture. This paper was overlooked by the following authors such as

Bałuk (1975), who placed this species in Semibittium Cossmann, 1896 [type species Cerithium cancellatum Lamarck 1804 from the Eocene of France, designated by Cossmann (1897, p. 60); this name is available contrary to the opinion of Houbrick (1993)]. Several Miocene European species have been placed also in Semibittium by various authors (e.g. Bittium multiliratum Brusina, 1877; Cerithium turritella Eichwald, 1853; Bittium duvergieri Cossmann & Peyrot, 1922). All these species are characterised by their small size, around 5 mm in height, moderately convex whorls and especially by the predominant spiral sculpture. We are not convinced that this group is congeneric with the Eocene species, which are larger and have nearly straight-sided whorls. Nor are we convinced that the Miocene species should all be placed in Cerithidium, although we provisionally follow Gründel (1976). The Turkish shells are less slender than typical Paratethyan specimens of Cerithidium? schwartzi, although comparably stocky morphs are also present in the NHMW collections. In addition, their spiral ribs are somewhat broader and the whorls are slightly shorter. These delicate differences are probably not sufficient for a separation at the species level. The late Serravallian specimens from Turkey are stratigraphically younger than the Langhian to early Serravallian specimens from the Paratethys, which may also account for the slight differences between the two populations.

The slender *Turritella*-like shape of *C.? turritella* (Eichwald, 1853), also from the middle Miocene Paratethys, allows a clear separation from *Cerithidium? schwartzi* (Hörnes, 1856).

Distribution – **Middle Miocene:** Paratethys (Langhian-Serravallian): Vienna Basin, Austria, Czech Republic (Hörnes, 1856), Poland, Ukraine (Friedberg, 1914), Hungary (Strausz, 1966), Romania (Boettger, 1907); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Modulidae P. Fischer, 1884 Genus *Modulus* Gray, 1842.

Type species – Trochus modulus Linnaeus, 1758, by subsequent designation (Gray, 1847). Recent, Caribbean.

Modulus basteroti Benoist, 1874

Pl. 4, fig. 15

- *1874 Modulus Basteroti (Nobis), Benoist, p. 285.
- 1895b Modulus Basteroti Benoist Cossmann, p. 7, pl. 3, figs 15, 16.
- 1896d *Modulus Basteroti* (Ben.) Sacco, p. 4, pl. 1, fig.
 2.
- 1896d *Modulus Basteroti* var. *spiratissima* Sacc., Sacco, p. 4, pl. 1, fig. 3.
- 1896d Modulus Basteroti var. rotundolaevis Sacc., Sacco, p. 4, pl. 1, fig. 4.
- 1906 Modulus Basteroti Benoist Cossmann, p. 202, pl. 13, figs 16, 17.

- 1922 *Modulus Basteroti* Benoist Cossmann & Peyrot, p. 319, no. 646, pl. 5, figs 6-10.
- 1928 Modulus Basteroti Ben. Friedberg, p. 603, pl. 38, figs 17, 18.
- 1960 *Modulus basteroti* Benoist 1873 [*sic*] Kojumdgieva & Strachimirov, p. 111, pl. 32, figs 1, 2.
- 1961 Gibbula (Gibbula) buchi Dub. Florei, p. 681, pl.
 6, figs 38, 39 [non Trochus buchi Dubois de Montperreux, 1831 = Gibbula catenularis (Eichwald, 1830)].
- 1962 Modulus basteroti Benoist Strausz, p. 128, pl. 53, figs 14, 15
- 1966 *Modulus basteroti* Benoist, 1873 [*sic*] Strausz, p. 126, pl. 53, figs 14, 15.
- 1975 Modulus basteroti Benoist, 1873 [sic] Bałuk, p.
 128, pl. 15, fig. 1.
- 2001 *Modulus basteroti* Benoist, 1874 Lozouet *et al.*, p. 22, pl. 6, fig. 1.

Dimensions and material – Maximum height 14.2 mm. Locality 17a: NHMW 1847/0058/1572/1 (juvenile), NHMW 1847/0058/1573/2 (incomplete).

Discussion – Modulus basteroti Benoist, 1874 has a very variable shell, both in shape and in strength of sculpture. The specimen illustrated by Lozouet *et al.* (2001a, pl. 6, fig. 1) has a rather squat biconic profile, whereas the Turkish shell, as well as many seen from the Paratethys (see Kojumdgieva & Strachimirov, pl. 32, figs 1, 2) seem to have a taller spire and longer siphonal canal. Both forms are present in the early Miocene of the Aquitaine Basin (see Cossmann, 1906, pl. 13, figs 16, 17; both forms from Aquitaine Basin in NHMW collections).

This species is extremely uncommon in the Turkish deposits. It is represented by one juvenile and one incomplete adult shell found in the brackish assemblage at Seyithasan. Today *Modulus* species inhabit shallow vegetated habitats, and form a prominent faunal component of many marine and estuarine seagrass communities (Houbrick 1980).

Distribution – Early Miocene: northeastern Atlantic (Aquitanian): Aquitaine Basin, France (Cossmann, 1906; Cossmann & Peyrot, 1922; Lozouet *et al.*, 2001); Proto-Mediterranean Sea (Burdigalian): Italy (Sacco, 1896d). Middle Miocene: Paratethys (Langhian-Serravallian): Hungary (Strausz, 1962, 1966), Bulgaria (Kojumdgieva & Strachimirov, 1960), Poland (Friedberg, 1928; Bałuk, 1975); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Siliquariidae Anton, 1838 Genus *Tenagodus* Guettard, 1770 Subgenus *Tenagodus s. str.*

Type species – Serpularia anguina Linnaeus, 1758, by subsequent designation (Sacco, 1896b). Recent, Indian Ocean.

Tenagodus (Tenagodus) obtusus (Schumacher, 1817) Plate 5, fig. 8

- *1817 Anguinaria obtusa Schumacher, p. 262.
- 1958 *Tenagodus anguineus* var. *miocenicus* Cossmann et Peyrot – Erünal-Erentöz, p. 20, pl. 2, fig. 13.
- 1988 *Tenagodus (Tenagodus) obtusus* (Schumacher, 1817) Chirli, p. 16, pl. 1, fig. 8.
- 1998 Siliquaria (Siliquaria) anguinea (Linné) Schultz, p. 58, pl. 22, fig.8.
- 2004a *Tenagodus (Tenagodus) obtusus* (Schumacher, 1817) Landau *et al.*, p. 14, pl. 2, fig. 7 (with additional synonyms).
- 2012 *Tenagodus (Tenagodus) obtusus* (Schumacher, 1817) Wesselingh *et al.*, p. 46, fig. 40.

Dimensions and material – Maximum height 40.4 mm. Locality 9: RGM 783 812/3; locality 13: NHMW 1874/0058/0999/1, 1874/0058/1000/13, JvdV/2, YI 88/1; locality 17: NHMW 1847/0058/1650/1.

Discussion - The presence of a continuous shell slit places this species in Tenagodus sensu stricto. There is agreement in the literature that the early Pliocene to Recent European specimens represent a single species Tenagodus (Tenagodus) obtusus (Schumacher, 1817) (= Tenagodus anguinus auct. non Linnaeus, 1758, which is a tropical Indopacific species). The same cannot be said about the Miocene forms. Most authors report them under the name Tenagodus anguinus miocaenicus Cossmann & Peyrot, 1921 (Glibert, 1949; Kojumdgieva & Strachimirov, 1960; Strauz, 1966; Bałuk, 1975), although as pointed out by Lozouet et al. (2001a, p. 28), they should be referred to by the earlier name Tenagodus terebellus (Lamarck, 1818). This separation is made mainly on the basis of size, the Miocene specimens being smaller (Glibert, 1949). The Turkish Miocene specimens are as large as most Pliocene ones and therefore separating the Miocene forms as a smaller chronosubspecies is unjustified. For further discussion see Landau et al. (2004a, p. 14).

Distribution - Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896b). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Landau et al., 2004a). Middle Miocene: northeastern Atlantic (Aquitanian-Serravallian): Aquitaine Basin, (Cossmann & Peyrot, 1921), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Bulgaria (Kojumdgieva & Strachimirov, 1960), Poland (Bałuk, 1975), Hungary (Strausz, 1966); Vienna Basin, Austria (Schultz, 1998); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic, Messinian, Loire Basin, France (NHMW collection); Proto-Mediterranean Sea, Tortonian, Po Basin, Italy (Sacco, 1896b). Early Pliocene: North Sea Basin, Belgium (Marquet, 1997a); western Mediterranean, Estepona Basin, Spain, (Landau et al., 2004a); central Mediterranean, Italy (Anfossi et al., 1983). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1896b; Malatesta, 1974; Chirli, 1988; Cavallo & Repetto, 1992). **Recent**: Mediterranean to West Africa, 100-300 m depth (Poppe & Goto, 1991).

Family Turritellidae Lovén, 1847 Subfamily Turritellinae Lovén, 1847

In this work we follow Beu (2010) and have tried to use a more restricted concept of monophyletic genera. We are not aware of any molecular phylogenetic work on the group to date. Marwick (1957) reviewed the genera of the Turritellidae and drew special attention to the shape of the outer lip trace, using the terms lateral sinus for the trace on the whorl sides and the basal sinus for the trace on the base. He also highlighted the importance in the order of appearance of the cords on the neanic whorls and used a lettering system for the spiral cords in which B was the medial primary, D the peribasal primary generally involved with the suture, A was the first to appear adapical to B and C the first to appear abapical to B, between B and D (Marwick, 1957, p. 148). We have adopted this descriptive nomenclature in this section.

In the European literature there is no consensus as to which genera/subgenera to use for the fossil Neogene species. Most recent workers have not used subgenera (*i.e.* Bernasconi, 1990; Landau *et al.*, 2004a; Sosso & dell'Angelo, 2010), but placed all the species in the genus *Turritella* (*s. lat.*). In the spirit of this work we have attempted to ascribe the Turkish fossil species to genera using Marwick's criteria. We stress that the generic attributions here are provisional pending an in-depth review of the European Neogene turritellids and molecular phylogenetic work on the Recent species, which is beyond the scope of this work.

Genus Ptychidia Handmann, 1882

Type species – Turritella (Ptychidia) vindobonensis Handmann, 1882, by monotypy. Miocene, Paratethys.

Ptychidia vindobonensis (Handmann, 1882) Plate 5, fig. 9; Plate 55, fig. 7; Plate 79, fig. 1

- 1848 *Turritella Vindobonensis* Partsch, M. Hörnes *in* Cžjžek, p. 21, no. 302 (*nomen nudum*).
- 1855 Turritella turris Bast. Hörnes, p. 423, pl. 43, figs 15, 16 (non de Basterot, 1825).
- 1866 *Turritella turris* Bastérot Fischer, p. 248 (*non* de Basterot, 1825).
- *1882 *Turritella (Ptychidia) Vindobonensis* Partsch forma *typica* Handmann, p. 215 [*nom nov. pro Turritella turris* Bast. *in* Hörnes, 1855 (*partim*, pl. 43, fig. 15 only)].
- 1882 Turritella (Ptychidia) Vindobonensis Partsch var. vermicularis Handmann, p. 215 [non Turritella vermicularis (Brocchi, 1814)].
- 1882 *Turritella (Ptychidia) Vindobonensis* Partsch var. *quadricarinata* Handmann, p. 215.

- 1882 Turritella (Ptychidia) Vindobonensis Partsch var. tricarinata Handmann, p. 215 [nov. nom. pro Turritella turris Bast. in Hörnes, 1855 (partim, pl. 43, fig. 16 only); non Turritella tricarinata (Brocchi, 1814)].
- 1882 *Turritella (Ptychidia) Vindobonensis* Partsch var. *consolida* Handmann, p. 215.
- 1882 *Turritella (Ptychidia) Vindobonensis* Partsch var. *exsuperans* Handmann, p. 215.
- 1882 *Turritella (Ptychidia) Vindobonensis* Partsch var. *complanata* Handmann, p. 215.
- 1882 *Turritella (Ptychidia) Vindobonensis* Partsch var. *Archimedica* Handmann, p. 216.
- 1882 *Turritella (Ptychidia) Vindobonensis* Partsch var. *Semiarchimedis* Handmann, p. 216.
- 1896a Turritella turris var. badensis Sacc., Sacco, p. 3.
- 1909 Turritella turris var. badensis Sacco Friedberg, p. 255, pl. 2, figs 3, 4.
- 1909 Turritella turris var. sexcincta mihi, Friedberg, p. 255, pl. 2, fig. 5.
- 1909 Turritella turris var. oligocincta mihi, Friedberg, p. 255, pl. 2, figs 6, 7.
- 1909 *Turritella turris* var. *duplicata* mihi, Friedberg, p. 255, pl. 2, figs 8, 9.
- 1909 *Turritella turris* var. *tricincta* mihi, Friedberg, p. 255, pl. 2, fig. 10.
- 1914 *Turritella turris* Bast. Friedberg, p. 327, text-fig.
 70, pl. 19, figs 14, 15 (*non* de Basterot, 1825).
- 1914 Turritella turris var. sexcincta Friedb. Friedberg, p. 329.
- 1914 *Turritella turris* var. *oligocincta* Friedb. Friedberg, p. 329, text-fig. 71.
- 1914 Turritella turris var. duplicata Friedb. Friedberg, p. 330.
- 1916 *Turritella Vindobonensis* Partsch *in* Hörnes Stefanini, p. 92, pl. 2, fig. 31.
- 1954 Turritella (Haustator) badensis badensis Sacc. Strausz, p. 13, pl. 1, fig. 15.
- 1955 *Turritella (Archimediella) turis [sic]* Basterot, 1825 – Moisescu, p. 123, pl. 10, fig. 11 (*non* de Basterot, 1825).
- 1956 Turritella (Haustator) badensis Sacco -Csepreghy-Meznerics, p. 381, pl. 2, fig. 17.
- 1956 *Turritella (Haustator) badensis sexcincta* Friedberg – Csepreghy-Meznerics, p. 382, pl. 2, fig. 30.
- 1958 *Turritella (Turritella) turris* var. *capriciosa* Erünal-Erentöz, p. 11, pl. 1, figs 9-15.
- 1958 *Turritella (Turritella) turris* var. *taurolaevis* Sacco – Erünal-Erentöz, p. 12, pl. 1, fig. 16.
- 1958 *Turritella (Haustator) turris* Basterot, 1825 var. Hölzl, p. 180, pl. 18, fig. 1 (*non* de Basterot, 1825).
- 1958 *Turritella turris* Basterot Jovanović & Dolić, pl. 2, fig. 14 (*non* de Basterot, 1825).
- 1958 Turritella (Haustator) badensis badensis Sacco Sieber, p. 239, pl. 3, figs 2, 8/6.
- 1958 *Turritella (Haustator) badensis plana* Sieber, p. 240, pl. 1, fig. 32.
- 1958 *Turritella* (*Haustator*) badensis tricarinata (Handm.) Sieber, p. 240, pl. 1, fig. 18.
- 1958 Turritella (Haustator) badensis carinata Sieber, p.

241, pl. 1, fig. 24, 8/7.

- 1959 *Turritella turris* Basterot Stevanović & Miloševic, p. 95, pl. 4, fig. 2 (*non* de Basterot, 1825).
- 1960 *Turritella turris* Basterot Eremija, pl. 1, fig. 11 (*non* de Basterot, 1825).
- 1960 Turritella (Haustator) turris turris Bast. Sieber,
 p. 234, pl. 1, figs 8, 16; pl. 3, fig. 8/1 (non de Basterot, 1825).
- 1960 Turritella (Haustator) badensis badensis Sacco Sieber, p. 239, pl. 3, figs 2, 8/6.
- 1960 *Turritella (Haustator) badensis plana* Sieber, p. 240, pl. 1, fig. 32.
- 1960 *Turritella (Haustator) badensis* var. *tricarinata* (Hand.) Sieber, p. 240, pl. 1, fig. 18.
- 1960 *Turritella (Haustator) badensis carinata* Sieber, p. 241, pl. 1, fig. 24, pl. 3, fig. 8/7.
- 1960 Turritella (Haustator) badensis Sacco Báldi, p. 58, pl. 1, fig. 13.
- 1960 Turritella (Archimediella) turris var. badensis
 Sacco 1895 Kojumdgieva & Strachimirov, p. 113, pl. 32, fig. 8.
- 1962 Turritella turris badensis Sacco Strausz, p. 23, pl. 3, figs 13-17, pl. 78, fig. 4.
- 1963 *Turritella turris* Basterot Grković, p. 119, pl. 1, fig. 4 (*non* de Basterot, 1825).
- 1966 Turritella turris badensis Sacco, 1895 Strausz, p. 99, pl. 3, figs 13-17, pl. 78, fig. 4.
- Archimediella turris Basterot Zelinskaja et al., p.
 170, pl. 41, fig. 2 (non de Basterot, 1825).
- 1968 Archimediella turris var. gracilis (Friedberg, 1909) – Zelinskaja et al., p. 170, pl. 41, fig. 3.
- 1969 Archimediella turris badensis Sacco 1895 Atanacković, p. 197, pl. 9, figs 1, 2.
- 1970 Turritella (Torculoidella) bieniaszi Friedb. Rado & Mutiu, p. 148, pl. 5, figs 9-11.
- 1971 Turritella turris badensis Sacco 1895 Stancu et al., p. 125, pl. 8, fig. 1.
- 1971 *Turritella (Archimediella) turris* Basterot Eremija, p. 34, pl. 9, figs 7, 8 (*non* de Basterot, 1825).
- 1973 Turritella (Haustator) badensis Sacco 1895 Bohn-Havas, p. 1040, pl. 3, fig. 11.
- ?1973 Turritella (Haustator) turris carinatoides Sacco 1895 – Bohn-Havas, p. 1040, pl. 3, fig. 12.
- 1975 Turritella (Haustator) badensis Sacco, 1895 Bałuk, p. 105, pl. 12, figs 22-27.
- 1978 Turritella (Haustator) badensis badensis Sacco, 1895 – Steininger et al., p. 331, pl. 2, fig. 1.
- 1978 *Turritella (Haustator) badensis plana* Sieber, 1960 – Steininger *et al.*, p. 364, pl. 2, fig. 2.
- 1978 *Turritella (Haustator) badensis carinata* Sieber, 1960 – Steininger *et al.*, p. 364, pl. 2, fig. 3.
- 1982 Turritella (Haustator) turris turris Basterot, 1825
 Mikuž, p. 58, pl. 1, figs 1-3, 6-8 (non de Basterot, 1825).
- 1982 Turritella (Haustator) badensis plana Sieber, 1960 [sic] – Mikuž, p. 78, pl. 5, fig. 2.
- 1982 Turritella (Haustator) badensis carinata Sieber,
 1960 [sic] Mikuž, p. 80, pl. 5, fig. 3.
- 1998 Turritella (Haustator) badensis plana Sieber Schultz, p. 56, pl. 21, fig. 3.

- 1998 Turritella (Haustator) badensis carinata Sieber Schultz, p. 56, pl. 21, fig. 4.
- 2003 *Turritella badensis* Sacco Mikuž, p. 308, pl. 10, fig. 22.
- 2009 *Turritella (Haustator) turris turris* Basterot, 1825 – Mikuž, p. 8, pl. 1, fig. 1 (*non* de Basterot, 1825).
- 2009 Turritella (Haustator) badensis badensis Sacco, 1895 – Mikuž, p. 10, pl. 1, fig. 11.
- 2009 *Turritella (Haustator) badensis plana* Sieber, 1960 [sic] Mikuž, p. 10, pl. 1, fig. 12.
- 2009 Turritella (Haustator) badensis carinata Sieber, 1960 – Mikuž, p. 10, pl. 1, fig. 13.
- non 1899 Turritella turris f. asologermanica de Gregorio, p. 11, pl. 1, fig. 4 (might be close to Turritella partschi Rolle, 1856).
- non 1993 Turritella badensis Sacco, 1895 Iljina, p. 35, pl. 3, fig. 12.

Dimensions and material – Maximum height 69.7 mm. Localities 2 & 3: JvdV/50+, RGM 783 932/50+, MTA 2013/010/35, YI 96/50+; locality 6: NHMW 1874/0058/1500/14, RGM 783 863/28; localities 7 & 8: NHMW 1874/0058/1002/4, JvdV/12, RGM 783 878/50+; locality 9: JvdV/50+, RGM 783 813/50+, YI 100/14; locality 10: MTA 2013/011/8, YI 101/50+; locality 12: JvdV/11, RGM 783 608/31; locality 13: NHMW 1874/0058/1001/1, 1847/0058/1671/1, 1874/0058/1002/23, JvdV/17, RGM 784 015/2, RGM 783 637-638/50+, YI 97/50+, MTA 2013/090/10; locality 17: JvdV/10, RGM 783 730/1, YI 99/50+; locality 18: JvdV/33. Exact locality unknown: AÜ LE-K-202/1.

Discussion – The protoconch consists of just over 1.5 smooth whorls with a medium-sized nucleus (dp = 300 μ m, hp = 230 μ m, dp/hp = 1.3, dp1 = 230 μ m, dn = 140 μ m; Pl. 55 fig. 7b, c). The transition to the teleoconch is marked by the beginning of the spiral sculpture. On the first teleoconch whorl the cord B is well developed, with B and C weaker. On the third teleoconch whorl a secondary spiral cord develops between A and B, which weakens abapically, making the spire whorls progressively less angular and more convex. Further cords of irregular strength develop on later whorls. The lateral and basal sinuses are combined to form a wide, shallow sinus, sweeping back from the adapical suture in an almost even, weakly convex line to the columella. The teleoconch is covered by a pustular microsculpture (Pl. 55, fig. 7d). Under UV light a very clear colour pattern of rows of small spots running along the tops of the spiral cords and irregular vertical flammules can be seen (Pl. 79, fig. 1).

In the fossil literature, this species has been consistently placed in the subgenus *Haustator* Montfort (1810) (type species: *Turritella gallicus* Montfort, 1810, by original designation; Eocene France). However, if we follow Marwick's (1957) generic description, *Turritella vindobonensis* can immediately be excluded from the genus. According to Marwick (1957, p. 154) the neanic whorls of *Haustator* species are tricostate, as in *T. vindobonensis*,

with the primaries starting in the order C-B-A, whereas in *T. vindobonensis* the order is B-A-C, with C and A appearing simultaneously. Moreover, *Haustator* has a moderately deep, moderately oblique lateral sinus, whereas the lateral sinus in *T. vindobonensis* is very shallow, similar to that illustrated by Marwick (1957, p. 146, fig. 1) for the genus *Turritella*. The order of appearance of the cords is also similar to that seen in the genus *Turritella*, except that the secondary cord between A and C does not begin before C, and never rivals B in strength as occurs in the genus *Turritella*. Handmann (1882) introduced the subgenus *Ptychidia* for *Turritella vindobonensis*, which was overlooked by all subsequent authors.

Ptychidia vindobonensis Handmann, 1882 has often been confused with, or considered a subspecies of 'Turritella' turris de Basterot, 1825, an early Miocene species from France. Although the later adult whorls are sometimes quite similar, the early adult whorls are not. In 'T'. turris the first few whorls are not carinate, as in P. vindobonensis, and primary cords B and C appear simultaneously and are of equal strength on the first teleoconch whorl, one at the periphery, the second below. Unfortunately the protoconch is not preserved in the specimens of 'T'. turris at hand (NHMW collection). In both species the sculpture on the later adult whorls is quite variable, which has led to the long synonymy listed above. Ptychidia vindobonensis is among the most abundant species in the Langhian and Serravallian of the Paratethys. Its variability in the strength of spiral ribs in adult specimens is reflected by the synonymy including about 15 names, given above.

This species was first mentioned as Turritella Vindobonensis Partsch in a list of Miocene fossils from the Vienna Basin in an annotation by Hörnes (1848) added to the geological map by Cžjžek (1848). Hörnes referred to the name on the collection labels in the Natural History Museum Vienna given by Partsch as curator. Both combinations are unavailable: vindobonensis Partsch, 1848 is a manuscript name and vindobonensis Hörnes, 1848 is a nomen nudum. The problem seemed to be solved when Hörnes (1855) considered the middle Miocene shells to be conspecific with Turritella turris. Sacco (1896a) recognised that these taxa are not conspecific and introduced Turritella badensis for the Austrian shells, a name accepted in various combinations by later authors. All, however, overlooked the paper by Handmann (1882) in which the Austrian turritellids were discussed in great detail and Turritella vindobonensis was made available. Although it might be desirable to treat T. badensis as a nomen protectum, the use of T. vindobonensis by Stefanini (1916) prevents it from being treated as a nomen oblitum.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1855; Sieber, 1960; Steininger *et al.*, 1978; Schultz, 1998), Poland (Friedberg, 1909, 1914; Bałuk, 1975), Hungary (Baldí, 1960; Strausz, 1962, 1966; Csepreghy-Meznerics, 1956; Bohn-Havas, 1973), Bulgaria (Kojumdgieva & Strachimirov, 1960), Bosnia (Eremija, 1959, 1971a, b), Serbia (Jovanovíc & Dolić, 1958; Stevanović & Miloševic, 1959), Romania (Moisescu, 1955, Rado & Mutiu, 1970; Stancu *et al.*, 1971), Slovenia (Mikuž, 1982, 2003, 2009), Ukraine (Zelinskaja *et al.*, 1968), Bosnia (Grković, 1963; Atanacković, 1969); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Fischer, 1866; Erünal-Erentöz, 1958).

Genus Oligodia Handmann, 1882

Type species – Turritella bicarinata Eichwald, by subsequent designation herein. Neogene, Europe.

Oligodia bicarinata (Eichwald, 1830)

Plate 5, fig. 10; Plate 55, fig. 8; Plate 79, fig. 2

- *1830 Turritella bicarinata Eichwald, p. 220.
- 1831 Turritella scalaria Léop. de Buch Dubois de Montpereux, p. 36, pl. 2, fig. 18.
- 1831 *Turritella duplicata* Lin. Dubois de Montpereux, p. 37, pl. 2, fig. 19 (*non* Linnaeus, 1758).
- 1831 Turritella Archimedis Alex. Brong. Dubois de Montpereux, p. 38, pl. 2, figs 21, 22.
- 1853 *Turritella bicarinata* mihi Eichwald, p. 280, pl. 10, fig. 23.
- 1855 *Turritella bicarinata* Eichw. Hörnes, p. 426, pl. 43, figs 8-12.
- 1882 *Turritella (Oligodia) bicarinata* Eichw. Handmann, p. 217.
- 1889 *Turritella bicarinata* Eichw. Handmann, p. 64, pl. 4, fig. 42.
- 1896a Archimediella bicarinata var. subunocincta Sacc., Sacco, p. 15.
- 1896a Archimediella bicarinata var. taurocrassula Sacc., Sacco, p. 15, pl. 1, fig. 48.
- 1896a Archimediella bicarinata var. subtricarinatula Sacc., Sacco, p. 15, pl. 1, fig. 49.
- 1896a Archimediella bicarinata var. percingulellata Sacc., Sacco, p. 15, pl. 1, fig. 50.
- 1896a Archimediella bicarinata var. tauroevanescens Sacc., Sacco, p. 15, pl. 1, fig. 51.
- 1904 *Turritella bicarinata* var. *subtricarinatula* Sacc., Sacco, p. 124, pl. 25, fig. 17.
- 1907 *Turritella (Archimediella) conospira* Boettger, p. 116, no. 567.
- 1908 *Turritella bicarinata* Eichw. Schaffer, p. 117, pl. 11, fig. 24.
- 1909 *Turritella bicarinata* Eichw. Friedberg, p. 261, pl. 3, figs 9-12.
- 1909 *Turritella bicarinata* Eichw. var. *scalaria* Buch Friedberg, p. 262, pl. 3, fig. 16.
- 1912 *Turritella (Archimediella) bicarinata* Eichw. Cossmann, p. 121, pl. 6, figs 29, 30.
- 1914 *Turritella bicarinata* Eichw. Friedberg, p. 332, pl. 19, figs 19-21.
- ?1918 Turritella (Archimediella) bicarinata (Eichwald)
 Harmer, p. 456, pl. 43, figs 19, 20.
- 1934 *Turritella (Archimediella) conospira* Boettger Zilch, p. 216, pl. 6, fig. 9.
- 1935 Turritella bicarinata Eichw. Friedberg, p. 137,

pl. 4, figs 8-12.

- 1949 Turritella (Archimediella) bicarinata Eichwald, 1853 – Glibert, p. 117, pl. 6, fig. 17.
- 1955 *Turritella (Torculoidella) bicarinata* Eichwald, 1830 Moisescu, p. 125, pl. 10, figs 9, 12.
- 1956 *Turritella (Archimediella) subarchimedis* d'Orb. Csepreghy-Meznerics, p. 431, pl. 2, fig. 19.
- 1958 *Turritella (Archimediella) bicarinata* Eichwald Erünal-Erentöz, p. 13, pl. 1, figs 18, 19.
- 1960 Turritella (Torculoidella) bicarinata bicarinata Eichw. – Sieber, p. 257, pl. 2, figs 7, 19, 21, 23, pl. 3, fig. 8/18
- 1960 *Turritella (Torculoidella) bicarinata levis* Sieber, p. 258, pl. 2, fig. 22.
- 1960 *Turritella (Torculoidella) bicarinata tauroevanescens* Sacco – Sieber, p. 258, pl. 2, fig. 25.
- 1960 *Turritella (Torculoidella) bicarinata subunocincta* Sacco – Sieber, p. 258, pl. 2, fig. 20.
- 1960 *Turritella (Torculoidella) scalaria praescalaria* Sieber, p. 259, pl. 2, figs 24, 26.
- 1960 *Turritella bicarinata* Eichw. Eremija, pl. 1, fig. 1 (not mentioned in text).
- 1960 Turritella (Torculoidella) bicarinata var. subarchimedis Orbigny 1852 – Kojumdgieva & Strachimirov, p. 115, pl. 32, fig. 15.
- 1962 *Turritella bicarinata* Eichwald Strausz, p. 24, pl. 2, fig. 13.
- 1966 *Turritella bicarinata* Eichwald (1930) [*sic*], 1853 Strausz, p. 86, pl. 2, fig. 13.
- 1966 *Turritella (Torculoidella) bicarinata subarchimedis* Orbigny, 1852 – Strausz, p. 87, pl. 2, figs 7-8.
- 1968 *Torculoidella bicarinata* (Eichwald) Zelinskaya *et al.*, p. 170, pl. 41, fig. 4.
- 1971 *Turritella (Torculoidella) bicarinata* Eichw. Eremija, p. 35, pl. 14, fig. 12.
- 1975 *Turritella (Eichwaldiella) bicarinata* Eichwald, 1850 Bałuk, p. 109, pl. 12, figs 1-6.
- 1978 Turritella (Eichwaldiella) bicarinata Eichwald,
 1850 Steininger et al., p. 332, pl. 3, fig. 3.
- 1984 Archimediella bicarinata var. taurocrassula Sacco, 1895 – Ferrero Mortara et al., p. 230, pl. 41, fig. 2.
- 1985 *Turritella (Torculoidella) bicarinata bicarinata* (Eichwald) – Atanacković, p. 94, pl. 22, fig. 9.
- 1998 *Turritella (Eichwaldiella) bicarinata bicarinata* Eichwald – Schultz, p. 56, pl. 21, fig. 14.
- 2000 Turritella (Eichwaldiella) bicarinata (Eichwald, 1830) Popa & Ianoliu, p. 85, pl. 2, fig. 8.
- 2002 *Turritella (Eichwaldiella) bicarinata* (Eichwald, 1830) Harzhauser, p. 78, pl. 2, figs 17-19.
- 2003 Turritella bicarinata Eichwald, 1830 İslamoğlu & Taner, p. 38, pl. 1, fig. 11.
- 2004 *Turritella bicarinata* Eichwald, 1830 İslamoğlu,
 p. 142, pl. 1, fig. 9.
- 2009 Turritella (Eichwaldiella) bicarinata cf. subunocincta Sacco, 1895 – Mikuž, p. 11, pl. 2, fig. 22.
- non 1993 Turritella bicarinata Eichwald, 1830 Iljina, p. 35, pl. 3, fig. 11.

Dimensions and material – Maximum height 52.0 mm. Localities 2 & 3: JvdV/6; localities 7 & 8: NHMW 1874/0058/1007/3, JvdV/25, RGM 783 880/12; locality 12: JvdV/13, RGM 783 607/6); locality 13: NHMW 1874/0058/1006/15, JvdV/25, RGM 783 639/19; locality 17: NHMW 1874/0058/1004/1, 1847/0058/1672, 1874/0058/1005/16, JvdV/50+, RGM 784 017/2, RGM 783 729/50+, MTA 2013/012/22, YI 95/50+; locality 18: JvdV/50+. Exact locality unknown: AÜ LE-K-203/2.

Discussion - The protoconch consists of just over 1.75 smooth, loosely coiled whorls with a large nucleus (dp = 290 μ m, hp = 315 μ m, dp/hp = 0.9, dp1 = 200 μ m, dn = 110 μ m; Pl. 55 fig. 8b, c). The transition to the teleoconch is marked by the beginning of spiral B. The first seven teleoconch whorls bear a single elevated central carina (B), the whorl profile biconcave to the suture (Pl. 55, fig. 8a). On the seventh or eighth whorl primary spiral cord D forms at the abapical suture, rapidly becoming equal in strength to B, and migrates adapically to be placed just above the abapical suture. Therefore, in Turritella bicarinata Eichwald, 1830, the very characteristic sculpture of two strong prominent elevated cords, the adapical just above mid-whorl (B), the abapical just above the abapical suture (D), only develops from the eighth teleoconch whorl. Secondary sculpture of irregular weaker cords appears on the adapical half of the whorl and the whole whorl surface is covered with fine tertiary threads. The lateral sinus is shallow and the basal sinus almost straight to the columella.

Under UV light a very clear colour pattern of rows of small spots running along the tops of the spiral cords and irregular vertical flammules can be seen, similar to that in *Ptychidia vindobonensis* Handmann, 1882, but the spots are slightly larger (Pl. 79, fig. 2).

The reference for the late Pliocene Red Crag of England (Harmer, 1918) is the only Pliocene occurrence of this species and needs to be confirmed.

As with the preceding species, there is quite some variability in the sculpture of the later teleoconch whorls, which has led to the lengthy synonymy above. Although it seems likely that all these names represent a single polymorphic species, a detailed analysis of the early spire whorls would be necessary to decide on this matter.

This species was placed in the literature rather uncritical in various (sub)genera such as Torculoidella Sacco, 1895, Archimediella Sacco, 1895 and Eichwaldiella Friedberg, 1933. However, Handmann (1882) proposed the subgenus Oligodia for this and other species, a name that was overlooked by all later authors. Torculoidella was considered a subgenus of Archimediella by Marwick (1957). Eichwaldiella Friedberg, 1933 is preoccupied by Eichwaldiella Whitley, 1930 (Pisces), and was considered a synonym of Torculoidella by Marwick (1957). The type species of Eichwaldiella Friedberg, 1933 is T. bicarinata, therefore according to Marwick it belongs within the genus/subgenus Torculoidella. The lateral and basal sinus is similar in both Archimediella and Torculoidella. However, in Torculoidella the medial primary, B and the peribasal D dominate strongly, whereas in Archimediella the primaries B and C form the two main keels. Therefore we would use *Torculoidella* at full genus rank.

Handmann (1882) included Turritella archimedis Brongniart, 1823 sensu Hörnes (1855) and Turritella bicarinata Eichwald, 1830 in his newly established subgenus Oligodia without designation of a type species. The middle Miocene Paratethyan shells described as Turritella archimedis by Hörnes (1855) are not conspecific with the Paleogene T. archimedis of Brongniart (1823) and consequently Cossmann introduced Turritella erronea Cossmann in Friedberg, 1914 for the Miocene species. Unfortunately, Turritella erronea and Turritella bicarinata are not congeneric. Turritella erronea should be placed in Archimediella Sacco, 1895, with the type species Turritella archimedis Brongniart, 1823 whilst Turritella bicarinata would better fit in Torculoidella Sacco, 1895 with Turbo varicosa Brocchi, 1814 as type species. Sacco (1895), however, did not include T. bicarinata in his genus Torculoidella but treated it as Archimediella with a questionmark.

To solve this confusion, as first revisers, we choose *Turritella bicarinata* as the type species of the genus *Oligodia* Handmann, 1882. This designation has the advantage that the well established genus *Archimediella* remains valid. The genus *Torculoidella* might turn out to be a junior synonym of *Oligodia*, but a descision has to await revision of the Miocene turritellids.

Distribution - Early Miocene: Paratethys (Aquitanian-Burdigalian): Austria, (Schaffer, 1908; Harzhauser, 2002); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896a), (late Burdigalian): Kasaba Basin, Turkey (İslamoğlu, 2004). Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1855; Sieber, 1960; Steininger et al., 1978; Schultz, 1998), Poland (Friedberg, 1909, 1914; Bałuk, 1975), Hungary (Strausz, 1954, 1962, 1966; Csepreghy-Meznerics, 1956), Bulgaria (Kojumdgieva & Strachimirov, 1960), Bosnia (Eremija, 1959, 1971a; Atanacković, 1985), Slovenia (Mikuž, 2009), Romania (Zilch, 1934; Moisescu, 1955; Popa & Ianoliu, 2000), Ukraine (Zelinskaya et al., 1968); Proto-Mediterranean Sea (Langhian): Kasaba Basin, Turkey (İslamoğlu, 2004); (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896a), (early Tortonian): Antalya Basin, Turkey (İslamoğlu & Taner, 2003).

Genus Helminthia Handmann, 1882

Type species – Turbo vermicularis Brocchi, 1814, by subsequent designation herein. Neogene, Europe.

Helminthia vermicularis (Brocchi, 1814)

Plate 5, fig. 11

*1814 *Turbo vermicularis* nob., Brocchi, p. 372, pl. 6, fig. 13.

- 1855 *Turritella vermicularis* Brocch. var. Hörnes, p. 422, pl. 43, figs 17, 18.
- 1882 *Turritella (Helminthia) vermicularis* Brocc. Handmann, p. 214.
- 1882 *Turritella (Helminthia) vermicularis* Brocc. var. *conica*, Handmann, p. 214.
- 1882 *Turritella (Helminthia) vermicularis* Brocc. var. *imminuta,* Handmann, p. 214.
- 1882 *Turritella (Helminthia) vermicularis* Brocc. var. *dilatata*, Handmann, p. 214.
- 1882 *Turritella (Helminthia) vermicularis* Brocc. var. *conica*, Handmann, p. 214.
- 1882 *Turritella (Helminthia) vermicularis* Brocc. var. *contorta*, Handmann, p. 214.
- 1882 *Turritella (Helminthia) vermicularis* Brocc. var. *tricarinata*, Handmann, p. 214.
- 1909 Turritella tricincta Bors. Friedberg, p. 22, pl. 14, fig. 15 (non Turritella tricincta Borson, 1821).
- 1912 Turritella (Haustator) vermicularis var. tricincta Schff. – Schaffer, p. 161, pl. 52, figs 23-25 (non Turritella tricincta Borson, 1821).
- 1914 Turritella tricincta Bors. Friedberg, p. 350, pl. 20, fig. 15 (non Turritella tricincta Borson, 1821).
- 1956 *Turritella* (*Haustator*) *vermicularis* Br. Csepreghy-Meznerics, p. 382, pl. 2, figs 26, 27.
- 1958 *Turritella (Haustator) tricincta* (Borson) Erünal-Erentöz, p. 14, pl. 2, figs 1, 2 (*non Turritella tricincta* Borson, 1821).
- 1960 Turritella (Haustator) vermicularis tricincta Schaffer – Sieber, p. 244, pl. 3, fig. 8/8 (non Turritella tricincta Borson, 1821).
- 1970 Turritella tricincta Borson Bałuk, p. 117, pl. 10, fig. 20 (non Turritella tricincta Borson, 1821).
- 1971 *Turritella tricincta* Borson Eremija, p. 69, pl. 6, fig. 2 (*non Turritella tricincta* Borson, 1821).
- 1975 Turritella (?Haustator) tricincta Borson, 1821
 Bałuk, p. 108, pl. 12, figs 7-9 (non Turritella tricincta Borson, 1821).
- 1998 *Turritella* (*Haustator*) *vermicularis tricincta* Schaffer – Schultz, p. 56, pl. 21, fig. 5.
- 2004 *Turritella (Haustator) tricincta* Borson 1821 – İslamoğlu, p. 144, pl. 1, fig. 6 (*non Turritella tricincta* Borson, 1821).
- 2004a Turritella vermicularis (Brocchi, 1814) Landau et al., p. 22, pl. 3, figs 3, 11.
- 2011 *Turritella vermicularis* (Brocchi, 1814) Landau *et al.*, p. 11, pl. 2, fig. 9 (with additional synonyms).
- non 1938 Turritella (Haustator) vermicularis Brocchi Stchepinsky, p. 58, pl. 6, figs 22, 23.
- non 1939 Turritella (Haustator) vermicularis var. tricincta Schaffer – Stchepinsky, p. 32, pl. 9, figs 12-14 (non Turritella tricincta Borson, 1821).

Dimensions and material – Maximum height 122.0 mm. Localities 2 & 3: JvdV/5); YI 468/2; localities 7 & 8: JvdV/6, RGM 783 879/2; locality 12: JvdV/7, RGM 783 606/6; locality 13: NHMW 1874/0058/1008/8, JvdV/23, RGM 794 063/1 (ex JvdV collection), RGM 783 640/11, YI 102/8; locality 17: RGM 783 731/4, MTA 2013/013/7, YI 103/50+. Exact locality unknown: AÜ LE-K-204/2, AÜ LE-K-205/3.

Discussion – The protoconch is not preserved in the Turkish material. On the earliest whorl preserved spiral B develops first, followed by C and then A. The lateral sinus is moderately deep, moderately oblique and the basal sinus is arcuate.

Turritella vermicularis (Brocchi, 1814) has consistently been placed in the genus/subgenus *Haustator* Montfort 1810 (type species: *Turritella gallicus* Montfort, 1810, by original designation; Eocene France). The shape of the lateral and basal sinuses do indeed match those figured by Marwick (1957, fig. 14) for the genus *Haustator*, however, the order of appearance of the spiral cords for *Haustator*, C-B-A do not match the order seen in *T. vermicularis*, which is B-C-A. Handmann (1882) introduced the subgenus name *Helminthia* for this species. He included three species in *Helminthia* but did not select a type species. From the context it is clear that Handmann (1882) considered *Turritella vermicularis* as the typical species and consequently we designate this as type species of the genus *Helminthia*.

There is a great confusion in the Paratethys literature about the status of Turritella tricincta Borson, 1820 versus Turritella vermicularis Brocchi, 1814. This was partly caused by the introduction of the new variation name Turritella (Haustator) vermicularis var. tricincta by Schaffer (1912), for the specimens from the Vienna Basin described as T. vermicularis by Hörnes (1855). In later papers, such as Friedberg (1909, 1914) and Bałuk (1970), typical T. vermicularis specimens where described as Turritella tricincta Borson, 1821 (= Turritella riepeli Hörnes, 1855). The two species occur syntopically at many Paratethyan localities and can be separated easily. Based on shells from the Vienna Basin, the middle Miocene species H. vermicularis differs from H. tricinc*ta* in the smaller size, the more slender outline, the deeper sutures and especially in the early whorls, which bear two prominent spiral ribs, whereas the much higher early whorls of *H. tricincta* have numerous fine spiral threads. These characters are not always clearly illustrated and therefore many references have not been listed in the synonymy. For clarification, however, we list here several (mainly) Paratethyan references of *Helminthia tricincta*:

Helminthia tricincta (Borson, 1821)

- *1821 *Turritella tricincta* nob., Borson, p. 342, pl. 6, fig. 11.
- 1855 *Turritella Riepeli* Partsch, Hörnes, p. 421, pl. 43, fig. 2.
- 1882 *Turritella (Eurotropis) Riepeli* Partsch Handmann, p. 212.
- 1960 *Turritella (Haustator) tricincta tricincta* Bors. Sieber, p. 245, pl. 3, fig. 8/12.
- 1960 Turritella (Torculoidella) tricincta Borson 1821 Kojumdgieva & Strachimirov, p. 116, pl. 32, fig. 18.

- 1976 *Turritella (Haustator) tricincta* Borson 1821 Pavia, p. 152, pl. 1, fig. 10.
- 1978 *Turritella (Haustator) tricincta tricincta* Borson, 1821 – Steininger *et al.*, p. 332, pl. 2, fig. 5.
- 1998 *Turritella (Haustator) tricincta tricincta* Borson Schultz, p. 56, pl. 21, fig. 7.

Distribution of Helminthia vermicularis (Brocchi, 1814) - Early Miocene: Paratethys (Aquitanian): Vienna Basin, Austria (Schaffer, 1912); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896a; Caprotti, 1975). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1855; Steininger et al., 1978), Hungary (Csepreghy-Meznerics, 1956; Strausz, 1966), Poland (Friedberg, 1909, 1914; Bałuk, 1970, 1975); Proto-Mediterranean Sea (late Burdigalian-Langhian): Kasaba Basin, Turkey (İslamoğlu, 2004), (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): southern Spain (Wenz, 1942); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896a), Tunisia (Stchepinsky, 1938). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Gonzàlez Delgado, 1986; Landau et al., 2011), Morocco (Brébion, 1979); western Mediterranean, Estepona Basin (Landau et al., 2004a), northeastern Spain, (Martinell, 1979), Roussillon Basin, France (Fontannes, 1879; Chirli & Richard, 2008); central Mediterranean, Italy (Sacco, 1896a; Palla, 1967; Bernasconi, 1990), Tunisia (Fekih, 1975). Earlylate Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Zbyszewski, 1959; Silva, 2001), Morocco (Lecointre, 1952); central Mediterranean, Italy (Ruggieri et al., 1959; Malatesta, 1974; Caprotti, 1975; Cavallo & Repetto, 1992). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1912; Malatesta, 1960; Caprotti, 1975).

Genus Mesalia Gray, 1847

Type species – Turritella mesal Deshayes, 1843 (*Cerithi-um mesal* Adanson, 1757 (pre-Linnean) = *Turritella varia* Kiener, 1844), by original designation. Recent, West Africa to Senegal, Mediterranean.

Mesalia cochleata (Brocchi, 1814)

Plate 5, figs 12-14; Plate 55, fig. 9

- *1814 Turbo cochleatus Brocchi, p. 373, pl. 6, fig. 17.
- 1896a Mesalia cochleata (Br.) Sacco, p. 30, pl. 2, fig. 40.
- 1896a Mesalia cochleata var. convexulina Sacc., Sacco, p. 30, pl. 2, fig. 41.
- 1896a Mesalia cochleata var. crassecincta Sacc., Sacco, p. 30, pl. 2, fig. 42.
- 1896a Mesalia cochleata var. angulatella Sacc., Sacco, p. 30, pl. 2, fig. 43.
- 1896a Mesalia cochleata var. taurocompressa Sacc., Sacco, p. 30, pl. 2, fig. 44.
- 1896a Mesalia cochleata? var. depressoturrita Sacc.,

Sacco, p. 31, pl. 2, fig. 45.

- 1896a Mesalia cochleata? var. brevialoides Sacc., Sacco, p. 31, pl. 2, fig. 46.
- 1922 Mesalia taurocompressa Sacco Cossmann & Peyrot, no. 444, p. 64, pl. 2, fig. 44.
- 1955 *Mesalia (Mesalia) cochleata* (Brocchi) 1814 Rossi Ronchetti, p. 103, fig. 46.
- 1960 Mesalia (Mesalia) cochleata angulatella Sacco Sieber, p. 264, pl. 1, fig. 22.
- 1978 *Turbo cochleatus* Brocchi, 1814 Pinna & Spezia,
 p. 162, pl. 58, fig. 3.
- 2004a Mesalia cochleata (Brocchi, 1814) Landau et al., p. 25, pl. 3, fig. 12 (with additional synonyms).
- 2006 Mesalia cochleata (Brocchi, 1814) Chirli, p. 114, pl. 43, figs 9-15.
- 2009 Mesalia cochleata (Brocchi, 1814) Forli, p. 16, figs 1, 2.
- 2011 *Mesalia cochleata* (Brocchi, 1814) Landau *et al.*, p. 11, pl. 2, fig. 10 (with additional synonyms).

Dimensions and material – Maximum height 29.8 mm. Localities 2 & 3: RGM 794 566/1 (ex JvdV collection); locality 6: JvdV/1, locality 17: NHMW 1874/0058/1009/1, 1874/0058/1010/9, RGM 784 047/1, JvdV/1, YI 116/9.

Discussion – The shells of the genus *Mesalia* Gray, 1847 differ from *Turritella* Lamarck, 1799 in having a more rounded aperture and a sinuous outer lip. Today *Mesalia* is mainly a West African genus that extends into the Alboran Sea and the neighbouring Atlantic coast of southern Portugal and on to the Canaries (Poppe & Goto, 1991).

Sacco (1896a) separated the Italian early Miocene Burdigalian forms by having more evenly rounded whorls and by having weaker spiral sculpture. These same differences were reported by Cossmann & Peyrot (1922) for specimens from the Miocene Burdigalian and Langhian of the Aquitaine Basin. The specimens illustrated here from the Karaman Basin vary enormously in the strength of their spiral sculpture, with relatively smooth specimens (Pl. 5, fig. 12) coexisting with strongly sculptured ones (Pl. 5, fig. 13). This supports the position adopted by Landau et al. (2004a), in which all Sacco's (1896a) varieties of Mesalia cochleata (Brocchi, 1814) were synonymised. The protoconch in the Karaman shells is paucispiral, consisting of 1.25 smooth whorls with a large nucleus (dp = 640 μ m, hp = 490 μ m, dp/hp = 1.3, dp1 = $620 \,\mu\text{m}, \,\text{dn} = 400 \,\mu\text{m}; \,\text{Pl.} 55, \,\text{fig.} 9$), as described for the early Pliocene western Mediterranean Estepona material by Landau et al. (2004a). For further discussion and comparison see Landau et al. (2004a, p. 25).

Distribution – Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, (Cossmann & Peyrot, 1922); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896a). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, (Cossmann & Peyrot, 1922); Paratethys (Langhian-Serravallian): Styrian Basin, Austria (Sieber, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896a). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Gonzàlez Delgado, 1986; Landau *et al.*, 2011); western Mediterranean, Estepona Basin (Landau *et al.*, 2004a), Morocco (Lecointre, 1952); central Mediterranean, Italy (Chirli, 2006; Forli, 2009).

Subfamily Vermiculariinae Dall, 1913 Genus Vermicularia Lamarck, 1799

Type species – Serpula lumbricalis Linnaeus, 1758, by monotypy. Recent, West Africa.

Vermicularia milleti (Deshayes, 1839)

Pl. 5, fig. 17

*1839 Vermetus milleti Deshayes, pl. 70, figs 9-10.
2004a Vermicularia milleti (Deshayes, 1839) – Landau et al., p. 26, pl. 3, fig. 18 (with additional synonyms).

Dimensions and material – Height 10.3 mm. Locality 13: NHMW 1874/0058/1669/1.

Discussion – This species is very distinctive, resembling a turritellid gastropod to begin with, but with the adult whorls unwinding. In the Turkish assemblages the species is represented by a single incomplete, worn specimen, but it is undoubtedly *Vermicularia milleti* (Deshayes, 1839). The subsutural cord is slightly weaker than in some of the French Atlantic populations we compared with this specimen, but as discussed by Landau *et al.* (2004b, p. 27), despite small sculptural differences, they probably represent a single species.

Although this is a relatively long-lived and widespread species in the Atlantic and Paratethyan Miocene, we have not found any record of the species in the Italian Miocene. Surprisingly, Landau *et al.* (2004b) illustrated the species from the early Pliocene of the western Mediterranean, Estepona Basin, although it has not been found elsewhere in the European Pliocene.

Distribution – Early Miocene: northeastern Atlantic: Aquitaine Basin (Burdigalian), France (Cossmann & Peyrot, 1922). Middle Miocene: northeastern Atlantic: Aquitaine Basin (Langhian), France (Cossmann & Peyrot, 1922), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Poland (Bałuk, 1975), Vienna Basin (Hörnes, 1856), Hungary (Strausz, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian; early Redonian) Loire Basin France (NHMW collection). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Landau *et al.*, 2004b). Superfamily Vermetoidea Rafinesque, 1815 Family Vermetidae Rafinesque, 1815 Subfamily Vermetinae Rafinesque, 1815 Genus *Petaloconchus* Lea, 1843

Type species – Petaloconchus sculpturatus H.C. Lea, 1845, by monotypy. Neogene, eastern Atlantic.

Petaloconchus intortus (Lamarck, 1818)

Plate 5, fig. 15

- *1818 Serpula intortus Lamarck, no. 889, p. 365.
- 1914 Vermetus intortus Lam. Friedberg, p. 323, textfig. 68, pl. 19, figs 11, 12.
- 1922 Vermetus (Petaloconchus) intortus var. taurinensis Sacco – Cossmann & Peyrot, p. 75, no. 452, pl. 3, figs 26, 27.
- 1938 Vermetus intortus Lamarck Stchepinsky, p. 64, pl. 7, fig. 1.
- 1955 Vermetus (Petaloconchus) intortus Lamarck, 1818
 Miosescu, p. 132, pl. 11, fig. 11.
- 1958 Vermetus (Petaloconchus) intortus var. woodi Mörch – Erünal-Erentoz, p. 18, pl. 2, fig. 18.
- 1961 Vermetus intortus Lam. Florei, p. 684, pl. 7, fig. 53.
- 1967 Petaloconchus intortus (Lamarck, 1818) Tejkal et al., p. 197, pl. 10B, fig. 11.
- 1968 Petaloconchus intortus woodi Morch Stancu & Andreescu, p. 462, pl. 3, fig. 30.
- 1970 Vermetus (Petaloconchus) intortus (Lamarck) Bałuk, p. 117, pl. 11, figs 3, 4.
- 1970 Petaloconchus (Petaloconchus) intortus (Lk.) Caprotti, p. 143, pl. 1, figs 6, 7.
- 1984a Petaloconchus (Macrophragma) intortus (Lamarck) – Martinell & Domènech, p. 6, pl. 1, fig. 7.
- 1989 Petaloconchus intortus (Lamarck, 1818) Moths,
 p. 110, pl. 10, fig. 46.
- 1998 Petaloconchus intortus (Lamarck) Schultz, p. 58, pl. 22, fig. 6.
- 2001 Petaloconchus (Macrophragma) glomeratus (L., 1758) – Baroncelli, pl. 1, figs 1-3 [non Petaloconchus glomeratus Linnaeus, 1758)].
- 2004a Petaloconchus glomeratus (Linnaeus, 1758) Landau et al., p. 27, pl. 3, figs 15, 16 (with additional synonyms – fossil references only) [non Petaloconchus glomeratus Linnaeus, 1758)].
- 2011 Petaloconchus glomeratus (Linnaeus, 1758) Landau et al., p. 13, pl. 4, fig. 1 [non Petaloconchus glomeratus Linnaeus, 1758)].

Dimensions and material – Maximum height 42.2 mm. Locality 9: JvdV/50+, RGM 783 815/50+, YI 89/1; locality 13: NHMW 1874/0058/1011/1, 1874/0058/1012/30, JvdV/50+, RGM 783 627/50+, MTA 2013/014/13, YI 90/50+; locality 17: YI 91/2. Exact locality unknown: AÜ LE-K-208/1.

Discussion – In a recent paper, Scuderi (2012) considered the fossil European Neogene species *Petaloconchus intortus* (Lamarck, 1818) to be distinct from the Recent

species P. glomeratus (Linnaeus, 1758). The fossil species differs from the Recent one in details of the protoconch. Whilst both have a protoconch consisiting of about 2.5 whorls, that of the fossil species is smaller $(0.65 \times 0.4, vs.)$ 1.1×0.7 mm), and there is a basal cord on the protoconch in the fossil species that is absent in *P. glomeratus*. We accept this distinction, although we do not have a specimen with a protoconch from the Turkish assemblages. Unfortunately, it is not clear from Scuderi (2012) what fossil material was examined, nor when the transition to the Recent species occurred, nor is any illustrations of the fossil protoconch included. A.W. Janssen (1984a, pl. 48, fig. 2) figured the protoconch of specimens from the middle Miocene North Sea Basin of Winterswijk-Miste, Netherlands and described the protoconch as consisting of about four whorls with a spiral rib at the base of the last whorl. A similar protoconch of 3.5-4 whorls was described by Silva (2001) for the early middle Pliocene specimens from the Atlantic coast of Vale de Freixo, Portugal. We therefore provisionally place all the fossil records in the synonymy, although further research is needed, as the specimens from Karaman are much larger than those from the Mediterranean Pliocene of Italy and Spain at hand. Moreover, they do not form the large conglomerations of numerous shells intertwined as seen in the Pliocene, although both of these characters are variable.

Scuderi (2012) went on to observe that the character of the internal laminae changed along the length of the tube, which would explain the comments in Landau *et al.* (2004a, p. 28) about the confusion in the literature concerning the number of laminae present. In the Turkish shells the laminae can clearly been seen as figured by Scuderi (2012, fig. 15).

Petaloconchus intortus is extremely abundant in the clayey facies in the Karaman deposits.

Petaloconchus laurae Scuderi, 2012 differs in having teleoconch sculpture in which the radial and spiral elements are of equal strength, whereas in both *P. intortus* and *P. glomeratus* the spiral element is predominant, and in having a protoconch of only 1.5 whorls as opposed to 2.5 as in its other two congeners, with a basal cord, as in *P. intortus*, which is absent in *P. glomeratus*.

Distribution - Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896b). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Germany (Anderson, 1964; Moths, 1989), Netherlands (A.W. Janssen, 1984a). Middle Miocene: northeastern Atlantic (Aquitanian-Serravallian): Aquitaine Basin, (Cossmann & Peyrot, 1924; Lozouet et al., 2001a), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Poland (Friedberg, 1914; Bałuk, 1970, 1975), Vienna Basin, Austria (Hörnes, 1856; Tejkal et al., 1967; Schultz, 1998), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1966), Romania (Moisescu, 1955; Stancu & Andreescu, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentoz, 1958). Late Miocene: northeastern Atlantic

(Messinian): Loire Basin, France (NHMW collection); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896b), Tunisia (Stchepinsky, 1938). Early Pliocene: North Sea Basin, England (Wood, 1848; Harmer, 1918), Belgium (Glibert, 1958; Marquet, 1997b); northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1986; Landau et al., 2011), Morocco (Lecointre, 1952); western Mediterranean, Estepona Basin (Landau et al., 2004a), northeastern Spain, (Martinell & Domènech, 1984a; Solsona, 1998), Rousillon Basin, France (Fontannes, 1879); central Mediterranean, Italy (Sacco, 1896b; Palla, 1967; Caprotti, 1974; Anfossi et al., 1983; Baroncelli, 2001); Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Zbyszewski, 1959; Silva, 2001); central Mediterranean, Italy (Malatesta, 1974; Cavallo & Repetto, 1992). Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1912; Taviani et al., 1998).

Genus Tylacodes Guettard, 1770

Type species – Serpulorbis polyphragma Sassi, 1827, by subsequent designation (Keen, 1961). Recent, Europe.

Note – Serpulorbis Sassi, 1827 is a synonym (Bieler & Petit, 2010).

Tylacodes arenarius (Linnaeus, 1758)

Plate 5, fig. 16

- *1758 Serpula arenaria Linnaeus, p. 1266.
- 1914 Vermetus arenarius Lam. Friedberg, p. 325, textfig. 69, pl. 19, fig. 13.
- 1954 Vermetus (Lemintina) arenarius taurogranosa Sacco – Csepreghy-Meznerics, p. 18, pl. 1, figs 26, 30.
- 1955 Vermetus (Serpulorbis) arenarius Linnaeus, 1776 [sic] – Miosescu, p. 131, pl. 11, fig. 13.
- 1958 Vermetus (Lemintina) arenarius var. turonensis Deshayes – Erünal-Erentöz, p. 19, pl. 2, figs 10, 11.
- 1968 *Lemintina arenaria perpustulata* Sacco Stancu & Andreescu, p. 462, pl. 3, fig. 29.
- 1968 Vermetus arenarius (Linné, 1766) Zelinskaya et al., p. 172, pl. 41, fig. 9.
- 1969 Vermetus (Serpulorbis) arenaria (Linné) Atanacković, p. 199, pl. 9, figs 11, 12.
- 1970 *Lemintina (Lemintina) arenaria* (Linneo) Caprotti, p. 144, pl. 1, fig. 8.
- 1971a Vermetus (Serpulorbis) arenarius Linné Eremija, p. 36, pl. 10, fig. 3.
- 1998 Lemintina arenaria (Linné) Schultz, p. 58, pl. 22, figs 6, 7.
- 2004a Serpulorbis arenaria (Linnaeus, 1758) Landau et al., p. 28, pl. 3, fig. 17 (with additional synonyms).
- 2011 Serpulorbis arenaria (Linnaeus, 1758) Landau et al., p. 13, pl. 4, fig. 2.

Dimensions and material – Maximum height 83.0 mm. Localities 2 & 3: YI 92/2; locality 9: JvdV/2, RGM 783 816/25; locality 12: JvdV/50+, RGM 783 610-783611/50+, YI 93/1; locality 13: NHMW 1874/0058/1013/1, RGM 783 626/3, YI 94/15; locality 17: NHMW 1874/0058/1093/1, 1874/0058/1014/5. Exact locality unknown: AÜ LE-K-206/1.

Discussion – By virtue of the loose, irregular coiling, characteristic of the genus, this species is very variable in shape. It differs from *Petaloconchus intortus* (Lamarck, 1818) in being much larger, more loosely coiled, and with circular rather than subquadrangular intermediate whorls and a granular spiral sculpture.

In view of the recent observations on protoconch morphology discussed above that allow the fossil *P. intortus* and Recent *P. glomeratus* (Linnaeus, 1758) to be separated, we have searched the literature for any similar information for the genus *Tylacodes*. A.W. Janssen (1984a, p. 151, pl. 7, fig. 1) described and figured a protoconch very similar to that of *Petaloconchus intortus* with a spiral cord at the base of the last whorl, but smaller and tentatively ascribed it to *T. arenarius*. Unfortunately we have not been able to find any description of the protoconch for the Recent shells, which seems to be unknown (see Kelly, 2007, table 1).

Tylacodes deshayesi (Mayer-Eymar, 1889), which occurs in the central Mediterranean Pliocene, is very similar but differs in the character of the spiral sculpture. The spiral cords are granular, but equal in strength rather than alternating, and are larger and less numerous. For further discussion see Landau *et al.* (2004a).

Distribution - Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896b). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Netherlands (A.W. Janssen, 1984a). Middle Miocene: northeastern Atlantic (Aquitanian-Serravallian): Aquitaine Basin, (Cossmann & Peyrot, 1924), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Poland (Friedberg, 1914, 1938; Bałuk, 1975), Vienna Basin, Austria (Hörnes, 1856; Schultz, 1998), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Csepreghy-Meznerics, 1954; Strausz, 1966), Romania (Moisescu, 1955; Stancu & Andreescu, 1968), Bosnia (Atanacković, 1969; Eremija, 1971), Ukraine (Zelinskaya et al., 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (NHMW collection); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896b). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1986; Landau et al., 2011), Morocco (Lecointre, 1952); western Mediterranean, Estepona Basin, Spain (Landau et al., 2004a), northeastern Spain, (Solsona, 1998), Rousillon Basin, France (Fontannes, 1879); central Mediterranean, Italy (Sacco, 1896b; Palla, 1967; Caprotti, 1974; Anfossi et al., 1983); Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Zbyszewski, 1959; Silva, 2001); central Mediterranean, Italy (Malatesta, 1974; Cavallo & Repetto, 1992). **Pleistocene**: western Mediterranean, Balearic Islands (Cuerda Barceló, 1987); central Mediterranean, Italy (Cerulli-Irelli, 1912). **Recent**: northeastern Atlantic, Iberian Peninsula, Morocco, Mediterranean (Poppe & Goto, 1991).

Superfamily Rissooidea Gray, 1847 Family Truncatellidae Gray, 1840 Genus *Truncatella* Risso, 1826

Type species – Truncatella costulata Risso 1826 (= *He-lix subcylindrica* Linné, 1767) by subsequent designation (Risso, 1826).

Truncatella subcylindrica (Linné, 1767) Plate 55, fig. 10

- *1767 Helix subcylindrica Linné, p. 1248.
- 1826 Truncatella costulata Risso, p. 125, pl. 4, fig. 57.
- 1896d Truncatella truncatula (Drp.) Sacco, p. 30, pl. 3, fig. 1.
- 1896d Truncatella truncatula var. laevigata (Risso) Sacco, p. 30, pl. 3, fig. 2.
- 1907 Truncatella kostejana Boettger, p. 200, no. 676.
- 1907 Truncatella biornata Boettger, p. 200, no. 677.
- 1934 *Truncatella kostejana* Boettger Zilch, p. 209, pl. 5, fig. 70.
- 1934 *Truncatella biornata* Boettger Zilch, p. 209, pl. 5, fig. 71.
- 1966 Truncatella (Truncatella) subcylindrica (Linné) Iljina, p. 94, pl. 4, figs 5-7.
- 1975 Truncatella (Truncatella) subcylindrica (Linnaeus, 1766 [sic]) – Bałuk, p. 64, pl. 8, figs 27-30.
- 2004 *Truncatella subcylindrica* (Linnaeus, 1767) Landau *et al.*, p. 33, pl. 4, fig. 4 (with additional synonyms).
- 2010 *Truncatella subcylindrica* (Linnaeus, 1767) Sosso & dell'Angelo, p. 23, unnumbered figure p. 33 second row centre.

Dimensions and material – Maximum height 3.1 mm. Locality 17: RGM 776 853/1 (ex JvdV collection).

Discussion – This species, which lives in a muddy habitat high on the shore overgrown with plants (Fretter & Graham, 1978a), is rare in the Turkish assemblages. The whorls are smooth, without traces of axial ornament. In the living populations the axial sculpture is very variable and is completely absent from some specimens (var. *laevigata* Risso, 1826). Not only is the sculpture variable, but the spire ranges from cylindrical to more tapering and the aperture can be ovate to subquadrate. Juvenile specimens have quite a different appearance, having a regularly turriculate shell of six to seven whorls, with stronger axial sculpture than the adult.

Truncatella wattebledi Benoist, 1878 from the Atlantic early Miocene Aquitaine Basin of France differs in being

smaller, broader, with more convex whorls and the axial sculpture is present over the entire whole whorl surface as opposed to absent, or limited to the area adjacent to the sutures. It seems, however, that the ornament of *T. wat-tebledi* is also very variable (Cossmann & Peyrot, 1919, p. 534). For further discussion see Landau *et al.* (2004a, p. 34).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1975), Romania (Boettger, 1907; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Early Pliocene**: western Mediterranean, Estepona Basin (Landau *et al.*, 2004); central Meiterranean, Italy (Sosso & dell'Angelo, 2010). **Late Pliocene**: central Meiterranean, Italy (Sacco, 1896d). **Pleistocene**: western Mediterranean, Balearic Islands (Cuerda Barceló, 1987), central Mediterranean, Sicily (Ruggieri & Greco, 1965). **Recent**: northeastern Atlantic, southern coast of England to the Mediterranean and Black Seas (Fretter & Graham, 1978a). High on the shore, under stones, wood and plants, in places occasionally wet by seawater (Poppe & Goto, 1991).

Family Rissoidae Gray, 1847 Subfamily Rissoinae Gray, 1847 Genus *Obtusella* Cossmann, 1921

Type species – Rissoa intersecta S.V. Wood, 1857, by monotypy. Recent, Mediterranean.

Obtusella taurominima (Sacco, 1895) Plate 56, figs 2, 3

- *1895b *Cingulina? taurominima* Sacc., Sacco, p. 32, pl. 1, fig. 85.
- 1907 *Cingula (Cingulina) communis* Boettger, p. 162, no. 557.
- 1934 *Cingula (Obtusella) communis* (Boettger) Zilch, p. 210, pl. 5, fig. 78.
- 1975 Putilla (Pseudosetia) taurominima (Sacco, 1895) – Bałuk, p. 65, pl. 8, figs 1-3.
- 1984 *Cingulina? taurominima* Sacco Ferrero-Mortara *et al.*, p. 219, pl. 40, fig. 5.

Dimensions and material – Maximum height 2.0 mm. Localities 2 & 3: JvdV/15, RGM 783 598/7; locality 6: JvdV/10, RGM 783 599/6; localities 7 & 8: RGM 783 572/1; locality 13: JvdV/50+, RGM 776 855/1 (ex JvdV collection); locality 17: NHMW 1847/0058/1717/2, RGM 784 093/3, RGM 783 169/50+.

Revised description – Shell very small, globose, slightly higher than wide, consisting of 4.5 convex whorls; protoconch of 2.5 whorls, 270 μ m diameter, sharply delimited from teleoconch by sinuous scar, smooth except for a single spiral thread above suture on last protoconch whorl; teleoconch of two convex, smooth whorls, aperture ovate, orthocline, peristome complete, sharp-edged, columellar callus erect, reflected over medium-sized umbilicus.

Discussion – It is almost impossible to distinguish species within this genus without the help of SEM images. We therefore consider it useful to provide an amended description. Even when provided in the literature a description is not always adequate (see Ferrero-Mortara *et al.*, 1984, pl. 40, fig. 5). We provisionally accept the synonymy suggested by Bałuk (1975), pending better illustrations. As rightly pointed out by Bałuk there is quite some variability in shape between individuals, larger shell tending to be higher-spired. However, contrary to Bałuk's (1975) description, the protoconch is clearly distinguished from the teleoconch (Pl. 56, fig. 2d; arrow marks boundary).

Obtusella taurominima (Sacco, 1895) differs from the Recent European species Obtusella intersecta S.V. Wood, 1857 in lacking any form of spiral sculpture on the last few teleoconch whorls. Most specimens of Obtusella macilenta (Monterosato, 1880), also from European waters, are higher-spired, although squatter forms closely similar to the Karaman shells do occur (Giannuzzi-Savelli et al., 1997, fig. 301). Obtusella intersecta does not seem to have a thread close to the suture on the last protoconch whorl. Obtusella lata (Rolán & Rubio, 1999) from the Recent Cape Verde fauna is also extremely similar to O. taurominima and clearly has the same thread close to the suture on the protoconch (Rolán & Rubio, 1999, fig. 6), but O. lata has subobsolete spiral sculpture covering the whole teleoconch and a wider umbilicus. There is also some difference in the number of protoconch whorls; O. lata has 1.5 whorls, O. intersecta closer to 2.0 and Obtusella taurominima 2.5 whorls.

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1895b). Middle Miocene: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1975), Romania (Boettger, 1907; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Rissoa Desmarest, 1814

Type species – Rissoa ventricosa Desmarest, 1814, by subsequent designation (Bucquoy, Dautzenberg & Doll-fus, 1884). Recent, Mediterranean.

Rissoa clotho Hörnes, 1856

Plate 6, fig. 1; Plate 56, fig. 4

- *1856 *Rissoa Clotho* Hörn., Hörnes, p. 574, pl. 48, fig. 20.
- 1975 *Turboella (Turboella) clotho* (Hörnes, 1856) Bałuk, p. 70, pl. 8, fig. 8.
- 2004 *Rissoa clotho* Hörnes Kowalke & Harzhauser, p. 117, fig. 4D.
- ?non 1956 Alaba (Gibborissoa) clotho M. Hörnes Csepreghy-Meznerics, p. 387, pl. 1, figs 22, 23.

- ?non 1960 Gibborissoa clotho (Hoernes 1856) Kojumdgieva & Strachimirov, p. 103, pl. 30, fig. 24.
- *Pron* 1966 *Alaba clotho* (Hoernes 1856) Strausz, p. 128, pl. 13, figs 1, 2.

Dimensions and material – Maximum height 3.5 mm. Locality 13: JvdV/6; locality 17: NHMW 1874/0058/1026/1, 1874/0058/1027/2, RGM 794 591/3 (ex JvdV collection), RGM 783 552/7.

Discussion – Rissoa clotho Hörnes, 1856 has a rather distinctive shell, with its whorls somewhat inflated in the mid-portion, sculpture of about 12 broad, straight axial ribs and faint spiral cords, weakening further on the adapical portion of the whorl, and with a drop-shaped aperture. The protoconch illustrated here for the Turkish shell is similar to that figured by Kowalke & Harzhauser (2004, p. fig. 4 D₂), dome-shaped, consisting of 2.25 convex whorls (dp = 350 μ m, dp1 = 155 μ m, dn = 90 μ m; Pl 56, fig 4d). For further discussion see Kowalke & Harzhauser (2004, p. 117).

It is almost impossible to tell which species is being referred to by Csepreghy-Meznerics (1956, pl. 1, figs 22, 23), Kojumdgieva & Strachimirov (1960, pl. 30, fig. 24) and Strausz (1966, pl. 13, figs 1, 2) due to their poor illustrations, but it is unlikely that they refer to this species.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856), Poland (Bałuk, 1975); Proto-Mediterranean (Serravallian): Karaman Basin, Turkey (this paper).

Genus Pusillina Monterosato, 1884

Type species – Rissoa pusilla Philippi, 1836 (*non* Grateloup, 1828) = *Rissoa dolium* Nyst, 1843 = *Rissoa philippi* Aradas & Maggiore, 1844, by monotypy. Recent Mediterranean.

Pusillina philippi (Aradas & Maggiore, 1844)

Plate 6, fig. 2; Plate 56, figs 5, 6

- 1836 Rissoa pusilla Philippi, p. 154, pl. 10, fig. 13 (non Brocchi, 1814).
- *1844 *Rissoa philippi* Aradas & Maggiore, p. 136 (*nov. nom. pro Rissoa pusilla* Philippi, 1836, *non* Brocchi, 1814).
- 1844 Rissoa nana Ph., Philippi, p. 127
- 1845 *Rissoa dolium* Nob., Nyst, p. 417 (*nov. nom. pro Rissoa pusilla* Philippi, 1836, *non* Brocchi, 1814).
- 1993 Pusillina philippii [sic] (Aradas & Maggiore, 1844) – Bouchet & Warén, p. 674, figs 1567, 1568, 1579.
- 1997 *Pusillina philippi* (Aradas & Maggiore, 1844) Giannuzzi-Savelli *et al.*, p. 84, figs 284, 285.
- 1997 Pusillina philippi (Aradas & Maggiore, 1844) Giribet & Peñas, p. 48, figs 15, 16.

Dimensions and material – Maximum height 3.4 mm. Locality 6: JvdV/17; locality 17: NHMW 1874/0058/1015/1, 1874/0058/1016/3, RGM 794 594/3 (ex JvdV collection), RGM 776 910/2, RGM 783 570/3, YI 159/12.

Discussion – It is not easy to place species within the genera *Pusillina* Monterosato, 1884 or *Rissoa* Desmarest, 1814, based on shell characters alone (Ponder, 1985a). Nevertheless, based on the rather thin shell, lack of spiral sculpture and non-thickened outer lip we place these species in *Pusillina*.

The shell is typically rissoiform, with the spire whorls somewhat inflated in the mid-portion. The protoconch consists of 2.5 convex whorls. Protoconch I is well delimited (Pl. 56, fig. 6d) and no sculpture is present on protoconch II (dp = $350 \,\mu$ m, hp = $290 \,\mu$ m, dp1 = $150 \,\mu$ m). The teleoconch consists of about four strongly convex whorls with the periphery just below mid-whorl. Sculpture starts on the second teleoconch whorl and consists of 15 strongly prosocline, elevated, rounded ribs, obsolete at the sutures. Spiral sculpture is absent. The aperture is ovate, the outer lip simple, the columella hardly thickened, slightly erect abapically bordering a small umbilical chink. There is quite some intraspecific variability, with some of the shells more slender and having the penultimate whorl swollen (Pl. 56, fig. 6).

These Turkish shells are extremely close to the living Mediterranean species *Pusillina philippi* (Aradas & Maggiore, 1884) which, according to Giannuzzi-Savelli *et al.* (1997, figs 284, 285), has similar slender and squatter forms in the Recent populations. The protoconch of the Recent shell illustrated by Giribet & Peñas (1997, fig. 16) is similar to that figured for the fossil shells. We therefore consider them conspecific. *Pusillina philippi* differs from most of its European congeners in having a regularly rounded last whorl, not angular at the base as in most species, and the axial ribs do not stop as abruptly at the base as in its Recent European congeners, many of which have one or more spiral cords delimiting the base.

Distribution – **Middle Miocene**: Proto-Mediterranean (Serravallian): Karaman Basin, Turkey (this paper). **Recent**: Mediterranean (Giannuzzi-Savelli *et al.*, 1997).

Pusillina cf. inconspicua (Alder, 1844) Plate 56, fig. 7: Plate 57, figs 1, 2

Plate 56, fig. 7; Plate 57, figs 1, 2

?*1844 Rissoa inconspicua Alder, p. 54.

Dimensions and material – Maximum height 2.0 mm. Locality 17: RGM 783 554/1, RGM 783 555/1.

Discussion – The shells from Turkey are similar to the smoother forms of the extremely variable Recent European species *Pusillina inconspicua* (Alder, 1844) (Fretter & Graham, 1978b, fig. 170; Warén, 1996, fig. 15), but differ in protoconch characters. In the Recent shells the protoconch consists of 3-3.5 whorls, but there is some discrepancy as to the total diameter (200 μ m *fide* Fret-

ter & Graham, 1974, p. 199; 450 μ m *fide* Warén, 1996, fig. 18F; definitely more than 300 μ m in Giribet & Peñas, 1997, fig. 19, although the protoconch boundary is not clear). In the Recent shells there is a spiral line on the last protoconch whorl close to the abapical suture. The Turk-ish shells have a protoconch consisting of only 2.5 whorls (dp = 430 μ m, hp = 260, dp/hp = 1.65, dp1 = 115 μ m, dn = 60 μ m) without any sculpture. There is quite some difference in the number and strength of the axial ribs in the fossil shells illustrated (Pl. 56, fig. 7a; Pl. 57, fig. 2a). Turkish fossil specimens and Recent shells would be difficult to separate based on their teleoconch morphology.

Distribution – **Middle Miocene**: Proto-Mediterranean (Serravallian): Karaman Basin, Turkey (this paper).

Pusillina sp.

Plate 57, fig. 3

Dimensions and material – Maximum height 2.8 mm. Locality 17: damaged during SEM imaging.

Discussion – A single shell from the Seyithasan deposits represents a rather slender *Pusillina* species with strongly convex whorls. The protoconch consists of 2.5 smooth whorls (dp = 330 μ m, hp = 330, dp/hp = 1.0, dp1 = 110 μ m, dn = 50 μ m) without any sculpture. The teleoconch consists of 2.5 whorls with one or two very faint spiral lines on the adapical portion of the penultimate and last whorls.The aperture is significantly flared abapically. It is not unlike smooth forms of the Recent Mediterranean species *Pusillina interrupta* (J. Adams, 1800) (see Giannuzzi-Savelli, 1997, fig. 270a). More information on and SEM images of fossil Euopean Neogene *Pusillina* species are required to clarify their diversity and distribution in the fossil assemblages.

Distribution – **Middle Miocene**: Proto-Mediterranean (Serravallian): Karaman Basin, Turkey (this paper).

Genus Alvania Risso, 1826

Type species – Alvania europea Risso, 1826 (*= Turbo cimex* Linnaeus, 1758), by subsequent designation (Nevill, 1885). Recent, Mediterranean.

Alvania critica Boettger, 1907

Plate 6, fig. 3; Plate 57, fig. 4

- *1907 *Alvania (Alvania) helenae* var. *critica* Boettger, p. 156, no. 538.
- 1934 Alvania (Alvania) helenae critica Boettger Zilch, p. 211, pl. 5, fig. 84.
- 1975 Alvania (Alvania) helenae Boettger, 1901 [sic] –
 Bałuk, p. 81, pl. 9, fig. 10.

Dimensions and material – Maximum height 2.5 mm. Locality 13: JvdV/3, RGM 794 589 (ex JvdV collection); locality 17: NHMW 1874/0058/1017/1, 1874/0058/1018/3, JvdV/38, RGM 783 596/50+, YI 160/11.

Discussion - This very small Alvania species is characterised by its rather squat, globose shape. The protoconch is multispiral, composed of almost three whorls bearing spiral rows of dots (dp =420 μ m, hp = 320 μ m, dp/hp = 1.3, dp1 = 140 μ m, dn = 85 μ m; Pl. 57, figs 4c, d). The junction with the teleoconch is sharply delimited by the beginning of the teleoconch sculpture. The teleoconch is composed of three weakly convex whorls, with spirally elongated cancellate sculpture consisting, on the penultimate whorl, of 16 narrow, straight ribs crossed by five equally narrow, elevated spiral cords. The last whorl is globose and the aperture is of medium size, ovate, bearing denticles within the outer lip. The Turkish shells are extremely similar to and probably conspecific with Alvania critica Boettger, 1906, which was originally described as a variety of Alvania helenae Boettger, 1902 from the same Romanian deposits as A. critica, but differs in having only three teleoconch whorls. Moreover, A. helenae has a slightly higher spire and a more open reticulate sculpture with slightly fewer axial and spiral elements. Alvania giselae Boettger, 1902, from the same Romanian deposits, is extremely similar, but has at least four teleoconch whorls, whereas all the Turkish specimens have only three whorls. Alvania giselae also has more numerous axial ribs.

In our opinion the specimen figured by Bałuk (1975, pl. 9, fig. 10) as *Alvania helenae* is conspecific with the Turkish specimens. Bałuk commented that his Polish shells differ from the Romanian specimens in having only three teleoconch whorls.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1975), Romania (Boettger, 1907; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Alvania lachesis (de Basterot, 1825)

Plate 6, fig. 4; Plate 57, fig. 5

- *1825 *Turbo Lachesis* Nob., de Basterot, p. 27, pl. 1, fig. 4.
- 1828b Rissoa bulimoides Nob., Grateloup, p. 132, no. 101.
- 1837 Rissoa curta Duj., Dujardin, p. 279, pl. 19, fig. 5.
- 1838c Rissoa bulimoides Nob., Grateloup, p. 201, pl. 5, figs 34, 35.
- 1847 *Rissoa bulimoïdes* Grat. Grateloup, pl. 4, figs 34, 35.
- 1856 Rissoa curta Duj. Hörnes, p. 571, pl. 48, fig. 15.
- 1864 *Rissoa Lachesis* Bastérot Mohrenstern, p. 30, pl. 2, fig. 17.
- 1895b *Alvania curta* var. *cristatocosta* Sacc., Sacco, p. 23.
- 1919 Alvania curta var. Lachesis (Basterot) Cossmann & Peyrot, no. 334, pl. 17, figs 43-46.
- 1919 Alvania curta (Dujardin) Cossmann & Peyrot,

no. 335, pl. 17, figs 9, 10.

- 1923 Alvania curta Duj. Friedberg, p. 374, pl. 22, figs 7-9.
- 1949 Alvania curta Dujardin, 1837 Glibert, p. 105, pl. 6, fig. 3.
- 1956 *Alvania curta cristatocosta* Sacco Csepreghy-Meznerics, pl. 1, fig. 24 (figure only, no discussion in text).
- 1954 Alvania curta Duj. Strausz, p. 11, pl. 3, fig. 60.
- 1962 Rissoa (Alvania) curta Dujardin Strausz, p. 108, pl. 46, figs 8, 9.
- 1966 *Rissoa (Alvania) curta* Dujardin, 1837 Strausz, p. 71, pl. 46, figs 8, 9.
- 1973 Alvania curta (Dujardin) 1837 Bohn-Havas, p. 1038, pl. 2, fig. 26.
- 1973 Alvania curta var. cristatocosta Sacco 1895 Bohn-Havas, p. 1038, pl. 2, fig. 27.
- 1975 Alvania (Alvania) curta (Dujardin, 1837) Bałuk,
 p. 78, pl. 9, fig. 11.
- 1981 Alvania (Alvania) curta (Dujardin, 1837) Švagrovský, p. 117, pl. 37, figs 1, 2.
- 1985 Alvania (Alvania) curta (Dujardin, 1837) Atanacković, p. 87, pl. 20, figs 13, 14.
- 2001 Alvania (Alvania) curta (Dujardin, 1837) Gürs & Weinbrecht, p. 80, fig. 2.4, pl. 1, fig. 6.
- 2001a *Alvania lachesis* (Basterot, 1825) Lozouet *et al.*, p. 31, pl. 12, fig. 5, pl. 13, fig. 3.
- 2003 Alvania (Alvania) curta (Dujardin 1837) İslamoğlu & Taner, p. 35, pl. 1, fig. 7.
- 2004 *Alvania (Alvania) curta* (Dujardin, 1837) Kowalke & Harzhauser, p. 118, fig. 6C.
- 2010 Alvania (Alvania) curta (Dujardin, 1837) Moths et al., p. 39, text-fig. 24e, pl. 12, fig. 2, pl. 36, fig. 1.
- non 1856 Rissoa Lachesis Bast. Hörnes, p. 572, pl. 48, fig. 16 (= Alvania acuticosta Sacco, 1895).
- *Pron* 1920 *Alvania curta* Dujardin Harmer, p. 611, pl. 51, figs 24, 25.

Dimensions and material – Maximum height 3.6 mm. Locality 6: JvdV/50+; locality 13: JvdV/3; locality 17: NHMW 1874/0058/1019/1, 1874/0058/1020/50+, JvdV/50+, RGM 784 041/2, RGM 783 970/50+, RGM 783 553/32, YI 161/50+.

Discussion – Alvania lachesis (de Basterot, 1825) was discussed by Kowalke & Harzhauser (2004, p. 118) under the name Alvania (Alvania) curta (Dujardin, 1837). Their discussion is a little misleading, as Lozouet *et al.* (2001a, p. 31) did not consider the French Aquitanian-Serravallian forms to be a distinct taxon, *A. lachesis*, but synonymised Dujardin's (1837) name with Alvania lachesis (de Basterot, 1825), as a junior subjective synonym. The Turkish shells tend to be slightly more angular at the base than the specimens figured by Lozouet *et al.* (2001, pl. 12, fig. 5, pl. 13, fig. 3) or Kowalke & Harzhauser (2004, fig. 6C1), but Glibert (1949, pl. 6, fig. 3) illustrated a similar form. The protoconch is multispiral, consisiting of 3.5 whorls with a small nucleus (dp = $350 \mu m$, hp = $340 \mu m$, dp/hp = 1, dp1 = 110 μ m, dn = 60 μ m; Pl. 57, fig. 5c, d), similar to that illustrated by Lozouet *et al.* (2001a, pl. 13, fig. 3) and Kowalke & Harzhauser (2004, fig. 6C2), except that it has a spiral sculpture of very fine lines of dots or interrupted threads. For discussion see (Kowalke & Harzhauser, 2004, p. 118).

Distribution - Early Miocene: northeastern Atlantic (Aquitanian-Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1919; Lozouet et al., 2001a); Proto-Mediterranean Sea (late Burdigalian): Antalya Basin, Turkey (İslamoğlu & Taner, 2003). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Germany (Gürs & Weinbrecht, 2001; Moths et al., 2010). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, (Cossmann & Peyrot, 1919), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Poland (Friedberg, 1928; Bałuk, 1975), Slovakia (Hörnes, 1856; Švagrovský, 1981), Hungary (Strausz, 1954, 1962, 1966; Bohn-Havas, 1973), Czech Republic (Kowalke & Harzhauser, 2004), Bosnia (Atanacković, 1985); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1895b), (early Tortonian): Antalya Basin, Turkey (İslamoğlu & Taner, 2003).

Alvania miocenica Sacco, 1895

Plate 6, fig. 5, Plate 57, fig. 6, Plate 58, figs 1, 2

- 1856 Rissoa Montagui Payr. Hörnes, p. 569, pl. 48, fig. 13 [non R. montagui Payraudeau, 1826 = Alvania discors (Allan, 1818)].
- *1895b Alvania Montagui var. miocenica Sacc., Sacco, p. 23 [nom. nov. pro Rissoa Montagui Payr. in Hörnes, 1856].
- Alvania Montagui Payr. Friedberg, p. 375, pl.
 fig. 11 [non R. montagui Payraudeau, 1826 = Alvania discors (Allan, 1818)].
- 1932/33 Alvania miocenica Sacco Meznerics, p. 330, pl. 13, fig. 2.
 - 1956 Alvania montagui miocaenica [sic] Sacco Csepreghy-Meznerics, p. 431, pl. 2, figs 1-4.
 - Alvania (Alvania) montagui var. miocaenica [sic]
 Sacco 1895 Kojumdgieva & Strachimirov, p.
 101, pl. 30, fig. 17.
 - 1966 Rissoa (Alvania) montagui miocaenica [sic] Sacco, 1895 – Strausz, p. 74, pl. 47, figs 19, 20.
 - 1981 Alvania (Alvania) montagui miocaenica [sic] Sacco – Svagrovský, p. 114, pl. 35, figs 5-7.
 - 1982 Alvania (Alvania) montagui miocaenica [sic] Sacco – Svagrovský, p. 11, pl. 3, figs 3, 4.
 - 1985 Alvania (Alvania) montagui miocaenica [sic] Sacco – Atanacković, p. 86, pl. 20, figs 9, 10.
 - 2004 Alvania (Alvania) ampulla (Eichwald, 1853) Kowalke & Harzhauser, p. 119 (partim) [non fig. 6D = Alvania ampulla (Eichwald, 1853)].

Dimensions and material - Maximum height 3.2 mm. Lo-

cality 6: JvdV/12; locality 13: JvdV/3, RGM 794 589/3 (ex JvdV collection); locality 17: NHMW 1874/0058/1021/1, 1874/0058/1022/6, JvdV/7, RGM 794 587/2 (ex JvdV collection), RGM 783 246/9, YI 162/22.

Discussion – Alvania miocenica Sacco, 1895 was based on the excellent figure given by Hörnes (1856, pl. 48, fig. 13), which clearly illustrates the characteristics of the species; a rather squat, solid shell, with a short conical spire composed of almost straight-sided whorls, a sculpture of broad axial ribs overrun by narrow elevated spiral cords, a relatively small, ovate aperture and a broad labial varix. Hörnes's figure clearly shows the protoconch to be multispiral, similar to that seen in the Karaman shells. The protoconch in the Turkish shells consists of 2.5 convex whorls with a microsculpture of pustules (dp = 365 μ m, hp = 250 μ m; dp/hp = 1.46; dp1 = 200 μ m, dn = 110 μ m; Pl. 57, fig. 6c, Pl. 58, figs 1a, 2c). There teleoconch also has a microsculpture of very fine spiral threads (Pl. 57, fig. 6c, Pl. 58, fig. 2c).

Bałuk (1975, p. 80) suggested that A. miocenica was a junior synonym of Alvania ampulla (Eichwald, 1853). Hörnes (1856) also noted that his 'Rissoa Montagui' was the same shell as that described by Eichwald. Unfortunately, Eichwald's (1853, pl. 10, fig. 16) crude figure illustrates the generic characters, but could represent any number of species. To complicate matters further, the specimen illustrated by Bałuk (1975) differs in having more rounded whorls, a proportionately larger, more rounded aperture and a very poorly developed labial varix. This is the shell illustrated by Kowalke & Harzhauser (2004) as A. ampulla, which differs from Hörnes' illustration in being less squat, in having an extra teleoconch whorl, in having sculpture composed of more numerous spiral and axial elements, which are of more equal strength, and in having almost no labial varix.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856; Meznerics, 1933); Poland (Friedberg, 1923), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Csepreghy-Meznerics, 1956; Strausz, 1966), Slovakia (Švagrovský, 1981, 1982), Bosnia (Atanacković, 1985); Proto-Mediterranean (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1895b).

Alvania perregularis (Sacco, 1895)

Plate 6, fig. 6

- 1856 *Rissoa Mariae* d'Orb. Hörnes, p. 563, pl. 48, fig.
 9 (*non* d'Orbigny, 1852).
- *1895b Alvania (Acinus) Mariae? perregularis Sacc., Sacco, p. 25. [nom. nov. pro Rissoa mariae in Hörnes, 1856].
- 1923 Alvania perregularis Sacco Friedberg, p. 378, pl. 22, figs 14, 15.
- 1923 Alvania perregularis var. varicosa Friedg., Fried-

berg, p. 379, pl. 22, fig. 16.

- 1932/33 *Alvania (Acinus) perregularis* Sacco Meznerics, p. 331, pl. 13, fig. 9.
 - 1960 Alvania (Alvania) perregularis (Sacco 1895) –
 Kojumdgieva & Strachimirov, p. 100, pl. 30, fig. 16.
 - 1973 Alvania perregularis Sacco 1895 Bohn-Havas, p. 1037, pl. 3, figs 1, 2.
 - 1975 Alvania (Turbona) perregularis (Sacco, 1895) –
 Bałuk, p. 85, pl. 9, figs 13-15.
 - 1981 Alvania (Turbona) perregularis (Sacco) Švagrovský, p. 118, pl. 36, fig. 4.
 - 1985 *Alvania (Alvania) perregularis* (Sacco) Atanacković, p. 87, pl. 20, figs 17, 18.
 - 2004 *Alvania (Alvania) perregularis* (Sacco, 1895) Kowalke & Harzhauser, p. 120, fig. 7B.
 - 2012 Alvania (Alvania) perregularis (Sacco, 1895) d'Amico et al., p. 164, pl. 2, fig. 20.
- non 1954 Alvania perregularis Sacc. Strausz, p. 11, 63, 91, pl. 3, fig. 59 (? = Alvania tenuicostata Bałuk, 1975).
- non 1966 Rissoa (Alvania) perregularis Sacco, 1895 Strausz, p. 73, pl. 46, figs 12, 13 (? = Alvania tenuicostata Bałuk, 1975).
- non 2000 Alvania (Turbona) perregularis (Sacco, 1895) Popa & Ianoliu, p. 84, pl. 2, fig. 6.

Dimensions and material – Maximum height 3.4 mm. Locality 17: NHMW 1874/0058/1023/1.

Discussion - Alvania perregularis (Sacco, 1895) is characterised by its evenly teardrop-shaped shell and very close-set cancellate sculpture, with 25-33 axial ribs and 6-7 spiral cords on the penultimate whorl. Initially described as a subspecies of the Miocene to Pleistocene Alvania mariae (d'Orbigny, 1852), these two species are very similar in shape. However, A. mariae has only five spiral cords on the penultimate whorl (see Chirli, pl. 12, figs 9-16). The Turkish specimen is small compared to those reported by Meznerics (1932/33) from the Vienna Basin, which reach up to 5 mm in height, more in keeping with the Polish specimens recorded by Bałuk (1975), with a maximum height of 3.8 mm. Unfortunately the protoconch is missing in the Turkish material, but it comprises 2.75 convex whorls with a microsculpture of granulated spiral threads (Kowalke & Harzhauser, 2004).

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856; Meznerics, 1932/33), Poland (Friedberg, 1928; Bałuk, 1975), Hungary (Bohn-Havas, 1973), Bosnia (Atanacković, 1985), Czech Republic (Kowalke & Harzhauser, 2004), Slovakia (Švagrovský, 1981), Bulgaria (Kojumdgieva & Strachimirov, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1895b; d'Amico *et al.*, 2012).
Alvania productilis Boettger, 1907

Plate 6, fig. 7; Plate 58, fig. 3

- *1907 *Alvania (Alvania) productilis* Boettger, p. 156, no. 539.
- 1934 Alvania (Alvania) productilis Boettger Zilch, p. 212, pl. 5, fig. 83.
- 1975 Alvania (Alvania) productilis Boettger, 1907 Bałuk, p. 81, pl. 9, fig. 6.

Dimensions and material – Maximum height 3.2 mm. Locality 6: JvdV/20; locality 17: NHMW 1874/0058/1024/1, 1874/0058/1025/12, RGM 794 586/6 (ex JvdV collection), RGM 783 571/15, YI 163/12.

Discussion – Alvania productilis Boettger, 1907 is a small, thin-walled species, characterised by its close-set axial ribs and weak spiral sculpture. The protoconch consists of 2.5 smooth, convex whorls with a medium-sized nucleus (dp = 430 μ m, hp = 415 μ m, dp/hp = 1.03; dp1 = 180 μ m, dn = 105 μ m; Pl. 58, fig. 3c, d). There is no trace of microsculpture on the protoconch or teleoconch.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1975), Romania (Boettger, 1907; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Alvania cf. *punctura* (Montagu, 1803) Plate 58, fig. 4

1 late 36, lig. 4

?*1803 Turbo punctura Montagu, p. 320, pl. 12, fig. 5.

Dimensions and material – Maximum height 3.0 mm. Locality 13: RGM 794 590/1 (ex JvdV collection).

Discussion – A single shell from the Akpinar deposits is characterised by having a protoconch comprising about 2.5 whorls with microsculpture of spiral rows of coalescing pustules. The teleoconch is relatively slender, consisting of four convex whorls with a fine squarely reticulate pattern. The teleoconch is also covered by microsculpture of pustules. The protoconch microsculpture is identical to that figured by Gianuzzi-Savelli et al. (1997, fig. 436) for the Recent European species Alvania punctura (Montagu, 1803). However, this species has an extra half protoconch whorl (Gofas & Warén, 1982, pl. 1, 10-12). The teleoconch is indeed very similar, intermediate in the number of sculptural elements between two of the Recent specimens figured by Gofas & Warén (1982, pl. 1, figs 1, 2). It is unclear whether the teleoconch of the Recent shells bears microsculpture, but judging from the figures in Gofas & Warén (1982, figs 10-12) it may be very similar to that seen in the Turkish shell.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Alvania transiens (Sacco, 1895) Plate 6, fig. 8

- 1856 Rissoa Venus d'Orb. Hörnes, p. 565, pl. 48, fig. 10 (non d'Orbigny, 1852).
- *1895b Alvania (Acinopsis) sculpta? var. transiens Sacc., Sacco, p. 27 (nom. nov. pro Rissoa venus d'Orb. in Hörnes, 1856).
- 1919 Alvania danubiensis nobis, Cossmann & Peyrot, p. 586 (nom. nov. pro Rissoa venus d'Orb. in Hörnes, 1856).
- 1921 Alvania danubiensis Cossm. et Peyr. Cossmann, p. 20, pl. 1, figs 43, 44.
- 1923 Alvania Venus var. danubiensis Cossm. et Peyr. Friedberg, p. 379, pl. 22, fig. 17.
- 1954 Alvania venus danubiensis Cossm. et Peyr. Strausz, p. 11, 63, 91, pl. 3, fig. 58.
- 1956 Alvania venus danubiensis Cossm. et Peyr. Csepreghy-Meznerics, p. 431, pl. 2, figs 15, 16.
- Alvania (Alvania) venus var. danubiensis (Cossmann et Peyrot 1919) Kojumdgieva & Strachimirov, p. 100, pl. 30, fig. 15.
- 1963 Alvania (Alvania) venus (d'Orbigny 1852) Steininger, p. 43, pl. 13, fig. 1 (non d'Orbigny, 1852)
- 1966 *Rissoa (Alvania) venus danubiensis* Cossmann & Peyrot, 1918 Strausz, p. 72, pl. 48, figs 17, 18.
- 1970 *Alvania (Alvania) venus danubiensis* Cossm. et Peyr. Radu & Mutiu, p. 147, pl. 4, figs 13, 14.
- 1975 Alvania (Acinulus) venus transiens Sacco, 1895 Bałuk, p. 86, pl. 9, figs 18, 19.
- 2004 *Alvania (Alvania) transiens* (Sacco, 1895) Kowalke & Harzhauser, p. 121, fig. 7C.
- 2012 *Alvania (Alvania) transiens* Sacco 1895 d'Amico *et al.*, p. 165, pl. 2, fig. 21.

Dimensions and material – Maximum height 3.7 mm. Locality 6: NHMW 1874/0058/1513/2, JvdV/4; locality 17: NHMW 1874/0058/1372/1, RGM 783 247/1.

Discussion – Kowalke & Harzhauser (2004) discussed the relationship between *Alvania transiens* (Sacco, 1895) and *Alvania venus* (d'Orbigny, 1852), highlighting their differences. The Turkish shell is identical to that figured by Kowalke & Harzhauser (2004) from the middle Miocene Paratethys of Austria, with the same number of axial and spiral elements. Unfortunately, the protoconch and early teleoconch whorls are eroded in the specimens from Seyithasan, but in the Austrian material the protoconch is multispiral, composed of about 2.75 convex whorls with microsculpture of granular spiral threads (Kowalke & Harzhauser, 2004, fig. C2).

Several Mediterranean Pliocene species are extremely similar to *A. transiens* and need to be compared. The most similar is *Alvania aglaja* de Stefani & Pantanelli, 1878, which occurs in the Italian late Miocene to early Pleistocene (Chirli, 2006, pl. 4, figs 1-10). This species has a greater number of axial ribs (17-22 vs. 15-16), and the spiral cords are narrower and do not form small tubercles over the sculptural intersections. The Pliocene to Recent *Alvania beani* (Hanley *in* Thorpe, 1844) has

a greater number of axial and spiral elements and *Alvania cancellata* (da Costa, 1778) differs in having a somewhat scalate spire and more spinous cancellate sculpture. Bałuk (1975) suggested that *Alvania anabaptizata* Boettger, 1902 from the middle Miocene Paratethys of Romania might be a synonym, but judging by the figured lectotype (Zilch, 1934, pl. 5, fig. 86), this species is slightly more globose, with more rounded whorls and narrower axial ribs and spiral cords. *Alvania erentoezae* İslamoğlu, 2006, described from the slightly younger early Tortonian of the Antalya Basin of Turkey can immediately be separated by its more open cancellate sculpture and paucispiral protoconch.

Distribution – Early Miocene: Paratethys (Burdigalian): Austria (Steininger, 1963); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1895b). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856; Cossmann, 1921; Kowalke & Harzhauser, 2004), Hungary (Strausz, 1954, 1966; Csepreghy-Meznerics, 1956), Bulgaria (Kojumdgieva & Strachimirov, 1960), Poland (Friedberg, 1923; Bałuk, 1975), Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1895b; d'Amico *et al.*, 2012). Early-late Pliocene: central Mediterranean, Italy (Sacco, 1895b).

Genus Manzonia Brusina, 1870

Type species – Turbo crassus Kanmacher, 1798, by original designation (as *Turbo costatus* J. Adams, 1797). Recent, northeast Atlantic and western Mediterranean.

Manzonia crassa (Kanmacher, 1798)

Plate 58, fig. 5

- *1798 Turbo crassus Kanmacher, p. 638, fig. 20.
- 1895b Manzonia costata var. depressicosta Sacc., Sacco, p. 29, pl. 1, fig. 72.
- 1923 Manzonia costata Adams var. Friedberg, p. 385, pl. 23, fig. 5.
- 1963 Folinia (Manzonia) costata (Adams) Venzo & Pelosio, p. 62, pl. 33, figs 20, 21.
- 1964 Folinia (Manzonia) costata (Adams) Brébion, p. 149, pl. 4, figs 9, 10.
- 1966 *Rissoa (Manzonia) costata* Adams, 1797 [*sic*] Strausz, p. 76, pl. 46, fig. 24.
- 1966 Folinia (Manzonia) costata (Adams) Iljina, p. 91, pl. 4, fig. 2.
- 1970 Folinia (Manzonia) costata (Adams) Bucchieri, p. 248, pl. 2, fig. 3.
- 1975 Folinia (Manzonia) costata (Adams, 1797) Bałuk, p. 74, pl. 8, fig. 12.
- 2004a *Manzonia crassa* (Kanmacher, 1798) Landau *et al.*, p. 47, pl. 10, fig. 1 (with additional synonyms).
- 2004 *Manzonia (Manzonia) crassa* (Kanmacher *in* J. Adams, 1798) Kowalke & Harzhauser, p. 122, fig 8C.

- 2006 *Manzonia crassa* (Kanmacher, 1798) Chirli, p. 41, pl. 20, figs 5-10.
- 2010 Manzonia crassa (Kanmacher, 1798) Sosso & dell'Angelo, p. 22, unnumbered figure p. 32 middle row right.

Dimensions and material – Maximum height 2.2 mm. Locality 17: RGM 784 002/1.

Discussion – The single shell from Turkey is in poor condition and missing the protoconch. Kowalke & Harzhauser (2004, p. 123) discussed the presence of Manzonia crassa (Kanmacher, 1798) in the middle Miocene Paratethys and considered it to be impossible to distinguish from the Recent Mediterranean shells based on shell characters. The French Atlantic middle Miocene species Manzonia costata falunica (Morgan, 1915) from the Langhian-early Serravallian of the Loire Basin was said to be smaller than usual for the Pliocene to Recent species *M. crassa*, with slightly less elevated whorls, giving the shell a squatter, less elongated appearance (Glibert 1949, p. 102, pl. 5, fig. 22). The size, even in Recent populations, is variable, North Atlantic specimens being larger than Mediterranean ones (van Aartsen et al., 1984). Although Landau et al. (2004a, p. 47) accepted M. costata *falunica* as a chronological subspecies, the presence of M. costata in the middle Miocene Paratethys and Proto-Mediterranean Sea casts doubt on this decision.

Manzonia miocristata Sacco, 1895 from the late Miocene, Tortonian of Italy has a more slender shell with fewer but more strongly developed axial ribs and a different mammillate protoconch, much more elevated, consisting of at least 2.5-3 whorls (Ferrero Mortara *et al.*, 1984, p. 218, pl. 39, fig. 8). For further discussion see Kowalke & Harzhauser (2004, p. 123) and Landau *et al.* (2004a, p. 47).

Distribution - Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Kowalke & Harzhauser, 2004), Hungary (Strausz, 1966), Poland (Friedberg, 1923; Bałuk, 1975), Romania (Kowalke & Harzhauser, 2004); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (Brébion, 1964); Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, Italy (Sacco, 1895b; Venzo & Pelosio, 1963). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Landau et al., 2004a); central Mediterranean, Italy (Chirli, 2006); Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1895b; Malatesta, 1974; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010). Early-late Pleistocene: North Sea Basin, British Isles (Harmer, 1918); western Mediterranean, France (Glibert, 1962b); central Mediterranean, Italy (Cerulli-Irelli, 1914; Bucchieri, 1970). Recent: northeastern Atlantic, Norway, southwards to Morocco, Mediterranean, from extreme low tide line to 50 m depth, often on sandy bottoms, but also under stones and in weeds (Poppe & Goto, 1991).

Subfamily Rissoininae Stimpson, 1865 Genus *Rissoina* d'Orbigny, 1840

Type species – Rissoina inca d'Orbigny, 1840, by original designation, Recent, Peru.

Rissoina subconoidea (Grateloup, 1847)

Plate 6, fig. 9

- 1825 Rissoa Cochlearella Lam. de Basterot, p. 37 (non Lamarck, 1804).
- 1828b Rissoa cochlearella var. B Bast. Grateloup, p. 131.
- 1838c Rissoa cochlearella var. B Nob. Grateloup, p. 197, pl. 5, figs 19, 20.
- 1847 *Rissoa cochlearella* var. A *subconoidea* Grateloup, pl. 4, figs 17, 18.
- 1847 *Rissoa cochlearella* var. B *elongata* Grateloup, pl. 4, figs 19-20 (*non* Defrance, 1827; *non* Eichwald, 1830).
- 1852 Rissoa subcochlearella d'Orb., d'Orbigny, p. 29, no. 388. (nom. nov. pro Rissoa Cochlearella Lam. in de Basterot, non Lamarck, 1804).
- 1856 Rissoina pusilla Brocc. Hörnes, p. 557, pl. 48, fig. 4 [non Rissoina pusilla (Brocchi, 1814)].
- 1895b *Rissoina pusilla* (Br.) Sacco, p. 35 (*partim*) [*non Rissoina pusilla* (Brocchi, 1814)].
- ?1895b Rissoina pusilla var. parvofusula Sacc., Sacco, p. 36, pl. 1, fig. 101.
- 1914 *Rissoina pusilla* Brocc. Friedberg, p. 358, pl. 20, fig. 22 [*non Rissoina pusilla* (Brocchi, 1814)].
- 1919 Rissoina elongata Grateloup Cossmann & Peyrot, no. 304, pl. 16, figs 101, 102 [non 133, 134 on plate = 105, 106 in plate text = Rissoina (Zebinella) subcancellata (Grateloup, 1847)].
- 1919 *Rissoina elongata (an monst.?)* var. *scalarata* Cossmann & Peyrot, no. 305, pl. 16, figs 131, 132.
- 1919 *Rissoina (Zebinella) recticostulata* Cossmann & Peyrot, no. 319, pl. 17, figs 36, 37.
- 1921 *Rissoina podolica* Cossmann, p. 317, pl. 3, figs 43, 44.
- 1954 *Rissoina podolica* Cossmann Csepreghy-Meznerics, p. 16, pl. 1, fig. 21.
- 1954 Rissoina podolica Cossm. Strausz, p. 11, pl. 3, fig. 65.
- 1956 Rissoina podolica Cossm. Csepreghy-Meznerics, p. 431, pl. 2, figs 13, 14.
- 1960 Rissoina (Rissoina) podolica Cossmann 1921 Kojumdgieva & Strachimirov, p. 102, pl. 30, fig. 19.
- 1962 *Rissoina pusilla podolica* Cossmann Strausz, p. 52, pl. 12, figs 23-28.
- 1966 Rissoina pusilla podolica Cossmann, 1921 Strausz, p. 79, pl. 12, figs 23-28.
- 1975 Rissoina (Rissoina) podolica Cossmann 1921 Bałuk, p. 90, pl. 10, figs 11-14.
- 2001a *Rissoina subconoidea* (Grateloup, 1847) Lozouet *et al.*, p. 32, pl. 12, fig. 11.

Dimensions and material – Maximum height 8.0 mm. Locality 13: JvdV/2, RGM 783 630/1, YI 164/9; locality 17: NHMW 1874/0058/1028/1, 1874/0058/1029/2, RGM 783 971/3.

Discussion – Rissoina subconoidea (Grateloup, 1847) is characterised by its rather solid slender shell, teleoconch consisiting of about eight slightly convex whorls, sculpture of narrow, weakly opisthocline axial ribs, 18-20 on the penultimate whorl, spiral sculpture subobsolete and restricted to the base of the last whorl, and ovate aperture with a strong labial varix.

We fully agree with Lozouet *et al.* (2001a), who suggested that *Rissoina podolica* Cossmann, 1921 might be a junior subjective synonym of *Rissoina subconoidea* (Grateloup, 1847). The specimen figured by Sacco (1895b, pl. 1, fig. 101) from the Burdigalian-Langhian Colli Torinesi of Italy as *Rissoina pusilla* var. *parvofusula* is likely to be the same species, although we cannot be certain as the figure is very poor and it has not been reillustrated.

Distribution – Late Oligocene: northeastern Atlantic (Chattian): Aquitaine Basin, France (Cossmann & Peyrot, 1919; Lozouet *et al.*, 2001a). Early Miocene: northeastern Atlantic (Aquitanian-Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1919; Lozouet *et al.*, 2001a); ?Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1895b). Middle Miocene: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1919); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856), Poland (Friedberg, 1914; Bałuk, 1975), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1954, 1962, 1966; Csepreghy-Meznerics, 1954, 1956); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Rissoina vindobonensis Sacco, 1895

Plate 6, fig. 10; Plate 58, fig. 6

- 1856 Rissoina Bruguierei Payr. Hörnes, p. 558, pl. 48, fig. 5 (non Payreaudeau, 1826).
- *1895b *Rissoina Bruguieri* var. *vindobonensis* Sacc., Sacco. p. 35 (*nom. nov. pro Rissoina Bruguierei* Payr. *in* Hörnes, 1856).
- 1921 Rissoina vindobonensis Sacco Cossmann, p. 83, pl. 3, figs 47, 48.
- 1954 Rissoina vindobonensis Sacc. Strausz, p. 12, pl. 3, fig. 66.
- 1960 Rissoina (Rissoina) vindobonensis (Sacco 1895) –
 Kojumdgieva & Strachimirov, p. 102, pl. 30, fig. 20.
- 1966 Rissoina bruguierei vindobonensis Sacco, 1895 Strausz, p. 80, pl. 12, figs 19-22.
- 1975 Rissoina (Rissoina) vindobonensis Sacco, 1895 Bałuk, p. 91, pl. 10, figs 6, 7.
- 1993 Rissoina (Rissoina) vindobonensis Sacco, 1895 Iljina, p. 51, pl. 5, figs 20, 21.
- ?2000 Rissoina (Rissoina) cf. vindobonensis Sacco, 1895

- Popa & Ianoliu, p. 85, pl. 2, fig. 7.

Dimensions and material – Maximum height 4.3 mm. Locality 17: NHMW 1874/0058/1030/1, RGM 776 854/1 (ex JvdV collection).

Discussion – Closely similar to the Pliocene to Recent Mediterranean Rissoina bruguierei (Payraudeau, 1826), R. vindobonensis differs from R. bruguierei in being smaller, less slender, with fewer teleoconch whorls and in having the axial ribs more sinuous and slightly broader. Rissoina exdecussata Sacco, 1895 from the middle Miocene Atlantic of France (see Glibert, 1949, pl. 6, fig 6) is also closely similar, but has a greater number of axial ribs, which are more strongly prosocline and slightly more flexuose. The protoconch of the Turkish shell is multispiral, dome-shaped, consisting of about three whorls with a small nucleus. The junction with the teleoconch is sharply delimited.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856), Poland (Bałuk, 1975), Hungary (Cossmann, 1921; Strausz, 1954, 1966), Bulgaria (Kojumdgieva & Strachimirov, 1960), ?Romania (Popa & Ianoliu, 2000), eastern Paratethys (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subgenus Zebinella Mörch, 1876

Type species – Helix decussata Montagu, 1803, by original designation, Recent, Caribbean.

Rissoina (*Zebinella*) *extranea* (Eichwald, 1830) Plate 6, fig. 11

- *1830 Rissoa extranea Eichwald, p. 218, 219 (footnote).
- 1833 *Rissoa striata* Andrzejowsky, p. 447, pl. 11, fig. 3 (*non* Quoy & Gaimard, 1833).
- 1837 Rissoa multiplicata m., Pusch, p. 96, pl. 9, fig.
 8 (nom. nov. pro Rissoa striata Andrzejowsky, 1833).
- 1853 *Rissoa cochlearella* Lam. Eichwald, p. 267 (*non* Lamarck, 1804).
- 1860 *Rissoina extranea* Eichwald –von Mohrenstern, p. 79, pl. 6, fig. 43.
- 1928 *Rissoina striata* Andrz. Friedberg, p. 607, pl. 38, fig. 13 (*non* Quoy & Gaimard, 1833).
- 1932/33 Rissoina (Zebinella) extranea Eichw. Meznerics, p. 326, pl. 13, fig. 4.
 - 1975 *Rissoina (Zebinella) extranea* (Eichwald, 1830) Bałuk, p. 94, pl. 10, fig. 10.

Dimensions and material – Height 7.5 mm. Locality 13: NHMW 1874/0058/1031/1, JvdV/1.

Discussion – Rissoina (Zebinella) extranea (Eichwald, 1830) is characterised by being small, but very thick-shelled. The protoconch is multispiral, dome-shaped,

composed of about three smooth convex whorls. The teleoconch consists of eight almost straight-sided whorls. In later adult whorls the abapical portion of the whorl slightly overhangs the suture. Sculpture consists of densely packed, opisthocline flattened ribs, slightly narrower than their interspaces, about 27 on the penultimate whorl. The last whorl is not particularly inflated, with weak spiral sculpture on the base visible only within the interspaces of the axial ribs. The aperture is small and the outer lip is strongly thickened. Bałuk (1975) was quite right to separate this very distinctive little rissoinid from its Paratethyan congeners. Within the Turkish deposits it is easily distinguished from Rissoina (Zebinella) obsoleta Partsch in Hörnes, 1856 and Rissoina (Zebinella) cf. decussata (Montagu, 1803) by having a smaller thicker shell and the axial sculpture well developed throughout.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Meznerics, 1932/33), Poland (Friedberg, 1928; Bałuk, 1975); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Rissoina (Zebinella) obsoleta Hörnes, 1856

Plate 6, fig. 12; Plate 58, fig. 7

- *1856 *Rissoina obsoleta* Hörnes, p. 556, pl. 48, fig. 3.
 1860 *Rissoina obsoleta* Partsch –von Mohrenstern, p. 78, pl. 5, fig. 42.
- 1895b Zebinella obsoleta var. tessellata (Micht.) Sacco, p. 38, pl. 1, fig. 110.
- 1903 *Rissoina obsoleta* Partsch Dollfus *et al.*, p. 21, pl. 36, figs 1, 3 (?2).
- 1949 *Rissoina (Zebinella) obsoleta* Partsch (*in* Hörnes),1856 Glibert, p. 111, pl. 6, fig. 8.

Dimensions and material – Maximum height 12.9 mm. Localities 2 & 3: JvdV/7, YI 156/1; localities 7 & 8: NHMW 1874/0058/1035/2; locality 13: NHMW 1874/0058/1034/50+, YI 157/12; locality 17: NHMW 1874/0058/1032/1, 1874/0058/1033/20, JvdV/50+, RGM 794 592/1 (ex JvdV collection), RGM 783 962/21, YI 158/41.

Discussion – Rissoina (Zebinella) obsoleta Hörnes, 1856 is probably the largest of the European Neogene rissoinids. It differs from R. (Z.) decussata Montagu, 1803 and R. (Z.) loueli (Hörnes, 1856) by its larger size, the almost straight-sided spire whorls and in having the last whorl weakly angular at the base. The protoconch is multispiral, composed of about three whorls (Pl. 58, fig. 7a). The teleoconch bears microsculpture of very fine spiral threads visible in the sculptural interspaces (Pl. 58, fig. 7b).

Distribution – **Middle Miocene**: northeastern Atlantic (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856);

Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (NHMW collection), (Tortonian): Cacela Basin, Portugal (Dollfus *et al.*, 1903); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1895b).

Rissoina (Zebinella) cf. *decussata* (Montagu, 1803) Plate 6, fig. 13; Plate 58, fig. 8

?*1803 Helix decussata Montagu, p. 399, pl. 15, fig. 7.

Dimensions and material – Maximum height 5.6 mm. Locality 17: NHMW 1874/0058/1036/1, 1874/0058/1037/6, JvdV/25, RGM 794 593/1 (ex JvdV collection), RGM 783 972/24, YI 165/9.

Discussion – A small Rissoina (Zebinella) species that occurs in the Karaman assemblages is characterised by having a multispiral protoconch composed of about 3.5 convex whorls (Pl. 58, fig. 8), slightly carinate early teleoconch whorls, weakly convex later whorls, sculpture of close-set flattened ribs, which persist onto the last whorl, and a rather broad last whorl with a wide aperture and a moderately thickened labial varix. It is similar to the widespread Miocene and Pliocene species R. (Z.) decussata (Montagu, 1803), but R. decussata is slightly more slender with a proportionately taller last whorl. Rissoina (Zebinella) extranea (Eichwald, 1830) from the middle Miocene Paratethys, is also similar, but has stronger, more elevated ribs and a thicker labial varix. The early whorls in the Turkish shells are slightly carinate, similar to those of R. (Z.) sororcula Boettger, 1902, which is also from the middle Miocene Paratethys, but in R. (Z.) sororcula the axial sculpture is more prominent and sharper. Rissoina (Zebinella) varicosa Boettger, 1907, another species from the Paratethys, differs in having a more slender shell with more convex whorls. Rissoina (Zebinella) loueli (Hörnes, 1856) has finely reticulate sculpture on the later teleoconch whorls, according to the specimen from the Atlantic Langhian Loire Basin of France illustrated by Glibert (1949, p. 6, fig. 7).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Stossicia Brusina, 1878

Type species – Rissoa buccinalis Grateloup, 1828, by original designation. Miocene, France.

Stossicia multicingulata (Boettger, 1887) Plate 6, fig. 14

1856 *Rissoa planaxoides* Desmoul. – Hörnes, p. 578, pl.
48, fig. 24 [*non* Desmoulins *in* Grateloup, 1838c = *Stossicia buccinalis* (Grateloup, 1828)].

- *1887 Stossichia multicingulata Boettger, p. 142, pl. 6, fig. 3.
- 1919 Stossichia planaxoides var. helvetica Cossmann & Peyrot, p. 566, no. 324, pl. 17, figs 21, 22.
- 1921 Stossichia multicingulata Boettger Cossmann, p. 76.
- 1923 Stossichia planaxoides des Moul. Friedberg, p. 361, pl. 21, fig. 4 [non Desmoulins in Grateloup, 1838c = Stossicia buccinalis (Grateloup, 1828)].
- 1932/33 Stossichia planaxoides var. helvetica Cossm. et Peyrot – Meznerics, p. 328, pl. 13, fig. 11.
 - 1934 Stossichia multicingulata Boettger Zilch, p. 209, pl. 5, figs 72, 73.
 - ?1949 Planaxis (Dalliella) dautzenbergi Glibert, p. 133, pl. 8, fig. 6.
 - 1966 *Stossichia planaxoides* var. *helvetica* Cossmann & Peyrot Kókay, p. 37, pl. 2, fig. 22.
 - 1975 Zebina (Stossichia) multicingulata (Boettger, 1887) Bałuk, p. 90, pl. 10, figs 11-14.
 - 1985 Zebina (Stossichia) planaxoides (Des Moulins)
 Atanacković, p. 90, pl. 20, figs 28, 29 [non Desmoulins in Grateloup, 1838c = Stossicia buccinalis (Grateloup, 1828)].
 - 2002 *Stossicia multicingulata* (Boettger, 1887) Harzhauser, p. 79, pl. 4, fig. 7.

Dimensions and material – Maximum height 5.0 mm. Locality 17: JvdV/1, RGM 794 166/1 (ex JvdV collection).

Discussion – Stossicia multicingulata (Boettger, 1887) is easily separated from *Stossicia buccinalis* (Grateloup, 1828) (= *Stossichia planaxoides* Desmoulins *in* Grateloup, 1838) by having more numerous and weaker spiral cords. We have not seen specimens from the Atlantic Serravallian Loire Basin, but Bałuk (1995) was probably right to place *Planaxis* (*Dalliella*) *dautzenbergi* Glibert, 1949 in synonymy with *S. multicingulata*. The species is exceedingly rare in the Turkish assemblages, represented by only two rather worn specimens.

Distribution – Early Miocene: Paratethys (Aquitanian-Burdigalian): Austria, (Harzhauser, 2002). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1919), ?(Langhian) Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856; Meznerics, 1932/33); Poland (Friedberg, 1923; Bałuk, 1975), Hungary (Kókay, 1966), Bosnia (Atanacković, 1985), Romania (Boettger, 1887; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Iravadiidae Thiele, 1928 (*sensu* Ponder, 1984) Genus *Hyala* H. Adams & A. Adams, 1853

Type species – Turbo vitreus Montagu, 1803, by monotypy. Recent, Europe.

Hyala vitrea (Montagu, 1803)

Plate 7, fig. 4; Plate 59, fig. 15

- *1803 *Turbo vitreus* Montagu, p. 321, pl. 12, fig. 3.
- 1848 *Rissoa vitrea* Mont. Wood, p. 102, pl. 11, fig. 3.
 1895b *Hyala vitrea* var. *pliomajor* Sacc., Sacco, p. 31, pl. 1, fig. 80.
- 1903 *Rissoia (Cingula) vitrea* Montagu Dollfus *et al.*,p. 21, pl. 36, figs 4, 5.
- 1914 *Rissoia (Hyala) vitrea* Mtg. Cerulli-Irelli, p. 369, pl. 15, figs 50, 51.
- 1921 Ceratia (Hyala) vitrea Montagu Cossmann, p. 45, pl. 2, figs 48, 49.
- 1959 *Cingula* (*s.s.*) *vitrea* (Montagu) Ruggieri & Curti, p. 99, pl. 20, fig. 121.
- 1966 *Cingula (Hyala) vitrea* (Montagu, 1803) Kókay, p. 36, pl. 2, fig. 17.
- 1972b *Hyala vitrea* (Montagu, 1803) Nordsieck, p. 168, pl. R 5, fig. 7.
- 1972b Hyala mediterranea Nordsieck, p. 168, pl. R 5, fig. 8.
- 1975 *Cingula (Hyala) vitrea* (Montagu, 1803) Bałuk, p. 66, pl. 8, fig. 21.
- 1975 *Cingula (Hyala) vitrea* (Montagu) Pavia, p. 111, pl. 4, fig. 1.
- 1975 Ceratia vitrea (Montagu) Fekih, p. 71, pl. 24, fig. 19.
- 1978 *Onoba vitrea* (Montagu, 1803) Fretter & Graham, p. 169, fig. 145.
- 1984a *Onoba vitrea* (Montagu) Martinell & Domènech, p. 6, pl. 1, figs 1, 2.
- 1986 *Cingula (Hyala) vitrea* (Montagu, 1803) González Delgado, p. 68, pl. 1, figs 3, 4.
- 1991 Onoba vitrea (Montagu, 1803) Poppe & Goto, p. 105, pl. 13, fig. 9.
- 1992 *Hyala vitrea* (Montagu, 1803) Cavallo & Repetto, p. 56, fig. 095.
- 1993 *Hyala vitrea* (Montagu, 1803) Bouchet & Warén,p. 701, figs 1651-1654, 1657.
- 1997 *Hyalea* [*sic*] *vitrea* (Montagu, 1803) Giannuzzi-Savelli *et al.*, p. 124, figs 549-551.
- 2001 *Hyala vitrea* (Montagu, 1803) Silva, p. 176, pl. 6, figs 8, 9, pl. 7, figs 3, 4.
- 2006 Hyala vitrea (Montagu, 1803) Chirli, p. 71, pl. 29, figs 10-14.
- 2011 *Hyala vitrea* (Montagu, 1803) Landau *et al.*, p. 11, pl. 3, fig. 3.

Dimensions and material – Maximum height 2.6 mm. Localities 2 & 3: JvdV/1; locality 6: JvdV/1; localities 7 & 8: RGM 783 958/3 fragments; locality 13: JvdV/2; locality 17: NHMW 1847/0058/170972, JvdV/3, RGM 783 944/10, RGM 783 945/1, RGM 784 083/1.

Discussion – Hyala vitrea (Montagu, 1803) is characterised by its tall columnar shape, convex spire whorls separated by a relatively deep suture and its subobsolete or absent spiral sculpture. The protoconch consists of about 2.5 whorls (Fretter & Graham, 1978). There is little difference between the Miocene fossil shells from Turkey and the Recent ones illustrated by Bouchet & Warén (1993) and Giannuzzi-Savelli *et al.* (1997).

Distribution - Middle Miocene: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1975), Hungary (Kókay, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Dollfus et al., 1903, confirmed NHMW collection). Early Pliocene: North Sea Basin, England (Wood, 1848, not subsquently confirmed); northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1986; Landau et al., 2011); northeastern Spain (Martinell & Domènech, 1984a); central Mediterranean, Italy (Pavia, 1975; Chirli, 2006); Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1895b; Ruggieri & Curti, 1959; Cavallo & Repetto, 1992). Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1914). Recent: Norway south into the Mediterranean (Poppe & Goto, 1991).

Genus Pseudonoba Boettger, 1902

Type species – Pseudonoba peculiaris Boettger, 1902; original designation; middle Miocene (Langhian), Romania.

Pseudonoba striata (Hörnes, 1856)

Plate 7, fig 1; Plate 58, fig. 9

- 1856 *Chemnitzia striata* Hörn., Hörnes, p. 541 (*partim*, pl. 43, fig. 21 only).
- 1975 Rhombostoma striatum (Hörnes) Pavia, p. 134, pl. 4, fig. 26.
- non 1892a Rhombostoma striata Segu. Sacco, p. 19, pl. 1, fig. 38 (= Rhombostoma diabolicum Palazzi, 1989).

Dimensions and material – Maximum height 4.5 mm. Locality 17: NHMW 1874/0058/1038/1, 1874/0058/1039/2, 1847/0058/1516/12, YI 457/6.

Discussion –Oligocene and Miocene Iravadiidae from the Mediterranean region are divided by most authors into two genera: *Pseudonoba* Boettger, 1902 and *Rhombostoma* Seguenza, 1876. The type species of *Pseudonoba* is the Langhian species *P. peculiaris* Boettger, 1902 from Romania, which has been cited previously from Burdigalian deposits of the Aquitaine by Lozouet (2003). In a strict sense, *Pseudonoba* is characterised by slender to subcylindrical shells with convex whorls, incised sutures, a dense spiral pattern of ribs or threads and a moderately wide aperture with a weak or distinct peristome (see Ponder, 1984 for details and additional characters). In contrast, *Rhombostoma* Seguenza, 1876, based on the Pliocene Italian species *Eulima carmelae* Brugnone, 1873, is represented by slender conical shells with a somewhat *Hydrobia*-like outline, moderately incised sutures, an ovoid aperture with a posterior and an anterior angulation, and many species have reduced spiral sculpture.

Pavia (1975) tried to solve the problems with the taxonomic position of a group of Miocene to Pliocene species from the Paratethys and the Mediterranean Sea. He correctly recognised that Chemnitzia striata Hörnes, 1856, from the middle Miocene of the Vienna Basin, is based on a mixed lot containing at least two species, and proposed to treat both as species of Rhombostoma. The specimen illustrated by Hörnes (1856, pl. 43, fig. 21) from Enzesfeld in Lower Austria is a slender, subcylindrical shell with incised sutures. In its overall morphology it is very close to Pseudonoba but seemingly lacks the peristome and its aperture is not as wide as in the type species. The aperture of the Viennese specimen, however, seems to be in a subadult stage as the Turkish specimens we refer to this species have a somewhat thickened aperture and a narrow but distinct inner lip. Moreover, the lack of an anterior angulation of the aperture was discussed by Ponder (1984) as a character of *Pseudonoba*, which separates it from true Rhombostoma. Therefore, we refer this species to Pseudonoba.

The other, much more common specimens of *Chemnitzia* striata Hörnes, 1856, belong clearly to *Rhombostoma* as suggested by Pavia (1975), who identified them as *R. imperforatum* (Sacco, 1892). This Pliocene Mediterranean species differs from the middle Miocene Paratethyan one in its more slender outline and higher aperture. Consequently, the species from the Vienna Basin possibly represents a new, as yet unnamed species.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Erentoezia nov. gen.

Type species – Pseudonoba tarbelliana Lozouet, 1998; Oligocene, Aquitaine Basin.

Other included species – Erentoezia akpinarensis nov. sp.

Diagnosis – Shell small, very solid, slender conical in profile. Protoconch composed of two strongly convex, smooth whorls, increasing rapidly in size. Spire whorls weakly convex bearing strong, closely-spaced spiral sculpture. Axial sculpture absent. Aperture small, ovate, weakly pointed abapically. Columellar callus erect, bordering small umbilical chink.

Etymology – Named after Lütfiye Erünal Erentoz, in recognition of her pioneering work in the Karaman Basin. Gender feminine.

Discussion – Species included in Erentoezia gen. nov. do not fit in the generic concept of Pseudonoba or Rhom-

bostoma as defined by Ponder (1984). The stocky conical shape, the weak convexity of the late teleoconch whorls and the weakly incised sutures along with the strongly angulated aperture allow a clear separation from *Pseudonoba*. *Rhombostoma*, which seems to be restricted to the Paratethyan and Mediterranean Miocene and Pliocene, is comparable in its aperture but differs in its taller shell and more strongly convex whorls and its last whorl is higher and more slowly contracting [see *R. imperforatum* (Sacco, 1892) and *R. carmelae* (Brugnone, 1873) in Pavia (1975) and Ponder (1984) for comparison].

Erentoezia akpinarensis nov. sp.

Plate 59, figs 1, 2

Type material – Holotype RGM 784 096, height 2.7 mm; paratype 1 RGM 784 097, height 2.7 mm.

Etymology – Named after the type locality of Akpınar.

Locus typicus – Pınarlar Yaylası, Akpınar, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Erentoezia* species with a protoconch consisting of two smooth whorls, teleoconch of four weakly convex whorls with an oblique suture, strong spiral sculpture with the adapical cord slightly more strongly developed than the others, small aperture and small umbilical chink.

Description – Shell small, solid, conical in profile. Protoconch of two strongly convex, smooth whorls, increasing rapidly in size (dp = $300 \ \mu$ m, hp = $180 \ \mu$ m). Junction with teleoconch marked by beginning of spiral sculpture. Teleoconch of four weakly convex whorls, with periphery about one third height from abapical suture. Suture oblique, linear, impressed. Spiral sculpture of close-set cords, eight on penultimate whorl, adapical cord slightly more strongly developed and more widely separated from others. Last whorl convex, base evenly rounded. Aperture relatively small, ovate, slightly pointed abapically. Outer lip weakly thickened. Peristome entire. Columellar callus erect, bordering small umbilical chink.

Discussion – The most closely similar species is the late Oligocene '*Pseudonoba' tarbelliana* Lozouet, 1998 from the Aquitaine Basin. It is comparable in sculpture and overall shape but differs from the Turkish species in its more slender outline, the convex first teleoconch whorl and the taller last whorl. In addition, the suture is less oblique than in *Erentoezia akpinarensis* no.v sp.and it has only three teleoconch whorls rather than four.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Rhombostoma Seguenza, 1876

Type-species – Eulima Carmelae Brugnone, 1873, subsequent designation by Sacco, 1892; Pliocene, Italy.

Rhombostoma? meesi nov. sp.

Plate 7, fig. 2

Type material – Holotype NHMW 1847/0058/1484, height 7.5 mm.

Etymology – Named after Mees Donders, friend of the senior author.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Rhombostoma*? species with a protoconch consisting of two smooth whorls, teleoconch of five convex whorls, very weak spiral sculpture, which disappears by the penultimate whorl, a wide aperture and no umbilical chink.

Description – Shell small, thin, elongate. Protoconch of two smooth, strongly convex whorls, increasing rapidly in size. Junction with teleoconch marked by beginning of spiral sculpture. Teleoconch of five convex whorls, with periphery just below mid-whorl. Suture linear, impressed. Spiral sculpture of very fine, weakly developed cords, weakening further abapically, obsolete on penultimate whorl. Last whorl tall, convex, smooth. Aperture ovate, slightly pointed abapically. Outer lip thin. Peristome complete. Umbilicus not present.

Discussion – The placement in *Rhombostoma* is tentative. The shell has a typical *Iravadia*-like protoconch and very weak spiral threads on the early and middle teleoconch whorls. The Italian Neogene *Rhombostoma* species were reviewed by Palazzi (1989). *Rhombostoma? meesi* nov. sp. differs from the three Italian species, *R. carmelae* (Brugnone, 1873), *R. imperforatum* Sacco, 1892 (which is possibly a synonym of *R. carmelae*; see Palazzi, 1989) and *R. diabolicum* Palazzi, 1989 in being thinner-shelled, with weaker spiral sculpture (although this can be variable; see Palazzi, 1989) and in having the aperture less pointed abapically.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Rhombostoma? daani nov. sp.

Plate 59, fig. 3

Type material - Holotype RGM 784 075, height 4.5 mm.

Etymology – Named after Daan Donders, friend of the senior author.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Rhombostoma*? species with a protoconch consisting of two smooth whorls, teleoconch of four convex whorls, very weak spiral sculpture on the first two whorls, smooth abapically, a wide aperture and no umbilical chink.

Description – Shell small, thin, conical. Protoconch of two strongly convex, smooth whorls, increasing rapidly in size. Junction with teleoconch marked by beginning of spiral sculpture. Teleoconch of four convex whorls, with periphery just above abapical suture. Suture linear, impressed. Spiral sculpture of very fine, weakly developed cords, clearly developed only on the first two teleoconch whorls, obsolete abapically. Last whorl inflated, convex, smooth. Aperture ovate, large, slightly pointed abapically. Outer lip thin. Peristome complete. Umbilicus not present.

Discussion – The placement in *Rhombostoma* is tentative. The shell has a typical *Iravadia*-like protoconch and weak spiral threads on early teleoconch whorls, excluding a relationship with hydrobiids. It is reminiscent of stocky and weakly sculptured specimens of *Rhombostoma imperforatum* (Sacco, 1892) but has fewer teleoconch whorls and a wider last whorl. Similarly, *R. carmelae* (Brugnone, 1873) is more slender and has a taller last whorl. *Rhombostoma? daani* nov. sp. differs from *Rhombostoma? meesi* nov. sp. in having a more conical outline, a relatively broader last whorl and the spiral sculpture becomes obsolete earlier.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Caecidae Gray, 1850 Subfamily Caecinae Gray, 1850 Genus *Caecum* Fleming, 1813

Type species – Dentalium imperforatum Kanmacher, 1798 (= *Dentalium trachea* Montagu, 1803), by subsequent designation (Gray, 1847). Recent, temperate Europe.

Caecum clarkii Carpenter, 1858 Plate 59, fig. 4

- *1858 Caecum clarkii Carpenter, p. 432.
 - 1870 *Caecum sardinianum* de Folin & Périer, p. 231, pl. 29, figs 11, 12.

- 1878a *Caecum sardinianum* de Folin & Périer Monterosato, p. 88
- 1884 Caecum semitracheum Monterosato, p. 24.
- 1980 *Caecum clarkii* Carpenter, 1858 Panetta, p. 286, pl. 2, fig. 3.
- 1991 *Caecum clarkii* Carpenter, 1858 Poppe & Goto, p. 98, pl. 12, fig. 6.
- 1995 *Caecum clarkii* Carpenter, 1858 Chirli, p. 22, pl. 1, fig. 1.
- 1997 Caecum clarkii Carpenter, 1858 Giannuzzi-Savelli et al., p. 122, fig. 534.
- 2006 *Caecum clarkii* Carpenter, 1858 Chirli, p. 62, pl.
 27, figs 1-4.

Dimensions and material – Maximum height 3.0 mm. Localities 2 & 3: JvdV/1, locality 17: NHMW 1874/0058/1040/24, JvdV/50+, RGM 784 001/2, RGM 783 937/50+.

Discussion – Caecum clarkii Carpenter, 1858 is characterised by its smooth shell, with some traces of longitudinal ridges, the septum is pointed, placed posteriorly, and pointing slightly to the right. Usually the anterior end is about double the diameter of the posterior end, although this is not as marked in our Turkish material as in other specimens. Caecum clarkii differs from C. trachea (Montagu, 1803) in having an almost smooth shell, devoid of annular rings. Caecum gougeroti Chirli, 1995, from the Pliocene of Italy, also has a pointed septum, but differs in having ornament of even coarser annular rings.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Early Pliocene**: Central Mediterranean, Italy (Chirli, 1995, 2006). **Recent**: northeastern Atlantic south into the Mediterranean (Poppe & Goto, 1991).

Caecum subannulatum de Folin, 1870

Plate 59, figs 5, 6

- *1870 *Caecum subannulatum* de Folin, p. 230, pl. 29, figs 9, 10.
- 1980 *Caecum subannulatum* de Folin, 1870 Panetta, p. 287, pl. 2, fig. 1.
- 1991 *Caecum subannulatum* (de Folin, 1870) Poppe & Goto, p. 98, pl. 12, fig. 8.
- 1993 *Caecum subannulatum* de Folin, 1869 [*sic*] de Porta *et al.*, p. 6, pl. 3, figs 1-3.
- 1995 Caecum subannulatum de Folin, 1870 Chirli, p. 24, pl. 1, fig. 5.
- 1997 *Caecum subannulatum* de Folin, 1870 Giannuzzi-Savelli *et al.*, p. 122, fig. 535.
- 2006 *Caecum subannulatum* de Folin, 1870 Chirli, p. 65, pl. 28, figs 3-6.

Dimensions and material – Maximum height 1.9 mm. Localities 2 & 3: NHMW 1874/0058/1386/9, RGM 776 937/1 (ex JvdV collection), RGM 776 938/1 (ex JvdV collection), RGM 783 949/2; locality 6: JvdV/9, RGM 783 997/11; locality 9: JvdV/4; llocality 13: JvdV/11; locality 17: RGM 783 942/2.

Discussion – Caecum subannulatum de Folin, 1870 is one of the smallest European *Caecum* species. Apart from its small size, it is characterised by very fine growth lines, sculpture of fine annular rings, its weakly convex, low septum, which is hardly protruding, and in having a well-developed annulus circling the aperture.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Langhian): Barcelona, Spain (de Porta *et al.*, 1993), (Serravallian): Karaman Basin, Turkey (this paper). **Ear-Iy Pliocene**: Central Mediterranean, Italy (Chirli, 1995, 2006). **Recent**: Mediterranean (Poppe & Goto, 1991).

Genus Parastrophia de Folin, 1869

Type species – Parastrophia asturiana de Folin *in* de Folin & Périer, 1870, by original designation. Recent, Europe.

Parastrophia asturiana (de Folin, 1870) Plate 59, figs 7, 8

- *1870 Parastrophia asturiana de Folin, p. 218, pl. 29, fig. 7.
- 1884 *Parastrophia folini* Bucqouy, Dautzenber & Dollfus, p. 233.
- 1954 Parastrophia garganica Moncharmont-Zei, p. 120, pl. 1.
- 1971 *Parastrophia garganica* Moncharmont-Zei de Castro-Coppa, p. 11, pl. 1, fig. 18, pl. 2, figs 1-6.
- 1975 *Parastrophia asturiana* de Folin, 1870 van Aartsen & Fehr-de Wal, p. 79.
- 1975 *Parastrophia radwanskii* Bałuk, p. 127, pl. 14, fig. 1.
- 1980 Parastrophia mediterranea (O.G. Costa, 1861) Panetta, p. 279, pl. 3, fig. 3.
- 1991 Parastrophia mediterranea (O.G. Costa, 1861) Poppe & Goto, p. 98, pl. 12, fig. 10.
- 1993 *Parastrophia garganica* Moncharmont-Zei, 1954 – de Porta *et al.*, p. 8, pl. 3, fig. 9.
- 1997 Parastrophia asturiana de Folin, 1870 Giannuzzi-Savelli et al., p. 122, fig. 538.
- 2000 Parastrophia asturiana de Folin, 1870 Baroncelli, p. 224, pl. 2, figs 2-4.
- 2001 Parastrophia asturiana de Folin, 1870 Baroncelli, p. 231, pl. 2, fig. 3.
- 2001 Parastrophia (Parastrophia) asturiana de Folin, 1869 [sic] – Silva, p. 171, pl. 7, figs 5-7.
- 2002 Parastrophia asturiana de Folin, 1870 Chirli & Bogi, p. 20, figs 12, 13.
- 2006 *Parastrophia asturiana* de Folin, 1870 Chirli, p. 68, pl. 28, figs 11-14.
- 2010 Parastrophia asturiana de Folin, 1870 Rolán, p. 22, figs 1-6.

Dimensions and material – Maximum height 1.9 mm. Localities 2 & 3: JvdV/1; locality 6: RGM 783 992/1; locality 9: JvdV/1; locality 13: JvdV/2, RGM 794 600/1 (ex JvdV collection), RGM 794 583/1 (ex JvdV collection).

Discussion – For the correct name of this species see van Aartsen & Fehr-de Wal (1975, p. 79). This species and its synonymies were discussed at length by Ruggieri (1982) and Silva (2001). We follow their position is accepting the presence of a single *Parastrophia* species in the Miocene to Recent European assemblages. Bałuk (1975) described *Parastrophia radwanskii* from the middle Miocene Paratethys of Poland. It is not clear how this species differs from *P. asturiana* and no comparison was offered in Bałuk's discussion. We see no significant difference between the shell figured by Bałuk (1975, pl. 14, fig. 1) and *P. asturiana*.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1975); Proto-Mediterranean Sea (Langhian): Barcelona, Spain (de Porta et al., 1993), (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Redonian, Loire Basin (NHMW collection). Early Pliocene: Central Mediterranean, Italy (Chirli & Bogi, 2002; Chirli, 2006). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); Central Mediterranean, Italy (Ruggieri, 1982, Baroncelli, 2000, 2001). Pleistocene: Central Mediterranean, Italy (Moncharmont-Zei, 1954; de Castro-Coppa, 1971). Holocene: western Mediterranean, Spain (Porta et al., 2003). Recent: Atlantic northern Spain to Morocco and São Tomé (Rolán, 2010), Mediterranean (Poppe & Goto, 1991; Giannuzzi-Savelli et al., 1997).

Family Elachisinidae Ponder, 1985 Genus: *Elachisina* Dall, 1918

Type species – Elachisina grippi Dall, 1918, by original designation. Recent western North-America.

Note – When establishing this family, Ponder (1985b) considered only extant representatives. In his unpublished thesis, Lozouet (1986) was the first to propose also a placement of the fossil genus Pseudocirsope Boettger, 1907 within the family Elachisinidae. This concept was introduced formally by Lozouet et al. (2001a) and was accepted by Rolán & Gofas (2003). Originally, Pseudocirsope was introduced as a subgenus of Lacuna Turton, 1827, based on the type species Lacuna (Pseudocirsope) galeodina from the middle Miocene of the Paratethys (Romania). This species is characterised by a depressed ampullinid shape, a thickened peristome lacking any anterior indentation, along with an open umbilicus, which is adjoined by a moderate funicle-like swelling. Later, the concept of Pseudocirsope was enlarged by Cossmann (1915), Cossmann & Peyrot (1919), Zilch (1934) and Bałuk (1975) by the inclusion of Miocene species with an ovate-conical shell, an ovoid aperture with a faint anterior indentation and a characteristic umbilical chink (e.g.: *Lacuna banatica* Boettger, 1902; *Lacuna hoernesi* Boettger, 1902; *Lacuna (Pseudocirsope) burdigalica* Cossmann & Peyrot, 1919). These species are quite distinct from *Pseudocirsope galeodina* and all are considered herein to represent *Elachisina*.

Elachisina hoernesi (Boettger, 1902)

Plate 7, fig. 3; Plate 59, fig. 9

- *1902 Lacuna hoernesi Boettger, p. 135, no. 419.
- 1915 Lacuna (Pseudocirsope) Hoernesi Boettger Cossmann, p. 102, pl. 4, fig. 5.
- 1934 Lacuna (Pseudocirsope) hoernesi (Boettger) Zilch, p. 208, pl. 4, fig. 63.
- 1975 *Lacuna (Pseudocirsope) hoernesi* (Boettger, 1901 [*sic*]) – Bałuk, p. 64, pl. 8, fig. 24.

Dimensions and material – Maximum height 1.7 mm. Localities 2 & 3: NHMW 1874/0058/1098/1, JvdV/7, RGM 784 074/2; locality 6: JvdV/2; localities 7 & 8: JvdV/2; locality 13: JvdV/7.

Discussion – The specimens from the Karaman assemblages we have identified as *Elachisina hoernesi* (Boett-ger, 1902) are very small, but seem to be conspecific with the specimen illustrated by Zilch (1934, pl. 4, fig. 63). The two specimens illustrated herein show some variability in the strength of the spiral sculpture and the prominence of the periumbilical keel, which are, nevertheless, both relatively weakly developed in this species. The protoconch is not mentioned in the original description, but in our specimens seems to consist of 2.5 smooth convex whorls (see Pl. 59, fig. 9) and not one whorl as was suggested tentatively by Bałuk (1975, p. 64).

The specimen figured by Hörnes (1856, pl. 44, fig. 11) as Lacuna basterotina was renamed by Sacco (1895b) as Epheria miocaenica. It is similar to E. basterotina, but smaller and more rounded at the base. Elachisina bourgeoisi (Tournouer, 1874) from the Atlantic middle Miocene of France is again larger-shelled and has a much more strongly developed periumbilical keel. Elachisina banatica (Boettger, 1902), also originally described from the middle Miocene Paratethys of Romania, has a prominent, rounded periumbilical cord, absent in E. hoernesi. According to Bałuk (1975, p. 63), E. burdigalica (Cossmann & Peyrot, 1919) from the middle Miocene of France should be regarded as a synonym of *E. banatica*. The specimen illustrated by Lozouet et al. (2001a, pl. 15, fig. 8, text-fig 10f) from the early Miocene Atlantic of France is higher-spired. The late Miocene to Pliocene Mediterranean E. basterotina (Bronn, 1831) differs from E. hoernesi in being much larger and having much less convex whorls (Landau et al., 2004a, p. 32).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Boettger, 1902; Zilch, 1934); Poland (Bałuk, 1975); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Elachisina rolani nov. sp. Plate 59, figs 10, 11

Dimensions and type material – Holotype RGM 783 556, 3.2 mm; paratype 1 RGM 783 557, height 3 mm.

Etymology – Named after Emilio Rolán of Santiago de Compostela, Spain in recognition of his work on the genus in the tropical Atlantic (Rolán & Gofas, 2003).

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Elachisina* species with a multispiral protoconch, sculpture of relatively broad, flattened spiral cords, a narrow, well-developed umbilicus delimited by an elevated keel, and an ovate aperture that is pointed abapically.

Description – Shell small, ovate, of medium thickness. Protoconch low dome-shaped, consisting of 2.9 smooth, convex whorls with a small nucleus (dp = 480 μ m, dn = 40 μ m, dp1 = 120 μ m). Transition to teleoconch delimited by beginning of spiral sculpture. Teleoconch of about two convex whorls, with periphery at abapical suture. Suture linear, superficial. Spiral sculpture of low, flattened spiral cords, 17 on last whorl, separated by narrow grooves each about one third width of one cord. Umbilicus narrow but well-developed, delimited externally by one elevated rounded keel. Aperture ovate, abapically angled and protruding at point where umbilical keel meets columella. Peristome continuous with simple outer lip. Columella curved; columellar callus reflected towards umbilicus.

Discussion – Two middle Miocene Paratethyan species are comparable with *Elachisina rolani* nov. sp.: *Elachisina hoernesi* (Boettger, 1902) attains nearly double the size at the same growth stage. Moreover, its last whorl is more inflated and the umbilical funicle is less prominent. In contrast, the also larger species *E. banatica* (Boettger, 1902) has a much more prominent funicle and its spiral sculpture is denser. *Elachisina burdigalica* (Cossmann & Peyrot, 1919), from the early Miocene of France, is distinguished by its much wider umbilical chink and its prominent funicle. *Pseudosirsope* sp. in Lozouet *et al.* (2001), from the Aquitanian of France, differs in its more slender outline and more weakly convex whorls.

The Recent West African Atlantic species *E. canaliculata* Rolán & Rubio, 2001 is reminiscent of the Turkish fossil in its overall shape, but has a shorter spire, somewhat denser spiral sculpture, and the upper part of the last whorl is less convex. It is immediately distinguished from the Turkish shell by having a paucispiral protoconch composed of little more than one whorl, with a large nucleus. The Recent species *E. tenuisculpta* Rolán & Rubio, 2003, also from West Africa, has similar sculpture and an abapically pointed aperture, but has a lower spire, giving it a more turbiniform shape, and the umbilicus is wider and less sharply delimited from the base. *E. pergrandis* Rolán & Gofas, 2003, a Recent species from Angola, has a similar protoconch, sculpture and pointed aperture, but differs in not having a well-developed umbilicus.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Elachisina gofasi nov. sp. Fig. 59, figs 12-14

Dimensions and type material – Holotype RGM 783 558, 2.5 mm; paratype 1 RGM 783 559, height 2.2 mm; paratype 2 RGM 783 560, height 2.2 mm; paratype 3 NHMW 1847/0058/1567, height 2.2 mm; paratype 4 NHMW 1847/0058/1568, height 2.0 mm.

Other material - Locality 17: JvdV/4, RGM 794 511/1.

Etymology – Named after Serge Gofas of the University of Málaga, Spain in recognition of his work on the genus in the tropical Atlantic (Rolán & Gofas, 2003).

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Elachisina* species with a paucispiral protoconch, sculpture of close-set, narrow spiral cords, obsolete on last half-whorl, a broad, round-edged umbilicus and an ovate aperture that is weakly pointed abapically.

Description – Shell small, elongate turbiniform, solid. Protoconch low dome-shaped, of 1.75 smooth, convex whorls with a large nucleus (dp = 430 μ m, hp = 260 μ m, dn = 110 μ m, dp1= 210 μ m). Transition to teleoconch delimited by prosocline scar and beginning of spiral sculpture. Teleoconch of just over two convex whorls, with periphery at abapical suture. Suture linear, impressed. Spiral sculpture of narrow, close-set spiral cords, sculpture obsolete on last half-whorl. Umbilicus wide, with rounded external edge. Aperture ovate, abapically weakly angled at point where umbilical outer edge meets columella. Peristome continuous with internally bevelled, simple outer lip. Columella curved; columellar callus thickened abapically.

Discussion – The elongate turbiniform outline and the rather wide umbilicus allow a separation of this species from the above-mentioned middle Miocene species from the Paratethys, *Elachisina hoernesi* (Boettger, 1902) and *E. banatica* (Boettger, 1902). In contrast, the early Miocene French species *Lacuna (Pseudocirsope) degrangei* Cossmann & Peyrot, 1919 and *L. (P.) bearnensis* Cossmann & Peyrot, 1919 are clearly distinguished from *E. gofasi* sp. nov. by their depressed turbiniform outline.

In their monograph of Recent, mainly Atlantic Elachsinidae, Rolán & Gofas (2003) described several species that are comparable with this Turkish fossil; E. azoreana Rolán & Gofas, 2003 displays comparable umbilical characters and a similar aperture but tends to develop a slight angulation in the middle of the last whorl and the spiral cords on the last whorl do not become obsolete on the last half-whorl. The protoconch is also smaller (350 µm vs. 430 µm). Elachisina canarica (Nordsieck & Garcia Talavera, 1979) also has a rather wide umbilicus but differs from E. gofasi sp. nov. in its dense spiral sculpture, much more slender outline and smaller protoconch (330 µm vs. 430 µm). Elachisina tenuisculpta Rolán & Gofas, 2003 differs in its even broader, depressed turbiniform shell.

Distribution - Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Tornidae Sacco, 1896 Subfamily Torninae Sacco, 1896 Genus Discopsis de Folin, 1869

Type species - Discopsis omalos de Folin, 1869, by original designation. Recent, Gulf of Mexico.

Note – Although is has been suggested that Discopsis de Folin, 1869 is possibly a synonym of Cochliolepis Stimpson, 1858 (Gofas, 2011 in WoRMS), Rubio & Rolán (2011) argued for the distinction of these two genera based on shell and opercular characters. Furthermore, they considered that Discopsis should be placed in the Torninae Sacco, 1896, whereas Cochliolepis belonged within the Vitrinellinae Bush, 1897.

Discopsis reductus (Rolán & Rubio, 1990) Plate 60, fig. 1

- *1990 Cochliolepis reductus Rolán & Rubio, p. 183, pl. 2, figs 5-7.
- 2002 Discopsis reductus (Rolán & Rubio, 1990) - Rolán & Rubio, p. 62, figs 189-192.

Dimensions and material - Maximum height 1.5 mm. Locality 17: RGM 794 599/1 (ex JvdV collection), RGM 783 928/1.

Discussion – The specimens from Turkey are larger than the largest dimensions recorded by Rolán & Rubio (2002) for Recent shells (1.5 mm vs. 1.2 mm), but the protoconch size and number of whorls are similar (about 400 μ m). It is possible that the holotype is not fully grown, as it has only 1/2 to 3/4 teleoconch whorl, whereas the Turkish shell has 1¼ teleoconch whorls. The Turkish shell also has a slightly more open umbilicus, possibly as a result of being more fully adult. Both have the very characteristic group of fine concentric striae close to the periphery on the base.

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Recent: West Africa, Gambia, São Tomé and Principe, Congo (Rolán & Rubio, 2002).

Genus Tornus Turton & Kingston, 1830

Type species – Helix subcarinata Montagu, 1803. Recent, Europe.

Tornus karamanensis nov. sp.

Plate 7, figs 5, 6; Plate 60, figs 2, 3

Dimensions and type material - Holotype RGM 783 978, maximum diameter 2.5 mm; paratype 1 RGM 783 979, maximum diameter 2.3 mm; paratype 2 RGM 783 980, maximum diameter 2.2 mm; paratype 3 RGM 783 018, maximum diameter 2.3 mm; paratype 4 RGM 776 941, maximum diameter 2.4 mm; paratype 5 NHMW 1847/0058/1569, maximum diameter 2.4 mm; paratype 6 NHMW 1847/0058/1570, maximum diameter 2.5 mm; furthermore two specimens in YI 454, maximum diameter 2.7 mm, and YI 455, maximum diameter 2.7 mm. All from the type locality.

Other material - Maximum diameter 2.7 mm. Localities 2 & 3: JvdV/9, RGM 783 955/3 juveniles; locality 6: JvdV/23; localities 7 & 8: JvdV/3; locality 9: JvdV/1; locality 17: NHMW 1874/0058/1094/30, JvdV/50+, RGM 783 981/50+.

Etymology – Reflecting the area in which it is found, the Karaman Basin.

Locus typicus - Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum - Tırtar Formation, Serravallian, middle Miocene.

Diagnosis - A turbiniform Tornus species, with strongly cancellate sculpture, relatively narrow but sharply delimited umbilicus and a well-developed funicle.

Description - Shell very small, solid, turbiniform. Protoconch of 2.25 depressed, convex whorls, junction with teleoconch marked by prosocline scar. Teleoconch of 2.5 whorls. Suture impressed. Spire whorl with two narrow, elevated, rounded spiral cords, the whorl periphery at the abapical cord. Axial sculpture of 19-20 narrow prosocline ribs, crossing the spiral elements, forming axially elongate cancellate pattern. Last whorl bearing five spiral cords; adapical cord delimiting shallow sutural ramp, profile angularly convex below. Aperture 54% of total height, ovate. Outer lip simple. Columella somewhat thickened abapically, bearing well-developed funicle. Umbilicus relatively narrow, sharply delimited by strongly developed, rounded perumbilical cord.

- 1966 Adeorbis quadrifasciatus var. miotaurinensis Sacco, 1896 – Strausz, p. 52, pl. 50, figs 26-31.
- 1984 *Adeorbis miotaurinensis* Sacco, 1896 Ferrero Mortara *et al.*, p. 275, pl. 50, fig. 4.
- 1984 Adeorbis miotaurinensis var. plioastensis Sacco, 1896 – Ferrero Mortara et al., p. 275, pl. 50, fig. 6.
- 2004a *Circulus miotaurinensis* (Sacco, 1896) Landau *et al.*, p. 58, pl. 13, fig. 2.

Dimensions and material – Maximum height 1.8 mm. Locality 6: JvdV/3; localities 7 & 8: NHMW 1874/0058/1096/1; locality 17: NHMW 1847/0058/1710/1.

Discussion – We have added *Adeorbis interpositus* Boettger, 1906 to the synonymy of *Circulus miotaurinensis* (Sacco, 1896). The holotype, illustrated by Zilch (1934, pl. 6, fig. 3), shows the characters of this species: a second carina placed just below the periphery and a smooth base, devoid of spiral sculpture, or almost so. *Circulus striatus* (Philippi, 1836) is extremely variable, and Chirli (2006, pl. 24, figs 6-14) figured variable specimens from the Pliocene of Italy with rounded whorls without any carina, ranging through to specimens with three carinae. However, the basal carina is never as strongly developed as it is in *C. miotaurinensis*, and the base in all the Italian Pliocene forms bears spiral ribs, which are absent in *C. miotaurinensis*. For further discussion see Landau *et al.* (2004a, p. 58).

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896c). Middle Miocene: Paratethys (Langhian-Serravallian): Hungary (Strausz, 1954, 1962, 1966), Romania (Boettger, 1907; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Landau *et al.*, 2004a). Early-late Pliocene: central Mediterranean (Sacco, 1896c).

Circulus planorbillus (Dujardin, 1837)

Plate 60, fig. 4

- *1837 Solarium Planorbillus Duj., Dujardin, p. 284, pl. 19, fig. 13.
- 1896c Adeorbis trigonostoma (Bast.) Sacco, p. 53, pl. 4, fig. 69 [non Cochliolepis trigonostoma (de Basterot, 1825)].
- 1917 Tornus planorbillus (Duj.) Cossmann & Peyrot, p. 237, no. 137, pl. 7, figs 57-62.
- 1928 Tornus planorbillus Duj. Friedberg, p. 524, pl. 33, figs 13, 14.
- 1949 Circulus planorbillus Dujardin, 1837 Glibert, p. 70, pl. 4, fig. 4.
- 1949 *Circulus planorbillus* (Dujardin) Csepreghy-Meznerics, p. 23, pl. 1, figs 6, 7.
- 1960 Adeorbis planorbillus Dujardin 1837 Kojum-

Discussion – Generic placement is problematic. The teleoconch is extremely similar to that of Parviturbo fenestratus (Chaster, 1896), but Parviturbo is a skeneid, and all species of skeneids have paucispiral protoconchs (Warén, 1992). The shell from Karaman has a protoconch of 2.25 whorls (Pl. 60, figs 2, 3). Moreover, skeneids tend to have rather fragile shells, whereas this shell is solid. Members of the genus Pareuchelus Boettger, 1907, placed in the Liotiinae by Harzhauser (2002) have very similar sculpture, but they are imperforate and do not have a funicle. We have placed this new species provisionally in Tornus Turton & Kingston, 1830, despite it being rather less depressed and having a narrower umbilicus than most members of the genus. Two Recent West African species, Tornus jullieni Adam & Knudsen, 1969 and T. umbilicorda Rolán & Rubio, 2002 have similar sculpture, and the latter is very similar in profile, with a strong periumbilical cord, as its name would suggest. Tornus umbilicorda also has a funicle within the umbilicus, but it is weaker than in Tornus karamanensis nov. sp. Both Recent species have a protoconch of about 2.5 whorls, very similar in shape and size to that of T. karamanensis.

In the middle Miocene Paratethys, *Turbo monachus* Hilber, 1879 is somewhat similar. The holotype, stored in the NHMW collection, is the only known specimen of this Langhian species. It is not very well-preserved and the shell aragonite is partly leached. Nevertheless, it differs clearly from the Turkish shells in its much more prominent spiral ribs, which are strong but more widely spaced than in *T. karamanensis*. The outer lip is somewhat serrated by the protruding spiral ribs, whilst the Turkish shells have a continuous outer lip.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Vitrinellidae Bush, 1897 Subfamily Circulinae Fretter & Graham, 1962 Genus *Circulus* Jeffreys, 1865

Type species – Delphinula duminyi Requiem, 1848 (= *Valvata striata* Philippi, 1836), by original designation. Recent, Mediterranean.

Circulus miotaurinensis (Sacco, 1896)

Plate 7, fig. 7

- *1896c Adeorbis miotaurinensis Sacc., Sacco, p. 53, pl. 4, fig. 70.
- 1896c Adeorbis miotaurinensis var. duplicocincta Sacc., Sacco, p. 54, pl. 4, fig. 71.
- 1896c Adeorbis miotaurinensis var. crassecincta Sacc., Sacco, p. 54, pl. 4, fig. 72.
- 1896c Adeorbis miotaurinensis var. plioastensis Sacc., Sacco, p. 54, pl. 4, fig. 73.
- 1907 Adeorbis interpositus Boettger, p. 195, no. 658.
- 1934 Adeorbis interpositus Boettger Zilch, p. 215, pl. 6, fig. 3.
- 1954 Adeorbis quadrifasciatus miotaurinensis Sacco,

dgieva & Strachimirov, p. 89, pl. 29, fig. 9.

- 1966 Adeorbis planorbillus Dujardin, 1837 Strausz, p. 52, pl. 50, figs 24, 25.
- 1975 Circulus planorbillus (Dujardin, 1837) Bałuk, p. 54, pl. 5, fig. 1.

Dimensions and material – Maximum diameter 2.0 mm. Locality 6: JvdV/2; locality 17: RGM 794 581/2 (ex JvdV collection), RGM 783 927/2, RGM 783 166/1.

Discussion – Circulus planorbillus (Dujardin, 1837) is characterised by its relative lack of sculpture and the flat whorl surface between the carinae. The shell has three carinae of roughly equal strength, one at the shoulder, one at the periphery and a lower one at the base. Two spiral ribs are present within the wide umbilicus. The protoconch is paucispiral, consisting of a single whorl (dp = 175 μ m, dn = 100 μ m; Pl. 60, fig. 4). *C. planorbillus* is extremely similar to *C. praecedens* (von Koenen, 1882), which is widespread in the North Sea Basin Miocene, but *C. praecedens* does not have ribs in the umbilicus (see A.W. Janssen, 1984a, pl. 45, fig. 5; Moths *et al.*, 2010).

Distribution – Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1917); Paratethys (Langhian-Serravallian): Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Csepreghy-Meznerics, 1949; Strausz, 1966), Poland (Friedberg, 1928; Bałuk, 1975); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896c). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1917), (Langhian): Loire Basin, France (Glibert, 1949); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Circulus striatus (Philippi, 1836)

Plate 60, fig. 5

- *1836 Valvata striata Philippi, p. 147, pl. 9, fig. 3.
- 1848 *Adeorbis striatus* S. Wood Wood, p. 137, pl. 15, fig. 7.
- 1848 Delphinula duminyi Réquien, p. 64.
- 1862 Skeneia striatula [sic] Philippi Weinkauff, p. 343.
- 1898 *Circulus striatus* Philippi Almera & Bofill, p. 91, pl. 6, fig. 16.
- 1916 Adeorbis striatus Phil. Cerulli-Irelli, p. 186, pl. 21, figs 19, 20.
- 1923 *Circulus striatus* (Philippi) Harmer, p. 759, pl. 60, fig. 25.
- ?1949 Circulus striatus turoniensis Glibert, p. 70, pl. 4, fig. 5.
- 1957 *Circulus striatus* Philippi, 1836 Glibert, p. 21, pl. 1, fig. 18.
- 1969 *Circulus striatus* (Philippi, 1836) Adam & Knudsen, p. 9, figs 4, 5.
- 1978b *Circulus striatus* (Philippi, 1836) Fretter & Graham, p. 227, fig. 190.

- 1975 Circulus striatus (Philippi, 1843 [sic]) Pavia, p. 128, pl. 2, figs 4, 6, 9, 12.
- 1980 *Circulus striatus* (Philippi, 1843 [*sic*]) Martinell,p. 123, pl. 1, figs 10, 11.
- 1985 *Circulus striatus* (Philippi, 1836) González Delgado, p. 68, pl. 2, figs 9-11.
- 1997 *Circulus striatus* (Philippi, 1836) Giannuzzi-Savelli *et al.*, p. 118, figs 514, 515.
- 1991 *Circulus striatus* (Philippi, 1836) Poppe & Goto, p. 97.
- 1992 *Circulus striatus* (Philippi, 1836) Cavallo & Repetto, p. 54, fig. 088.
- 1997a *Circulus striatus* (Philippi, 1836) Marquet, p. 18, pl. 4, fig. 2.
- 1998a Circulus striatus (Philippi, 1836) Marquet, p. 69, fig. 44.
- ?1998 Circulus striatus (Philippi) Ferrero et al., p. 48, pl. 1, fig. 4.
- 2001 *Circulus striatus* (Philippi, 1836) Silva, p. 155, text-fig. 3.33, pl. 6, figs 1, 2.
- 2006 *Circulus striatus* (Philippi, 1836) Chirli, p. 55, pl. 24, figs 6-14.
- 2011 *Circulus striatus* (Philippi, 1836) Landau *et al.*, p. 12, pl. 3, fig. 10.
- non 1959 Circulus striatus (Philippi) Anderson, p. 64, pl. 3, fig. 8 [= Circulus subcirculus (Cossmann & Peyrot, 1916, ? = Circulus semilaevis (Boettger, 1902)].
- non 1967 Circulus striatus (Philippi 1836) A.W. Janssen, p. 127, pl. 2, fig. 6 [= Circulus subcirculus (Cossmann & Peyrot, 1916, ? = Circulus semilaevis (Boettger, 1902)].

Dimensions and material – Maximum diameter 1.2 mm. Locality 17: localities 7 & 8: JvdV/2; locality 17: RGM 794 584/2 (ex JvdV collection).

Discussion – The shells from the Seyithasan deposits are small compared with specimens from the Atlantic Pliocene of Spain, which can reach 2.8 mm in diameter (Landau et al., 2011), or Recent shells from the British Isles or Mediterranean, which are up to 2.5 mm diameter (Fretter & Graham, 1978b; Giannuzzi-Savelli et al., 1997). The protoconch in both the Recent and Turkish shells consists of 2.5 whorls, although the protoconch diameter is smaller (450 μ m vs. 750 μ m for British shells; Fretter & Graham, 1978b, p. 227). However, the diameter of the nucleus is only slightly smaller (70 μ m vs. 80 μ m). We note that the protoconch dimensions for the early Piacenzian Pliocene Atlantic shells from the Mondego Basin of Portugal given by Silva (2001, text-fig. 3.33) are much closer to those of the Turkish fossil shells (dp = $500 \,\mu\text{m}$, dn = $60 \,\mu\text{m}$; Pl. 60, fig. 5). Glibert (1949, pl. 4, fig. 5) considered the Atlantic middle Miocene Langhian shells from the Loire Basin to be a separate subspecies, differing from the Recent shells in having closer-set and flatter spiral cords, a smaller umbilicus and a more strongly refected columellar edge. The specimen figured is rather worn making it difficult to assess the value of these small differences.

Circulus subcirculus (Cossmann & Peyrot, 1916) from the Miocene of France and the North Sea Basin differs in not having spiral sculpture on the ventral surface. Bałuk (1975, p. 56) considered *C. subcirculus* to be a junior subjective synonym of *Circulus semilaevis* (Boettger, 1902). They certainly seem very similar, but without better illustrations and details of protoconch morphology this synonymy cannot be confirmed.

Distribution – Middle Miocene: ?northeastern Atlantic (Langhian): Loire Basin, France (Glibert, 1949); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (NHMW collection). Early Pliocene: North Sea Basin, Belgium (Glibert, 1957; Marquet, 1997a, 1998a); British Isles (Wood, 1848; Harmer, 1923); northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1985; Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (NHMW collection), northeastern Spain (Almera & Bofill, 1898; Martinell, 1980); central Mediterranean, Italy (Pavia, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); central Mediterranean, Italy (Cavallo & Repetto, 1992). Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1916). Recent: northeastern Atlantic, Iceland south to the Mediterranean (Poppe & Goto, 1991).

Circulus supranitidus (Wood, 1842)

Plate 7, fig. 8; Plate 60, fig. 6

- *1842 Adeorbis supra-nitidus Wood, p. 530.
- 1848 Adeorbis supra-nitidus S. Wood Wood, p. 137, pl. 15, fig. 5.
- 1923 Adeorbis supra-nitidus S.V. Wood Harmer, p. 757, pl. 60, fig. 21.
- 1957 Circulus supranitidus Wood, 1842 Glibert, p. 21, pl. 1, fig. 19.
- 1997a *Circulus supranitidus* (Wood, 1842) Marquet, p. 17, pl. 4, fig. 1.
- 1998a *Circulus supranitidus* (Wood, 1842) Marquet, p. 68, fig. 43.

Dimensions and material – Maximum diameter 1.8 mm. Localities 7 & 8: NHMW 1847/0058/1096/1.

Discussion – Circulus supranitidus (Wood, 1842) is characterised by having a sharp peripheral carina and a second carina on the base. The umbilicus is wide and bears two spiral ribs. There is no sculpture on the dorsum above the peripheral carina. This species is closely similar to the North Sea Basin middle Miocene species Circulus praecedens (von Koenen, 1872), which has an extra keel on the dorsum. However, its variety gliberti Janssen, 1967 also lacks the dorsal keel, and seems to differ only in that the peripheral keel is stronger in C. supranitidus. We refrain from treating A.W. Janssen's species as a junior subjective synonym until details of the protoconch morphology are available. Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: North Sea Basin, British Isles (Wood, 1842, 1848; Harmer, 1923). Early-late Pliocene: North Sea Basin, Belgium (Glibert, 1957; Marquet, 1997a, 1998a); British Isles (Harmer, 1923);

Subfamily Teinostomatinae Cossmann, 1917 Genus *Idioraphe* Pilsbry, 1922

Type species – Cyclops angulatus Gabb, 1873, by original designation. Neogene, Dominican Republic.

Idioraphe defrancei (de Basterot, 1825)

Plate 7, fig. 9; Plate 60, fig. 7

- *1825 Rotella Defrancii Nob., de Basterot, p. 34, pl. 1, fig. 16.
- 1845 *Rotella Defrancii* de Bast. Grateloup, pl. 12, figs 45-47.
- 1918 *Tinostoma Defrancei* (Bast.) Cossmann & Peyrot, no. 124, pl. 7, figs 1-3.
- 1925 *Tinostoma Defrancii* Basterot Kautsky, p. 60, pl. 4, figs 4, 5.
- 1949 *Teinostoma defrancei* Basterot, 1825 Glibert, p. 68, pl. 4, fig. 2.
- 1959 *Teinostoma (Teinostoma) defrancei* (Basterot, 1825) Anderson, p. 58, pl. 3, fig. 1.
- 2010 *Teinostoma defrancei* (Basterot, 1825) Moths *et al.*, p. 43, pl. 13, fig. 2.

Dimensions and material – Maximum diameter 1.5 mm. Locality 17: NHMW 1874/0058/1097/2, JvdV/3, RGM 784 016/3, RGM 783 926/7.

Discussion – In this work we follow Beu (2010, p. 131) in elevating most subgenera to full generic status. Ranking groups as subgenera of another group expresses a phylogenetic hypothesis about their relationship, which at the moment within the Teinostomatinae cannot be proven, and therefore narrower taxa are more likely to be monophyletic than broader ones. *Idioraphe* Pilsbry, 1922 differs from *Teinostoma* H. Adams & A. Adams, 1853 in being even smaller-shelled, in having a concealed spire, in not being as strongly depressed, and in lacking the spout-like extension of the peristome characteristic of *Teinostoma politum* A. Adams *in* H. Adams & A. Adams, 1853, the type species (Woodring, 1957).

Distribution – Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1918). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Germany (Kautsky, 1925; Anderson, 1959; Moths *et al.*, 2010). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, (Cossmann & Peyrot, 1918), (Langhian): Loire Basin, France (Glibert, 1949); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Idioraphe minima (Boettger, 1907) Plate 7, fig. 10

- *1907 Tinostoma minimum Boettger, p. 193, no. 654.
- 1934 *Teinostoma minimum* Boettger Zilch, p. 204, pl. 2, fig. 43.
- 1962 *Teinostoma minimum* Boettger Strausz, p. 119, text-fig. 142c.
- 1966 *Teinostoma minimum* Boettger, 1906 [sic] Strausz, p. 47, text-fig. 28c.
- ?1975 Teinostoma (Idioraphe) minimum Boettger, 1907 – Bałuk, p. 101, pl. 11, fig. 6.
- ?2006 Teinostoma (Idioraphe) minimum Boettger, 1907
 Bałuk, p. 191, pl. 6, figs 13, 14.

Dimensions and material – Maximum diameter 1.5 mm. Locality 17: RGM 783 943/1.

Discussion – We ascribe a single very small shell from the Seyithasan assemblage to *Idioraphe minima* (Boettger, 1907). It is characterised by its rather flattened lentiform shape, the whole surface is covered with fine, punctiform, spiral grooves and the umbilicus is partially filled by a moderately developed callus. *Idioraphe simplex* (Benoist, 1874) from the Atlantic early Miocene of the Aquitaine Basin, France, has a less depressed lentiform shape and the umbilical callus is heavier and more extensive (see Lozouet *et al.*, 2001a, pl. 12, fig. 4.). The shells illustrated by Bałuk (1975, pl. 11, fig. 6; 2006, pl. 6, figs 13-14) possibly represent *I. minima*, although the spiral punctiform grooves are not clearly visible.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Hungary (Strausz, 1966), ?Poland (Bałuk, 1975, 2006), Romania (Boettger, 1907; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Megatyloma Cossmann, 1888

Type species – Teinostoma wateleti Deshayes, 1864, by original designation. Eocene, France.

Megatyloma auingeri (Boettger, 1902)

Plate 7, fig. 11; Plate 60, fig. 8

- *1902 *Tinostoma* [sic] auingeri Boettger, p. 168, no. 523.
 1907 *Tinostoma* [sic] auingeri Bttgr. Boettger, p. 193, no. 653.
- 1934 *Teinostoma auingeri* Boettger Zilch, p. 203, pl. 2, fig. 42.

Dimensions and material – Maximum diameter 2.1 mm. Locality 6: NHMW 1847/0058/1514/2, JvdV/2; locality 9: JvdV/1; locality 17: NHMW 1847/0058/1483/1, NHMW 1847/0058/1554/1, RGM 783 167/6.

Discussion – Megatyloma auingeri (Boettger, 1902) is quite a distinctive little species. The shell is far less

depressed than that of most teinostomatines and has a slightly elevated spire, which leads us to place it in the genus *Megatyloma* Cossmann, 1888. The protoconch consists of 1.25 smooth, depressed whorls (dp = 150 μ m; Pl. 60, fig. 8d). The teleoconch consists of 2.25 whorls. The first 1.5 whorls bear three very fine spiral threads, which fade out over on the last whorl. Similarly, the base also bears two very fine spiral threads (Pl. 53, figs 8a-c). On the last whorl there is a slightly elevated subsutural collar just below the adapical suture. On the ventral side the columellar callus is strongly thickened and delimited from the umbilical callus, which completely fills the umbilicus. We are not aware of any other *Megatyloma* species in the European Miocene to Recent faunas.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Boettger, 1902, 1907; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Solariorbis Conrad, 1865

Type species – *Delphinula depressa* I. Lea, 1833, by subsequent designation (Dall, 1892), Eocene, Alabama, USA.

Solariorbis punctatocarinatus nov. sp.

Plate 61, fig. 1

Dimensions and type material – Holotype NHMW 1847/0058/1345, height 1.5 mm, width 2.7 mm; paratype 1 RGM 784 094, height 1.4 mm, width 2.6 mm; paratype 2 RGM 784 095, height 1.5 mm, width 2.8 mm (incomplete); paratype 3 NHMW 1847/0058/1390, height 1.5 mm, width 2.6 mm.

Etymology – Reflecting the shape of the carinate last whorl and the punctate spiral sculpture.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis: A small *Solariorbis* species with a depressed dorsum and rounded venter, a protoconch consisting of about two depressed whorls, sculpture of spiral rows of punctate pits, a carinate last whorl and a moderately thickened funicle that does not fill the deep, sharply delimited umbilicus.

Description – Shell small, solid, lentiform, dorsum very depressed, venter convex. Protoconch consisting of 2.5 depressed whorls with medium to small nucleus (dp = $360 \ \mu$ m, dn = $62 \ \mu$ m; Pl. 61, fig. 1d). Transition to teleoconch delimited by beginning of punctate spiral sculpture. Teleoconch consisting of two flattened, rapidly

expanding whorls. Suture superficial, linear. Sculpture consisting of spiral rows of punctate pits. Last whorl dorsum depressed, roundly angular at carina placed at level of insertion of outer lip, tapering inwards below, weakly angular at base. Base bearing punctate spiral sculpture, which stops abruptly a short distance before umbilicus. Aperture ovate, outer lip sharp, thickened abapically forming moderate funicle. Umbilicus sharply delimited, open, moderately wide, deep, smooth within.

Discussion - Solariorbis punctatocarinatus nov. sp. is represented in the Karaman assemblages by four minute shells, which are all of the same dimensions, suggesting they are adult. The rather solid lentiform shell, punctate spiral sculpture, funicle and open umbilicus suggest placement within the genus Solariorbis Conrad, 1865. This new species differs from all its European congeners, which all have a more evenly lentiform shape and have the carina situated lower on the last whorl, characters that give the new species its very characteristic shape [S. woodi (Hörnes, 1856), with which S. punctatocarinatus co-occurs (see below); S. degrangei (Cossmann & Peyrot, 1917), S. biali (Cossmann & Peyrot, 1917) and S. planibasis (Cossmann & Peyrot, 1917) from the Atlantic Miocene of France, S. hosiusi (A.W. Janssen, 1967) and S. partimstriatus (A.W. Janssen, 1967) from the Miocene North Sea Basin; and the numerous species described by Boettger (1902, 1906; see Zilch, pl. 3, figs 45-49)]. Moreover, none of these European species have the umbilicus as deep or as sharply edged. The most closely similar species seem to be found on the opposite side of the Atlantic, in the Floridian Plio-Pleistocene of the southeastern United States. Solariorbis opsitelotus (Dall, 1892) is very similar indeed in the character of the umbilicus, but has the carina lower on the shell (Olsson & Harbison, 1953, pl. 53, fig. 4).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Solariorbis woodi (Hörnes, 1856)

Plate 7, fig. 12; Plate 61, fig. 2

- *1856 *Adeorbis Woodi* Hörnes, 1856, p. 440, pl. 44, fig. 4.
- 1928 Tinostoma [sic] Woodi Hoern. Friedberg, p. 521, pl. 33, fig. 10.
- 1954 *Cyclostrema woodi* Hörn. Strausz, p. 12, 81, 92, pl. 9, fig. 163.
- 1960 *Teinostoma woodi* (Hoernes) Kojumdgieva & Strachimirov, p. 89, pl. 29, fig. 8.
- 1962 *Teinostoma woodi* Hörnes Strausz, p. 119, textfig 142a, pl. 10, figs 4-6.
- 2003 Tinostoma [sic] woodi (Hoernes 1856) İslamoğlu & Taner, p. 32, pl. 1, fig. 2.
- 2004a *Solariorbis woodi* (Hörnes, 1856) Landau *et al.*, p. 59, pl. 13, figs 4, 5 (with additional synonyms).
- 2006 *Teinostoma woodi* (Hörnes, 1856) Chirli, p. 57, pl. 25, figs 8-15.

- 2010 Solariorbis woodi (Hörnes, 1856) Sosso & dell'Angelo, p. 22, p. 33, unnumbered figure top row middle.
- 2011 *Solariorbis woodi* (Hörnes, 1856) Landau *et al.*, p. 12, pl. 3, fig. 12.

Dimensions and material – Maximum diameter 3.0 mm mm. Localities 2 & 3: JvdV/30, RGM 783 954/3; locality 6: NHMW 1874/0058/1512/20, JvdV/50+, RGM 783 993/2; localities 7 & 8: NHMW 1874/0058/1100/5, JvdV/20, RGM 783 956/6, YI 166/3; locality 9: JvdV/8; locality 13: JvdV/50+, YI 167/3; locality 17: NHMW 1874/0058/1099/1, 1874/0058/1100/50+, JvdV/50+, RGM 784 013/2, RGM 783 930/50+, YI 168/33.

Discussion – We maintain the position defended by Landau *et al.* (2004a, p. 60) that the Miocene and Pliocene shells represent a single species, although the Turkish Miocene populations tend to be smaller and flatter than those from the Spanish early Pliocene. All the other shell characters are, however, similar. The protoconch is also similar, paucispiral composed of 1.25 smooth whorls (dp = 200 μ m, dp1 =160 μ m, dn = 80 μ m; Pl. 61, 2c).

Distribution - Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896c), (late Burdigalian): Antalya Basin, Turkey (İslamoğlu & Taner, 2003). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856), Poland (Friedberg, 1928; Bałuk, 1975), Hungary (Strausz, 1954, 1962, 1966), Bulgaria (Kojumdgieva & Strachimirov, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896c). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1985; Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (Landau et al., 2004a); central Mediterranean, Italy (Pavia, 1975; Chirli, 2006), Tunisia (Fekih, 1975). Earlylate Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); central Mediterranean (Sacco, 1896c; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010).

Superfamily Stromboidea Rafinesque, 1815 Family Strombidae Rafinesque, 1815 Subfamily Strombinae Rafinesque, 1815 Genus *Persististrombus* Kronenberg & Lee, 2007

Type species – Strombus granulatus Swainson, 1822, by original designation, Recent, Panamic Pacific.

Persististrombus inflexus (Eichwald, 1830) Plate 8, figs 1-5; Plate 61, fig. 3; Plate 79, fig. 3

Tate 0, figs 1-5, 1 fate 01, fig. 5, 1 fate 77, fig. 5

- *1830 Strombus inflexus Eichwald 1830, p. 222.
- 1837 Strombus tuberculiferus M. de Serres Pusch, p. 127, pl. 11, fig. 12.

- 1853 Strombus inflexus mihi Eichwald, p. 210, pl. 8, fig. 18.
- 1853 Strombus coronatus Defr. Hörnes, p. 187, pl. 17, fig. 1 [non Persististrombus coronatus (Defrance, 1827)].
- 1866 Strombus bonellii Brongniart Fischer, p. 237 [non Persististrombus bonellii (Brongniart, 1823)].
- 1884 Strombus coronatus Defr. Hoernes & Auinger, p. 163 (partim, pl. 18, figs 4, 5, pl. 19, fig. 1 only) [non pl. 18, figs 1-3 = Persististrombus lapugyensis (Sacco, 1893)].
- 1893c Strombus nodosus var. voeslauensis Sacc., Sacco, p. 6 [referring to Hoernes & Auinger, 1884, pl. 18, fig. 4).
- 1893c Strombus nodosus var. propenodosa Sacc., Sacco, p. 6 (referring to Hörnes, 1853, pl. 17, fig. 1).
- 1893c S. coronatus var. enzesfeldensis Sacc., Sacco, p. 11 (referring to Hoernes & Auinger, 1884, pl. 19, fig. 1).
- 1912 Strombus Bonelli [sic] Brongn. Friedberg, p. 136, text-fig. 38, pl. 7, fig. 10 [non Persististrom-bus bonellii (Brongniart, 1823)].
- 1938 Strombus coronatus Defrance Peyrot, p. 162 [non Persististrombus coronatus (Defrance, 1827)].
- 1949 Strombus coronatus Defrance, 1827 Glibert, p.
 209 [non Persististrombus coronatus (Defrance, 1827)].
- 1952a Strombus coronatus Defrance, 1827 Glibert, pl. 1, fig. 1 [non Persististrombus coronatus (Defrance, 1827)].
- 1958 Strombus coronatus Defrance Erünal-Erentöz, p. 36, pl. 4, figs 10, 11, pl. 5, fig. 1 [non Persististrombus coronatus (Defrance, 1827)].
- 1960 Strombus (Canarium) bonellii Brongniart 1823 Kojumdgieva & Strachimirov, p. 130, pl. 35, figs 3, 4 [non Persististrombus bonellii (Brongniart, 1823)].
- Strombus bonellii Brongniart Strausz, p. 221,
 pl. 25, fig. 1, pl. 66, fig. 6 [non Persististrombus bonellii (Brongniart, 1823)].
- Strombus (Strombus) bonellii Brongniart, 1823 Bałuk, p. 180, pl. 6, figs 4, 10 [non Persististrombus bonellii (Brongniart, 1823)].
- Strombus (Strombus) coronatus Defrance Schultz,
 p. 60, pl. 23, fig. 6 [non Persististrombus coronatus (Defrance, 1827)].
- 2003 Strombus coronatus Defrance, 1827 İslamoğlu & Taner, p. 47, pl. 3, fig. 1 [non Persististrombus coronatus (Defrance, 1827)].
- 2003 Strombus (Strombus) bonellii Brongniart 1823 İslamoğlu & Taner, p. 48, pl. 3, fig. 3 [non Persististrombus bonellii (Brongniart, 1823)].
- 2007 Strombus coronatus Defrance Tiţã, p. 547, fig.
 6a [non Persististrombus coronatus (Defrance, 1827)].
- 2012 Persististrombus inflexus (Eichwald, 1830) Harzhauser & Kronenberg, figs 3A-E.

Dimensions and material – Maximum height 128.2 mm. Localities 2 & 3: JvdV/8, YI 154/4 + 1 juvenile; localities 7 & 8: JvdV/3, RGM 783 882/1; locality 9: JvdV/2; locality 11: JvdV/1; locality 12: JvdV/1, RGM 783 605/1; locality 13: NHMW 1874/0058/1432/1, JvdV/13, RGM 777 865/1 (ex JvdV collection), 783 641/4, YI 155/4; locality 17: NHMW 1874/0058/1392-1874/0058/1431/40, 1847/0058/1625-1847/0058/1627/3, JvdV/50+, RGM 784 022/2, RGM 783 757-783 760/50+, RGM 783 961/8 juveniles, MTA 2013/015/10, YI 153/50+ (+ 6 juveniles). Exact locality unknown: AÜ LE-K-210/1.

Discussion - The European Miocene Persististrombus lineage has been discussed in detail recently by Harzhauser & Kronenberg (2012). The Turkish shells traditionally have been identified as P. coronatus (Defrance, 1827) based on the prominent spines (Erünal-Erentöz, 1958). Most authors, however, did not refer to the Pliocene species of Defrance (1827) but had the middle Miocene Paratethyan shell in mind, a species erroneously identified by Hörnes (1853) as Strombus coronatus. Already Hörnes (1853) was aware that Eichwald (1830) has proposed Strombus inflexus as a name for the Miocene species but treated it as a synonym of S. coronatus. Morphometric analysis of the various strombid taxa reveal very distinct groups and show that the Pliocene species P. coronatus is separated by its low spire and the deep but narrower stromboid notch (see Harzhauser & Kronenberg, 2013 for details).

The dataset of Harzhauser & Kronenberg (2012) was used here again including new data on Karaman specimens stored in the Naturalis collection in Leiden. Figure 17 clearly shows that these shells plot in the same area as Paratethyan specimens of *P. inflexus* and are well separated from other species.

The protoconch in the Turkish shells is tall, consisting of five smooth convex whorls with a small nucleus (dp = 1.2 mm, dp1 = 1.13 mm, dp/hp = 1.06, dp1 = 140 μ m, dn = 80 μ m; Pl. 61, fig. 3).

A colour pattern is present under UV light on one of the juvenile shells (Pl. 79, fig. 3), consisting of an irregular mottling on the spire and a couple of irregular broad bands on the last whorl. It is not unlike the colour pattern of the living representative of the genus, the Panamic Pacific species *P. granulatus* (Swainson, 1822).

Distribution – Middle Miocene: northeastern Atlantic (Langhian): Loire Basin (Peyrot, 1938; Glibert, 1949, 1952a); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1853; Hoernes & Auinger, 1884; Schultz, 1998), Poland (Friedberg, 1912; Bałuk, 1995), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1966), Romania (Tiţã, 2007); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Fischer, 1866; Erünal-Erentöz, 1958; Harzhauser & Kronenberg, 2012). Late Miocene: Proto-Mediterranean Sea (early Tortonian): Antalya Basin (İslamoğlu & Taner, 2003).



Figure 17. Principal component analysis of morphometric data of adult specimens of various *Persististrombus* species based on the apical angle and the relation between total height and the height of the last spire whorl (see Harzhauser & Kronenberg, 2012, for data and further discussion).

Family Aporrhaidae Gray, 1850 Subfamily Aporrhainae Gray, 1850 Genus *Aporrhais* da Costa, 1778

Type species – Aporrhais quadrifidus da Costa, 1778, by monotypy. Recent, European.

Aporrhais dactylifera (Boettger, 1902)

Figure 18/5; Plate 9, figs 1-3; Plate 61, fig. 4

- 1884 Chenopus (Aporrhais) alatus Eichw. Hoernes & Auinger, p. 166, pl. 18, figs 6, 8 [non Aporrhais alata (Eichwald, 1830)].
- 1884 Chenopus (Aporrhais) pes pelecani Phil. Hoernes & Auinger, p. 167, pl. 18, fig. 7, pl. 19, fig. 9 only [non Aporrhais pespelecani (Linnaeus, 1758)].
- 1896 Chenopus (Aporrhais) pes-pelecani Phil. Var. Boettger, p. 51, no. 9 [non Aporrhais pespelecani (Linnaeus, 1758)].
- *1902 Chenopus (Aporrhais) alatus var. dactylifera Boettger, p. 24, no. 90.
- 1912 Chenopus uttingerianus Risso Friedberg, p. 143, pl. 8, fig. 2 [non Aporrhais uttingeriana (Risso, 1826)].
- 1934 Aporrhais alatus dactylifera (Boettger) Zilch, p.

248, pl. 14, fig. 64.

- 1954 *Cenopus (Aporrhais) pespelecani alatus* Eichw. Strausz, p. 23, pl. 5, fig. 119 [*non Aporrhais alata* (Eichwald, 1830)].
- 1958 *Aporrhais uttingerianus* (Risso) Erünal-Erentöz, p. 34, pl. 4, figs 3-9.
- ?1962 Aporrhais pespelecani Linné Strausz, p. 75, pl.
 22, fig. 17 [non Aporrhais pespelecani (Linnaeus, 1758)].
- ?1966 Aporrhais pespelecani Linné, 1766 Strausz p. 218 (partim, pl. 22, fig. 17 only) [non Aporrhais pespelecani (Linnaeus, 1758)].
- 1970 Aporrhais pespelecani alatus (Eichwald) Bałuk,
 p. 118, pl. 12, fig. 1 [non Aporrhais alata (Eichwald, 1830)].
- 1993 Aporrhais pespelecani (Linné, 1758) Iljina, p. 53, pl. 6, figs 1, 2 [non Aporrhais pespelecani (Linnaeus, 1758)].
- 2002 *Aporrhais (Ap.) dactylifera* (Boettger, 1896) [*sic*] – Marquet *et al.*, p. 158, figs 14-16.
- 2002 *Aporrhais (Ap.) uttingeriana* (Risso, 1826) Marquet *et al.*, p. 158, figs 40, 41 [*non Aporrhais uttingeriana* (Risso, 1826)].

Dimensions and material – Maximum height 34.0 mm. Localities 2 & 3: JvdV/45; locality 6: JvdV/32, RGM 783 862/11, YI 118/11; localities 7 & 8: NHMW 1874/0058/1110/20,



Figure 18. Some European Neogene Apporhaidae. 1. Aporrhais pespelecani (Linnaeus, 1758), NHMW 2012/0197/0004 (ex BL collection), height 41.1 mm, Calabrian, Cava Lustrelle, Lecce, Italy; 2. Aporrhais pliorara (Sacco, 1893), NHMW 2012/0197/0005 (ex BL collection), height 32.1 mm, Pleistocene, Calabrian, Cava Lustrelle, Lecce, Italy; 3. Aporrhais uttingeriana (Risso, 1826), NHMW 2012/0197/0006 (ex BL collection), height 44.1 mm, late Pliocene, Piacenzian, Rio di Carbonari, Badagnano, Italy; 4. Aporrhais alata (Eichwald, 1830), NHMW 2012/0197/0007 (ex BL collection), height 31.1 mm, middle Miocene, Badenian, Gainfarn, Vienna Basin, Austria; 5. Aporrhais dactylifera (Boettger, 1902), NHMW 1874/0058/1104, middle Miocene, Serravallian, locality 13, Pinarlar Yaylasi, Akpinar, Karaman Basin, Turkey.

JvdV/32, RGM 783 883/41; locality 9: RGM 783 817/45; locality 11: JvdV/1; locality 12: RGM 783 609/50+; locality 13: NHMW 1874/0058/1102-1874/0058/1104/3, 1874/0058/1105/50+, JvdV/50+, RGM 783 636/50+, 794512/1, MTA 2013/016/12, YI 117/50+; locality 17: YI 119/5. Exact locality unknown: AÜ LE-K-209/6.

Discussion – Aporrhaids are extremely common in both the sandy and clayey Turkish deposits. The morphotypes found in each substrate type are somewhat different. Those found in the clayey deposits are typical of *Aporrhais dactylifera* (Boettger, 1902), with long, slender digits and a prominent hook next to the third digit. Those from sandy environments are inseparable from *A. pespelecani* (Linnaeus, 1758), with the digits shorter and the outer lip strongly webbed between the digits. The *A. dactylifera* morphotype is rare in the sandy deposits of Seyithasan, whereas a few specimens of the *A. pespelecani* morphotype are found in the Pinarlar Yaylasi clays.

Aporrhais dactylifera strongly resembles Aporrhais uttingeriana (Risso, 1826), a species that is widespread in the European middle-late Miocene to Pleistocene (Landau *et al*, 2004a), in the shape of its straight, elongated digits, but differs in having the first adapical digit free from the spire, whereas in *A. uttingeriana* the first digit is attached along the entire length of the spire and consequently, the angle between the first and second digitation is smaller in *A dactylifera*. Also of note is a prominent forwards and downwards-pointing hook, which forms abapically to the third digit, in most specimens. This feature is not present in *A. pespelecani* or *A. uttingeriana*.

As is often the case in taxonomy, some authors consider all the Miocene aporrhaids to belong to one or two species (Bałuk, 1995; Solsona, 1998; Solsona et al., 2000), whilst others recognise the morphological differences between populations at species level (Marquet et al., 2002; Brunetti & Forli, 2013). We agree with the latter position. Marquet et al. (2002, p. 153) stated that A. uttingeriana was in general the most common species found in the Paratethys Badenian. However, in our opinion this is incorrect, as we have not seen any specimen from the Badenian that can definitely be ascribed to this species; *i.e.* having the adapical digit attached to the whole length of the spire and extending adapically well beyond the apex. The name Aporrhais alata (Eichwald, 1830) has often been used for some of the Paratethyan shells. However, in our opinion, more than one species is present in the Paratethys, and the diagnosis of Rostellaria alata does not make it possible to know which Paratethyan species is being described (Marquet et al., 2002). Bałuk (1995) discussed the great sculptural variability and the nature of the labial digitations, but if one considers the specimens figured by Hörnes (1852, pl. 18, figs 1, 2) and Bałuk (1995, pl. 6, figs 1-3), and numerous specimens in the NHMW collections from various Austrian deposits, the adapical digitation of most specimens is short, straight and fused with the spire, whereas in A. pespelecani the adapical digit is longer, flattened and recurved away from the apex in most specimens. Marguet et al. (2002) recognised a further Paratethian form, A. praeter*itus* (Boettger, 1906), a small, slender species with a very weak adapical digit, which is also fused to the spire, with weak third and fourth digits and heavy, clearly defined sculpture. Indeed, if one takes into account the shape of the first digit, very few Paratethyan shells indisputably can be attributed to A. pespelecani. To summarise, in our opinion, at least two species are present in the Paratethys; A. dactylifera, with long straight spines fused by shallow webs, and a second with less pointed digitations fused by a broad labial web and with a short first digit that is usually fused to the spire along its entire length. We propose to retain the name A. alata for this second species. Aporrhais praeteritus may be an ecophenotype of A. alata. Unfortunately, in the case of aporrhaids the protoconch does not help to distinguish between species. Solsona et al. (2000) found no differences between the protoconchs of A. pespelecani and A. uttingeriana, both being multispiral and of about 2.75 smooth whorls. The protoconch of the the aporrhaids from the sandy and clayey deposits of the Karaman Basin are identical (dp = 610 μ m, hp = 770 μ m, dp/hp = 0.79, $dp1 = 170 \ \mu m$, $dn = 75 \ \mu m$; Pl. 61, figs 4, 5). Again, some authors consider Aporrhais uttingeriana to occur in the Recent faunas off the coast of West Africa (Solsona, 1998; Solsona et al., 2000), or reported as A. uttingeriana pesgallinae Barnard, 1963 (= A. elegantissima Parenzan, 1970) (Kronenberg, 1991). However, in our opinion these two species are distinct. In the Recent A. pesgallinae the first digit is connected only to 2-3 whorls, whereas in the fossil A. uttingeriana it is attached to the spire over its entire length.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Marquet *et al.*, 2002), Poland (Friedberg, 1912), ?Hungary (Strausz, 1954, 1962, 1966), Romania (Boettger, 1902; Zilch, 1934), eastern Paratethys (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Aporrhais pespelecani (Linnaeus, 1758) Figure 18/1; Plate 9, figs 4-6; Plate 61, fig. 5

gure 10/1, 1 luce 9, 11gs + 0, 1 luce 01, 11g. 5

- *1758 Strombus Pes pelecani Linnaeus, p. 742, no. 422.
 1896 Chenopus pespelecani Lin. Vinassa de Regny, p. 32, pl. 3, figs 13-21.
- 2004 Aporrhais pespelecani (Linne 1766 [sic]) İslamoğlu, p. 149, pl. 2, fig. 2.
- 2004a *Aporrhais* (*Aporrhais*) *pespelecani* (Linnaeus, 1758) Landau *et al.*, p. 65, pl. 14, fig. 7 (with additional synonyms).
- 2011 *Aporrhais* (*Aporrhais*) *pespelecani* (Linnaeus, 1758) Landau *et al.*, p. 14, pl. 4, fig. 5 (with additional synonyms).
- 2013 Aporrhais pespelecani pespelecani (Linnaeus, 1758) Brunetti & Forli, p. 184, figs 1-10, 70, 71.
- 2013 Aporrhais pespelecani crenatulina (Sacco, 1893)
 Brunetti & Forli, p. 188, figs 12-14, 18-22, 23-26, 72.

Dimensions and material – Maximum height 30.0 mm. Locality 6: YI 120/11; locality 13: YI 121/24; locality 17: NHMW 1874/0058/1106-1874/0058/1109/4, 1874/0058/ 1109/50+, JvdV/50+, RGM 784 023/1, RGM 783 756/22, RGM 783 977/1, 4 fragments, MTA 2013/017/3, YI 122/37.

Discussion – Until recently, in the European Neogene *Aporrhais pespelecani* (Linnaeus, 1758) was considered a widespread and long ranging species, present from the middle Miocene to Recent faunas (Landau *et al.*, 2004a). In this paper we question the presence of the species in the Paratethys, where several species may be present (see above under *A. dactylifera*).

Brunetti & Forli (2013) recently reviewed the Italian Plio-Pleistocene aporrhaids. They recognised two forms present in the Mediterranean Pliocene. Aporrhais pespelecani pespelecani, present from the early Pliocene Zanclean to Recent faunas, and A. pespelecani crenatulina (Sacco, 1893) present from the Zanclean to middle Piacenzian. According to Brunetti & Forli (2013, p. 189), this subspecies differed from A. pespelecani pespelecani in having a smaller-sized shell with a taller spire, in having the tubercles on the spire whorls more axially-elongated and more numerous (number of tubercles on penultimate whorl: A. pespelecani crenatulina; maximum 19, minimum 14, median, 18. A. pespelecani pespelecani (Pliocene); maximum 13, minimum 12, median, 12.5; A. pespelecani pespelecani (Pleistocene); maximum 16, minimum 10, median, 13.2; A. pespelecani pespelecani (Recent); maximum 15, minimum 10, median, 11.9), in having less elongated digits, with the interdigital webs more flattened and leaf-shaped, and, most importantly in having abapical apertural dentition developed on both the inner side of the outer lip and columella in all specimens. Brunetti & Forli (2013, p. 188) placed the shells illustrated by Landau et al. (2004a) from Estepona in the synonymy of A. pespelecani crenatulina.

This has led us to review these shell characters in the Spanish specimens available. It is not quite clear how the authors counted the number of tubercles on the penultimate whorl, as it is partly covered by the adapical digit. We have counted only tubercles visible. For the specimens from Estepona the average height is 20.9 mm and the average number of tubercles on the last whorl is 14.8 (maximum 17, minimum 12). Apertural dentition is present in 56% of specimens. Therefore, the Estepona shells are indeed relatively small, the digitations short and the wing leaf-like, as in the subspecies A. pespelecani crenatulina. However, apertural dentition is only present in just over half of the specimens and the number of tubercles on the penultimate whorl is intermediate between that recorded by Brunetti & Forli (2013, table 2) for the two subspecies.

We have also re-examined the specimens from the Atlantic early Pliocene of the Huelva Basin, southern Spain (Landau *et al.*, 2011). These have an average height is 31.1 mm and the average number of tubercles on the last whorl is 12.9 (maximum 16, minimum 10). None have any signs of apertural dentition. The tubercles are sharper and less elongated than in most of the Estepona shells, but there is some variation in this character. The specimens from Huelva are therefore large, they have relatively long digits, the number of tubercles in similar to that recorded by Brunetti & Forli (2013, table 2) for Pliocene specimens of *A. pespelecani pespelecani*, and the absence of apertural dentition would place them in this subspecies, as already stated by Brunetti & Forli (2013, p. 184).

A small number of specimens are also at hand from the early Pliocene, Zanclean, of the Roussillon Basin, France. These specimens are small, with an average height of 22.0 mm, an average of 11 tubercles on the penultimate whorl (maximum 12, minimum 10) and two of the three specimens have some traces of apertural dentition. These French specimens agree in size with the subspecies *A. pespelecani crenatulina*, and most specimens have apertural dentition, but they have fewer tubercles on the penultimate whorl.

Gijs Kronenberg (Eindhoven, The Netherlands) kindly reviewed Recent specimens of *A. pespelecani* present in his collection from the Atlantic and Mediterranean European coasts. He concluded that there was a tendency for the shell size to increase from west to east, with the Portuguese Atlantic specimens significantly smaller than those from Italy, and, as suggested by Brunetti & Forli (2013), none of the specimens has apertural dentition. At least two specimens were anomalous, one in having an extra digit, the other in having the adapical digit attached to the spire over almost the entire length, as opposed to the more usual loose first digit.

In summary, the presence or absence of apertural dentition in fossil Pliocene specimens from outside Italy seems to be more variable than suggested by Brunetti & Forli (2013). Interestingly, the presence or absence of apertural dentition is also a variable feature in middle Miocene Paratethyan shells usually referred to as Aporrhais alata (Eichwald, 1830) (see above), where this dentition can be quite strongly developed in some specimens. The two subspecies cannot be considered chronosubspecies, as their occurrences overlap, nor can they be considered to occupy different habitats, as both the species and subspecies are recorded by Brunetti & Forli (2013) from the same locality (i.e. Poggio alla Staffa, Siena; Bibbiano, Siena; Ciuciano, Siena). We therefore consider them a single species, A. pespelecani. Nevertheless, the observations made by Brunetti & Forli (2013) between the fossil and Recent specimens of A. pespelecani are valid, in so much as there are a greater number of early Pliocene shells which are smaller in size, with more numerous tubercles on the penultimate whorl and with apertural dentition, and that these characters have shifted over time to give the modern larger form, with fewer tubercles and smooth apertures.

We ascribed the specimens from the sandy deposits of Seyithasan to *Aporrhais pespelecani* (Linnaeus, 1758). In most of the Turkish specimens the adapical digit is not as long as in most fossil Pliocene and Recent *A. pespelecani* specimens, but in some the first digit is detached, flattened and recurved as in the modern shells. The average height for the Turkish shells is 27.5 mm, the average number of tubercles on the penultimate whorl is 16 (maximum 17, minimum 15), and only a couple of specimens show any trace of apertural dentition.

Distribution – Middle Miocene: Proto-Mediterranean Sea (Langhian): Kasaba Basin, Turkey (İslamoğlu, 2004), (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1893c). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1988; Landau et al., 2011), Morocco (Lecointre, 1952); western Mediterranean, Estepona (Landau et al., 2004a), northeastern Spain, (Martinell, 1979), Roussillon Basin, France (Fontannes, 1879); central Mediterranean, Italy (Sacco, 1893c; Brunetti & Forli, 2013); Tunisia (Fekih, 1975). Early-late Pliocene: North Sea Basin, England (Wood, 1848; Harmer, 1916), Belgium (Glibert, 1958; Marquet, 1998a), Mondego Basin, Portugal (Silva, 2001); central Mediterranean, Italy (Malatesta, 1974; Cavallo & Repetto, 1992; Brunetti & Forli, 2013). Pleistocene: northeastern Atlantic, British Isles (Wood, 1848; Harmer, 1916); central Mediterranean, Italy (Cerulli-Irelli, 1912; Brambilla et al., 1988; Taviani et al., 1998; Brunetti & Forli, 2013), Sicily (Glibert, 1963a). Recent: northeastern Atlantic, Iceland to Mauritania, Mediterranean, Black Sea (Poppe & Goto, 1991).

Superfamily Calyptraeoidea Lamarck, 1809 Family Calyptraeidae Lamarck, 1809 Genus *Calyptraea* Lamarck, 1809

Type species – Patella chinensis Linnaeus, 1758, by monotypy. Recent, European.

Calyptraea chinensis (Linnaeus, 1758) Plate 9, fig. 7; Plate 61, fig. 6

- *1758 Patella chinensis Linnaeus, p. 1257.
- 1852 *Calyptraea laevigata* Eichwald, p. 2, pl. 6, fig. 14.
 1853 *Calyptr. laevigata* Lam. (*non* Desh.) Eichwald,
- p. 143.
- 1866 Calyptraea chinensis Linné Fischer, p. 250.
- 1912 Calypraea Chinensis Lin. Schaffer, p. 168, pl. 54, figs 20, 21.
- 1923 Calyptraea chinensis Lam. [sic] Friedberg, p. 417, pl. 25, fig.8.
- 1963 Calytraea (C.) chinensis (L.) Venzo & Pelosio,
 p. 80, pl. 34, fig. 35.
- 1968 Calyptraea chinensis (Linné, 1766 [sic]) Zelinskaya et al., p. 174, pl. 41, figs 17, 18.
- 1988 Calyptraea chinensis (Linneo, 1758) Chirli, p. 17, pl. 1, fig. 18.
- 1993 Calyptraea (Calyptraea) chinensis (Linné, 1758) – Iljina, p. 57, pl. 6, fig. 11.
- 1998 Calyptraea (Calyptraea) chinensis taurostriatella

Sacco – Schultz, p. 60, pl. 23, fig. 3.

- 2004a *Calyptraea chinensis* (Linnaeus, 1758) Landau *et al.*, p. 70, pl. 15, fig. 3 (with additional synonyms).
- 2011 *Calyptraea chinensis* (Linnaeus, 1758) Landau *et al.*, p 14, pl. 4, fig. 9 (with additional synonyms).

Dimensions and material – Maximum diameter 31.3 mm. Localities 2 & 3: JvdV/5, 20 juveniles; locality 6: JvdV/1; locality 17: NHMW 1874/0058/1111/1, 1874/0058/1112/2, JvdV/50+, RGM 794 595/1 (ex JvdV collection), RGM 783 733/5, RGM 783 955/50+ juveniles, YI 126/14 + 12 juveniles.

Discussion – This species in extremely variable in both sculpture and profile, although most specimens are relatively constant within a population. The Turkish shells tend to have a smooth dorsum and are relatively depressed. The European Miocene species Calyptraea depressa Lamarck, 1822 differs from C. chinensis (Linnaeus, 1758) in the shape of the internal septum, and the tongue-like projection is narrower due to the insertion of the lamella at the outer edge being more adapically placed. The protoconch in the Turkish shells consists of 1.25 smooth, rapidly increasing whorls (dp = $600 \ \mu$ m), similar to that figured by Fretter & Graham (1981). For further discussion see Landau *et al.* (2004a).

Distribution – Early Miocene: Paratethys (Aquitanian): Vienna Basin, Austria (Schaffer, 1912); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1893c). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Germany (Anderson, 1964), Netherlands (A.W. Janssen, 1984a). Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France, (Cossmann & Peyrot, 1919), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Poland (Friedberg, 1923; Bałuk, 1975), Vienna Basin, Austria (Hörnes, 1856; Schultz, 1998), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1966), Ukraine (Zelinskaya et al., 1968), eastern Paratethys (Iljina, 1993); Proto-Mediterranean Sea (Burdigalian-Langhian): northeastern Spain (Solsona, 1998), (Serravallian): Karaman Basin, Turkey (Fischer, 1866). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (Brébion, 1964), (Tortonian): Cacela Basin, Portugal (Glibert, 1963a); Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, Italy (Sacco, 1893c; Venzo & Pelosio, 1963). Early Pliocene: North Sea Basin, England (Wood, 1848; Harmer, 1916), Belgium (Glibert, 1958; Marquet, 1997b); northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1988; Landau et al., 2011) Morocco (Lecointre, 1952); western Mediterranean, Estepona Basin, Spain (Landau et al., 2004a); northeastern Spain (Martinell, 1979), Roussillon Basin, France (Fontannes, 1879); central Mediterranean, Italy (Sacco, 1896c; Palla, 1967; Caprotti, 1974); Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Zbyszewski, 1959; Silva, 2001), Morocco (Lecointre, 1952); central Mediterranean, Italy (Malatesta, 1974; Chirli, 1988; Cavallo & Repetto, 1992). **Pleistocene**: northeastern Atlantic, British Isles (Glibert, 1963a), Morocco (Lecointre, 1952); central Mediterranean, Italy (Cerulli-Irelli, 1912; Taviani *et al.*, 1998), Sicily (Glibert, 1963a). **Recent:** northeastern Atlantic, British Isles to Zaire, Madeira and Canaries, Mediterranean, Black Sea (Poppe & Goto, 1991).

Genus Crepidula Lamarck, 1799

Type species – Patella fornicata Linnaeus, 1758, by monotypy. Recent, North Atlantic.

Crepidula gibbosa Defrance, 1818

Plate 9, fig. 8, 9

- *1818 Crepidula gibbosa Def., Defrance, p. 397.
- 1988 *Crepidula gibbosa* Defrance, 1818 Chirli, p. 17, pl. 2, fig. 1.
- 2004a *Crepidula gibbosa* Defrance, 1818 Landau *et al.*, p. 71, pl. 15, fig. 4 (with additional synonyms).
- 2011 *Crepidula gibbosa* Defrance, 1818 Landau *et al.*, p 14, pl. 4, fig. 10 (with additional synonyms).

Dimensions and material – Maximum length 22.5 mm. Locality 13: NHMW 1874/0058/1113/1, 1874/0058/1114/1, 1874/0058/1115/7.

Discussion – Crepidula gibbosa, Defrance, 1818 has a more elevated, convex dorsum than *C. unguiformis*, which usually has a concave dorsum. Moreover, *C. gibbosa* has a straight septum and lacks the central depression seen in *C. unguiformis*. For further discussion see Landau *et al.* (2004a, p. 72).

Distribution - Middle Miocene: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1919), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856), Poland (Bałuk, 1975), Hungary (Strausz, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (NHMW collection); Proto-Mediterranean Sea, Po valley, Italy (Sacco, 1896a). Early Pliocene: northeastern Atlantic, Guagalquivir Basin, Spain (González Delgado, 1988; Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (Landau et al., 2004a). Early-late Pliocene: northeastern Atlantic, Morocco (Lecointre, 1952); central Mediterranean, Italy (Chirli, 1988; Cavallo & Repetto, 1992). Recent: Mediterranean, below low tide line, often on other molluscs (Poppe & Goto, 1991).

Crepidula unguiformis Lamarck, 1822 Plate 9, fig. 10

- *1822 Crepidula unguiformis Lamarck, p. 25.
 - 1956 *Crepidula (Janacus) crepidula unguis* d'Orbigny – Csepreghy-Meznerics, p. 394, pl. 3, fig. 42.
- 1988 *Crepidula unguiformis* Lamarck, 1822 Chirli, p. 17, pl. 2, fig. 2.
- 2004a *Crepidula unguiformis* Lamarck, 1822 Landau *et al.*, p. 73, pl. 15, fig. 5 (with additional synonyms).
- 2011 *Crepidula unguiformis* Lamarck, 1822 Landau *et al.*, p 15, pl. 4, fig. 13 (with additional synonyms).

Dimensions and material – Maximum length 28.9 mm. Localities 2 & 3: JvdV/20; locality 13: JvdV/3; locality 17: NHMW 1874/0058/1116/1, 1874/0058/1117/10, JvdV/7, RGM 783 732/4, RGM 783 956/50+ juveniles.

Discussion – Crepidula unguiformis Lamarck, 1822 is often found inside the aperture of other shells. Its shape is therefore very variable, determined by the living substrate. Some specimens develop a corrugated shell, following the contour of internal lirae, if present inside the aperture of their host shell. For further discussion see Landau *et al.*, (2004a, p. 73).

Distribution - Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1919). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Germany (Anderson, 1964), Netherlands (A.W. Janssen, 1984a). Middle Miocene: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1919), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856), Poland (Bałuk, 1975), Hungary (Strausz, 1966); Proto-Mediterranean Sea, northeastern Spain (Solsona, 1998); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (NHMW collection), (Tortonian): Cacela Basin, Portugal (NHMW collection); Proto-Mediterranean Sea, Po valley, Italy (Sacco, 1896a). Early Pliocene: northeastern Atlantic, Guagalquivir Basin, Spain (González Delgado, 1988; Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (Landau et al., 2004a), Roussillon Basin, France (Fontannes, 1879), northeastern Spain (Solsona, 1998); central Mediterranean, Italy (Sacco, 1896a; Palla, 1967), Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Zbyszewski, 1959; Silva, 2001), Morocco (Lecointre, 1952); central Mediterranean, Italy (Sacco, 1896a; Chirli, 1988; Cavallo & Repetto, 1992). Early-late Pleistocene: central Mediterranean, Sicily (Glibert, 1963). Recent: Mediterranean, below low tide line to 100 m depth, often on other molluscs (Poppe & Goto, 1991).

Superfamily Vanikoroidea Gray, 1840 Family Vanikoridae Gray, 1840 Genus *Cymenorhytis* Cossmann, 1888

Type species – Rissoa fragilis Lamarck, 1804, by original designation. Eocene, France.

Cymenorytis brandenburgi (Boettger 1907)

Plate 54, fig.7; Plate 61, fig. 7; Plate 62, figs 1, 2.

- *1907 Escharella brandenburgi Boettger 1907, p. 176.
- 1934 Couthouya brandenburgi Boettger Zilch 1934:246, pl. 13, fig. 57.
- 1995 Couthouya brandenburgi (Boettger, 1907) Bałuk, p. 172, pl. 5, fig. 1.
- 2013 Cymenorhytis brandenburgi (Boettger, 1907) Sosso et al., p. 160, figs 1A-N.
- non Macromphalus brandenburgi (Boettger 1907) Chirli 2008: 13, pl. 2, figs 7–11 (= Cymenorytis dellabellai Sosso, dell'Angelo & Bonfitto, 2013).
- non Macromphalus cf. brandenburgi (Boettger, 1907)
 Landau et al., 2004: 75, pl. 16, figs 2, 3e (= Cy-menorytis landaui Sosso, dell'Angelo & Bonfitto, 2013).

Dimensions and material – Maximum length 2.3 mm. Locality 17: RGM 794 585/1 (ex JvdV collection), RGM 784 064/1, RGM 783 970/1, RGM 784 068/1.

Discussion - The genus Cymenorytis was revised recently by Sosso et al. (2013), who recognised three species in the European Neogene. Cymenorhytis brandenburgi (Boettger, 1907) from the middle Miocene Paratethys, C. dellabellae Sosso, dell'Angelo & Bonfitto, 2013 (= Macromphalus brandenburgi (Boettger 1907) in Chirli 2008, pl. 2, figs 7–11 = Macromphalus sp. in Landau et al., 2011, pl. 4, fig. 3) from the early Pliocene Zanclean of the Guadalquivir Basin, Spain and late Pliocene Piacenzian of Italy and C. landaui Sosso, dell'Angelo & Bonfitto, 2013 from the early Pliocene Zanclean of Estepona [Macromphalus cf. brandenburgi (Boettger 1907) in Landau et al., 2004, pl. 16, figs 2, 3e]. The teleoconch of all three is rather similar, but they can be separated by their protoconch sculpture. Cymenorhytis brandenburgi has a completely smooth protoconch, C. dellabellai has a smooth protoconch, with the surface close to the suture covered by close-set tubercles and lastly, the protoconch is completely covered in tubercles in C. landaui. A further species Micreschara tunisiensis Fekih & Gougerot, 1966 was described from the Piacenzian of Oued el Galea (Tunisia). The original figure is of poor quality, but this species seems to have stronger axial sculpture and a larger aperture than any of its European Neogene congeners.

The shells from Turkey have a smooth protoconch consisting of 2.6 whorls (dp = 140 μ m, hp = 220, dp/hp = 0.63, dp1 = 90 μ m, dn = 65 μ m; Pl. 61, fig. 7b, c). The protoconch type and shape are exactly the same as that figured by Sosso *et al.* (2013, fig 1 E, G) for *Cymenorhytis brandenburgi* from Varovtsy in the Ukraine, although it is only half the size for the same number of whorls. Nevertheless, we provisionally consider them to be conspecific.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1995), Romania (Boettger, 1907; Zilch, 1934; Sosso *et al.*, 2013), Ukraine (Sosso *et al.*, 2013); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Superfamily Xenophoroidea Troschel, 1852 (1840) Family Xenophoridae Troschel, 1852 (1840) Genus *Xenophora* Fischer von Waldheim, 1807

Type species – Xenophora laevigata Fischer von Waldheim, 1807 (= *Trochus conchyliophorus* Born, 1780), by subsequent designation (Gray, 1847). Recent, Caribbean.

Note – In their important work on the xenophorid gastropods of the Mediterranean Pliocene of the Siena Basin of Italy, Manganelli *et al.* (2004) discussed the problems surrounding the type material of some of the well-known Miocene species. A revision of these Miocene taxa was beyond the scope of their work, but the authors proposed neotypes for *X. burdigalensis* (Grateloup, 1845), *X. deshayesi* (Michelotti, 1847) and *X. italica* (Grateloup, 1845). For the two French species, *X. burdigalensis* and *X. italica* the neotypes proposed were specimens illustrated by Cossmann & Peyrot (1919; pl. 17, figs 105, 106 and pl. 13, figs 3, 4, repectively).

In this work we also follow the classification of the Miocene xenophorids by Cossmann & Peyrot (1919), and recognise these three closely allied species. They can be separated reliably based on the apical angle, the shape of the whorls and, most importantly, the shape of the collabral growth lines visible on the base. To summarise the differences, X. deshayesi has an apical angle of about 80°, weakly convex whorl sides and the curve in the collabral growth lines is wide, becoming less rapidly parallel to the periphery, so that the apex of the curve is the closest to the aperture of the three species. Xenophora burdigalensis has an apical angle of about 75°, weakly stepped whorls, and the collabral sinus is more acutely curved and remains perpendicular to the periphery for a greater distance. Xenophora italica has an apical angle of 80°, the whorls are straight-sided and the collabral growth lines are the most acutely angled of the three species, the angle closer to the periphery than in X. burdigalensis.

Xenophora deshayesi (Michelotti, 1847) Figure 19/2; Plate 9, figs 11, 12

*1847 Phorus Deshayesii mihi, Michelotti, p. 173.



Figure 19. Xenophora species. 1. Xenophora italica (Grateloup, 1845), NHMW 1874/0058/1064, maximum diameter 76.1 mm, locality 17, Seyithasan, Karaman Basin, Turkey, Tirtar Formation, Serravallian, middle Miocene; 2. Xenophora deshayesi (Michelotti, 1847), RGM 794 546 (ex JvdV collection), maximum diameter 84.8 mm, locality 17, Seyithasan, Karaman Basin, Turkey, Tirtar Formation, Serravallian, middle Miocene; 3. Xenophora sp. A, NHMW 1874/0058/1041, maximum diameter 67.2 mm, locality 13, Pinarlar Yaylasi, Akpinar, Karaman Basin, Turkey, Tirtar Formation, Serravallian, middle Miocene; 4-5. Xenophora sp. A, NHMW 1874/0058/1041, maximum diameter 67.2 mm, locality 13, Pinarlar Yaylasi, Akpinar, Karaman Basin, Turkey, Tirtar Formation, Serravallian, middle Miocene; 4-5. Xenophora sp. A, NHMW 1874/0058/1041, maximum diameter 67.2 mm, locality 13, Pinarlar Yaylasi, Akpinar, Karaman Basin, Turkey, Tirtar Formation, Serravallian, middle Miocene; 4-5. Xenophora sp. A, NHMW 1874/0058/1041, maximum diameter 67.2 mm, locality 13, Pinarlar Yaylasi, Akpinar, Karaman Basin, Turkey, Tirtar Formation, Serravallian, middle Miocene; 4-5. Xenophora sp. A, NHMW 1874/0058/1041, maximum diameter 67.2 mm, locality 13, Pinarlar Yaylasi, Akpinar, Karaman Basin, Turkey, Tirtar Formation, Serravallian, middle Miocene; 4-5. Xenophora sp. A, NHMW 1874/0058/1041, maximum diameter 67.2 mm, locality 13, Pinarlar Yaylasi, Akpinar, Karaman Basin, Turkey, Tirtar Formation, Serravallian, middle Miocene; 4-5. Xenophora sp. A, NHMW 1874/0058/1041, maximum diameter 76.0 mm, Le Castaing, Falun de Léognan, Léognan, Gironde department, France, Burdigalian, early Miocene.

- 1856 Xenophora Deshayesi Micht. Hörnes, p. 442, pl. 44, fig. 12.
- 1866 Xenophora deshayesi Michelotti Fischer, p. 249.
- 1896b Xenophora Deshayesi (Micht.) Sacco, p. 20, pl. 2, fig. 20.
- 1919 Xenophora Deshayesi (Michti) Cossmann & Peyrot, p. 465, no. 270, pl. 13, figs 7, 8.
- 1925 Xenophora Deshayesi (Mich) Kautsky, p. 63, pl. 6, fig. 9.
- 1928 Xenophora Deshayesi Micht. Friedberg, p. 419, pl. 27, fig. 1.
- 1949 Xenophora deshayesi (Michelotti) Glibert, p. 207 (partim, pl. 12, fig 20b only) [20a = Xenophora burdigalensis (Grateloup, 1845)].
- 1952b Xenophora deshayesi Michelotti, 1847 Glibert, p. 67, pl. 5, fig. 3.
- 1958 Xenophora Deshayesi Michtelotti Sorgenfrei, p. 181, pl. 34, fig. 115.
- 1960 Xenophora (Xenophora) deshayesi (Michelotti 1847) – Kojumdgieva & Strachimirov, p. 124, pl. 34, fig. 7.
- 1962 Xenophora deshayesi Michelotti Strausz, p. 125,

text-fig. 154.

- 1964 Xenophora deshayesi Michelotti 1847 Anderson, p. 224, pl. 18, fig. 147.
- 1966 Xenophora deshayesi Michelotti, 1847 Strausz, p. 214, text-fig. 93.
- 1968 Xenophora deshayesi (Michelotti, 1847) Zelinskaya et al., p. 175, pl. 42, figs 1, 2.
- 1972a Xenophora deshayesi (Michelotti, 1847) Nordsieck, p. 67, pl. 16, fig. 72.
- 1984 Xenophora deshayesi (Mich., 1847) Min-Da, p.
 18, pl. 1,fig. 10, pl. 8, figs 1-7, pl. 11, figs 4-5, pl.
 13, fig. 4, pl. 14, figs 3-4.
- 1984a Xenophora deshayesi (Michelotti) A.W. Janssen, p. 189, pl. 54, fig. 1.
- 1995 Xenophora deshayesi (Michelotti, 1847) Bałuk, p. 179, pl. 6, figs 1-3.
- 1998 Xenophora deshayesi (Michelotti) Schultz, p. 60, pl. 23, fig. 5.
- 2001a Xenophora deshayesi (Michelotti, 1847) Lozouet et al., p. 40, pl. 16, fig. 1.
- 2001 *Xenophora deshayesi* (Michelotti, 1847) Wienrich, p. 420, pl. 68, figs 1, 2. pl. 84, figs 7-11.

- 2004 Xenophora deshayesi (Michelotti, 1847) İslamoğlu, p. 46, pl. 2, fig. 1
- non 1958 Xenophora deshayesi (Michelotti) Erünal-Erentöz, p. 33, pl. 3, fig. 24, pl. 4, figs 1, 2 [= Xenophora burdigalensis (Grateloup, 1845)].

Dimensions and material – Maximum height 91.6 mm (incomplete specimen about 108+ mm). Locality 17: NHMW 1874/0058/1062/1, 1874/0058/1063/1, 1847/0058/1610-1847/0058/1612/3 (incomplete), JvdV/2, RGM 794 546/1 (ex JvdV collection), RGM 783 744/1, YI 350/2 + 2 juveniles.

Discussion – *Xenophora deshayesi* (Michelotti, 1847) is the largest xenophorid in the Karaman assemblages. Karaman specimens have a relatively strongly stepped spire and coarser rugose sculpture on the dorsum than its Turkish congeners. The apical angle in the Turkish shells varies from 70.5°-76°. Only one complete fully adult specimen is available to us (Pl. 9, fig. 11), but this and the other incomplete adults clearly show a preference for agglutinating large pebbles rather than shell fragments, whereas the much more common, sympatric species *Xenophora italica* (Grateloup, 1845) preferentially agglutinates small shell fragments or small pebbles. The same obervation was made by Min-Da (1984, p. 9), based on specimens from the French Atlantic Miocene.

Distribution - Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, (Cossmann & Peyrot, 1919; Lozouet et al., 2001; Min-Da, 1984); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896b). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Denmark (Sorgenfrei, 1958); Netherlands (Nordsieck, 1972; A.W. Janssen, 1984a), Belgium (Glibert, 1952b), Germany (Kautsky, 1925; Anderson, 1964; Wienrich, 1972). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, (Min-Da, 1984); Paratethys (Langhian-Serravallian): Poland (Friedberg, 1928; Bałuk, 2001), Vienna Basin, Austria (Hörnes, 1856; Schultz, 1998), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1962, 1966), Ukraine (Zelinskaya et al., 1968); Proto-Mediterranean Sea (Langhian): Kasaba Basin, Turkey (İslamoğlu, 2004), (Serravallian): Karaman Basin, Turkey (Fischer, 1866).

Xenophora italica (Grateloup, 1845)

Figure 19/1; Plate 10, figs 1-3; Plate 62, fig. 3

- 1845 *Trochus conchyliophorus* var. *Italica* Grateloup, pl. 13, fig. 2.
- *1852 Phorus Gratteloupi d'Orb., d'Orbigny, p. 7, no. 96 (nom. nov. pro Trochus conchyliophorus Grateloup pl. 13, fig. 2 only).
- 1919 Xenophora Grateloupi (d'Orbigny, em. orthog.) Cossmann & Peyrot, p. 469, no. 272, pl. 13, figs 3, 4.

- 1958 Xenophora deshayesi (Michelotti) Erünal-Erentöz, p. 33, pl. 3, fig. 24, pl. 4, figs 1, 2 (non Michelotti, 1847).
- 2004 Xenophora grateloupi sensu Cossmann & Peyrot (1919) Manganelli et al., p. 428, text-fig. 10.

Dimensions and material – Maximum height 67.4 mm. Localities 2 & 3: JvdV/18, RGM 783 933/4; locality 6: JvdV/8, RGM 783 864/1; localities 7 & 8: JvdV/4, RGM 783 881/2; locality 9: JvdV/1, RGM 783 818/4; locality 12: JvdV/15; locality 13: NHMW 1874/0058/1079-1874/0058/1088/10, 1847/0058/1674-1847/0058/1675/2, JvdV/26, RGM 784 014/1, 783 632-635/35, YI 124/22, MTA 2013/087/3; locality 17: NHMW 1874/0058/1064-1874/0058/1078/15, 1847/0058/1613-1847/0058/1614/2, JvdV/35, RGM 783 727-728/2, 783742-743/21, YI 123/50 + 5 juveniles, MTA 2013/086/15.

Discussion – This species was first figured as Trochus conchyliophorus var. Italica Grateloup, 1845, who figured a specimen from the Atlantic middle Miocene Serravallian of France (Grateloup, pl. 13, fig. 2). D'Orbigny (1852, p. 7) introduced the name Phorus Gratteloupi [sic] for this same shell, corrected to Xenophora grateloupi by Cossmann & Peyrot (1919, p. 469). Their reason for using d'Orbigny's name over that given by Grateloup is somewhat curious: 'Il nous a paru difficile de donner à notre espèce le nom *italica* sous lequelle Grateloup l'avait détachée, à titre de variété de X. conchyliophorus. Ce nom pourrait guère être repris que s'il y avait réelement identité entre la forme des Landes et celles du Pliocène d'Italie centrale' (Cossmann & Peyrot, 1919, p. 470). Manganelli et al. (2004) listed Trochus conchyliophorus var. Italica as a 'not available senior objective synonym of Phorus grateloupi d'Orbigny, 1852 (2004, p. 424)'. In their discussion the only justification we can find for this unusual statement is: 'They [Cossmann & Peyrot, 1919] realised that this nominal taxon was first named by Grateloup (1847 [sic]) as Trochus conchyliophorus var. italica, but thought it inappropriate to reintroduce this specific epithet (2004, p. 427)'. The authors went on to propose as neotype the shell illustrated by Cossmann & Peyrot (1919, pl. 13, figs 13,4).

We can find no justification for this decision. We can find no homonym that would disqualify *Trochus italicus* and we cannot argue for the status of *nomen oblitum* for *X*. *grateloupi*, as we cannot find the name *X*. *grateloupi* in 25 works, published by at least 10 authors in the immediately preceding 50 years and encompassing a span of not less than 10 years (ICZN Article 23.9.1.2.). Therefore we reinstate the senior name *Xenophora italica* (Grateloup, 1845).

Xenophora italica (Grateloup, 1845) is relatively common in the Karaman assemblages where it occurs in both the sandy deposits of Seyithasan and the slightly deeper-water clayey Akpinar outcrops. It tends to have agglutinated smaller objects, which straddle the suture, and used whatever was available in the habitat, as the Seyithasan specimens chose small stones whereas the Akpinar specimens agglutinated bivalve fragments. Where the suture is not obscured it is quite linear in comparison with its congeners.

Erünal-Erentöz (1958) identified this species as *Xenophora deshayesi* (Michelotti, 1847), but it clearly differs in having almost completely straight sided whorls, finer rugose sculpture on the dorsum and more angular collabral growth lines on the base. The apical angle in the Turkish shells varies from 78.5°-83.5°. It is more closely similar to *X. burdigalensis* (Grateloup, 1845) (Fig. 19/4-5), but again differs in having more straight-sided whorls and most importantly the angulation of the collabral lines on the base is more acute and placed almost at the periphery in *X. italica*, whereas in *X. burdigalensis* the angulation is nearer the centre and is less acute. The protoconch is low dome-shaped, multispiral, consisting of 3.25 convex whorls (dp = 560 μ m, dp1 = 200 μ m, dn = 100 μ m; Pl. 62, fig. 3).

Distribution – **Middle Miocene**: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1919); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Xenophora sp.

Figure 19/3; Plate 10, fig. 4

Dimensions and material – Height 40.0 mm (incomplete). Locality 13: NHMW 1874/0058/1041/1; YI 125/4 + 3 juveniles.

Discussion – A single incomplete shell from the Akpinar assemblage represents a third xenophorid species from the Karaman assemblages. The protoconch and part of the first teleoconch whorl are missing. The 3.5 preserved whorls are convex, depressed and rapidly expanding, resulting in a rather flattened teleoconch with a very wide apical angle of 106° and a stepped spire. The rugose sculpture on the dorsum is very fine. The collabral growth lines on the base are evenly curved, but the curve is deeper than in *Xenophora deshayesi* (Michelotti, 1847). The sculpture on the base is also finer than in its other Turkish congeners.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Superfamily Naticoidea Guilding, 1834 Family Naticidae Guilding, 1834 Subfamily Naticinae Guilding, 1834 Genus *Cochlis* Röding, 1798

Type species – Cochlis flammea Röding, 1798 (= *Nerita vittata* Gmelin, 1791), by subsequent designation (Hedley, 1916). Recent, eastern Atlantic.

Note – The European Neogene spotted naticids, historically placed in the genus *Natica* Scopoli, 1777 or

Naticarius Duméril, 1806, were transferred to *Cochlis* Röding, 1798 by Pedriali & Robba (2005). According to these authors, *Cochlis* differs from *Natica* in having a poorly developed or indistinct anterior lobe of the parietal callus and the umbilicus more or less widely filled by the funicle, whereas *Natica* has a well-developed anterior parietal lobe and the umbilicus lacks a funicle (for further discussion see Pedriali & Robba 2005, p. 132). In their revision of *Cochlis* in the Italian Pliocene, Pedriali & Robba (2005, 2008) recognised 13 species, distinguished by protoconch, teleoconch and opercular characters and morphometrics.

In the European Miocene the name *Natica tigrina* Defrance, 1825 has usually been used as a dumping ground for all the spotted naticids. Miocene species have not so far been submitted to rigorous appraisal and it is unlikely that all specimens belong to a single species. Any revision of this group must include the Recent species, including the type species, which is beyond the scope of this work. Furthermore, in order to characterise the species all three features, the protoconch, teleoconch and operculum must be present.

The Karaman assemblages offer a poor start for such work, for although naticids are relatively common, none of the genera with a calcareous operculum (*i.e. Cochlis* and *Tectonatica*) have been preserved together with their operculum. Indeed, even in sieved samples naticid opercula are uncommon. Secondly the protoconchs have almost invariably been eroded. Despite several attempts to photograph better-preserved material or juveniles, the protoconch was still too worn to distinguish the protoconch/teleoconch boundary clearly. Light microscopy also could not be used to distinguish this feature reliably, as several potential boundary positions were seen to be healed pathological fracture lines when examined under the SEM.

Based on teleoconch characters and colour pattern we recognise three species of *Cochlis* within the Karaman assemblages. The first is clearly separated from the rest based on shell shape, umbilical characters and colour pattern of two spiral rows of larger dots [*Cochlis curta* (Erünal-Erentöz, 1958)]. The Karaman spotted *Cochlis* species fall into two species; the first has a small funicle and a pattern of small spots (*Cochlis* sp. 2) whereas the second has a wider funicle and larger spots (*Cochlis* sp. 3), although some specimens seem to be intermediate. These spotted naticids be identified reliably only after the existing taxa have been characterised adequately.

For the terminology used for naticid shell features we follow Pedriali & Robba (2004, fig. 2)

Cochlis curta (Erünal-Erentöz, 1958)

Plate 11, fig. 1; Plate 62, fig. 4; Plate 78, fig. 5; Plate 79, fig. 4

- *1958 *Natica pachyope* var. *curta* Erünal-Erentöz, p. 39, pl. 5, fig. 8.
- 1958 Natica sp. Erünal-Erentöz, p. 40, pl. 5, figs 9, 10.

Specimen	D	Н	SA	IS	SH/H	AH/H	AH/AW
1	30.7	28.0	132.3	27.6	0.17	0.84	1.18
2	31.1	30.1	132.1	23.8	0.18	0.83	1.41
3	39.6	42.1	119.5	25.5	0.17	0.82	1.55
4	28.4	28.6	141.4	20.6	0.14	0.86	1.63
5	48.8	51.3	120.8	20.1	0.21	0.78	1.45
Mean			129.2	23.5	0.17	0.83	1.44

Table 2. Measurements of *Cochlis curta* (Erünal-Erentöz, 1958), locality 13, Pınarlar Yaylası, Akpınar, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene. Maximum diameter (D), height (H), spire angle (SA), inner lip slope (IS), spire height (SH), aperture height (AH), aperture width (AW) (for explanation of measurements see Pedriali & Robba, 2005, p. 111, fig. 2).

Dimensions and material – Maximum height 53.5 mm. Localities 2 & 3: JvdV/4; locality 6: JvdV/3, YI 246/8; localities 7 & 8: NHMW 1874/0058/1348/2, JvdV/2; locality 12: JvdV/2; locality 10: YI 245/7; locality 13: NHMW 1874/0058/1346/1, 1874/0058/1347/17, JvdV/50+, RGM 777 866/1 (ex JvdV collection), RGM 783 657/21, RGM 794 513/1, MTA 2013/018/2, YI 242/16; locality 17 YI 244/1. Exact locality unknown: holotype AÜ LE-K-214/1.

Description - Shell medium to large, globose, solid. Protoconch not clearly delimited, possibly 2-2.5 whorls. Spire strongly depressed in younger shells, elevated only in the most gerontic specimens, whorls weakly convex. Suture linear, impressed. Last whorl strongly inflated, somewhat depressed, subsutural ramp poorly delimited, shallow. Outer lip simple, expanded abapically. Aperture D-shaped, mean AH/AW = 1.44. Parietal callus moderately thick, abapically fusing with umbilical callus, partly covering and overhanging adapical sulcus; anterior lobe moderately developed; callus edge concave between apex and anterior lobe. Umbilicus wide, largely filled by funicle. Umbilical callus broad, depressed, fused adapically with parietal callus. Abapical sulcus widening and broadening with growth. Basal fasciole wide, relatively smooth, somewhat depressed, round-edged. Colour pattern, visible under UV light only, consisting of two spiral rows of larger blotches running along the shoulder, delimiting the base, with very irregular small dots between the two rows of larger dots (Pl. 79, fig. 4).

Discussion – This is the largest *Cochlis* in the Karaman assemblages and is easily separated from its congeners. It is characterised by its low spire, its very wide umbilicus and its broad flattened funicle, which is fused adapically with the small anterior lobe of the parietal callus. The colour pattern, consisting of two spiral rows of large blotches with a dense irregular cover of smaller dots, immediately distinguishes it from the regularly spotted *Cochlis* species. The protoconch figured (Pl. 62, fig. 4) is relatively well preserved but the protoconch/teleoconch boundary is unclear. Two possible positions are marked by arrows suggesting that it is composed of at least 2.0

 $(dp = 505 \ \mu m, dp1 = 260 \ \mu m, dn = 100 \ \mu m)$ or possibly 2.5 whorls (dp = 720 μ m). A single shell in the Erünal-Erentöz collection in Ankara labelled Natica pachyope var. curta (collection number AÜ LE-K-214/1; Pl. 78, fig. 5) is undoubtedly the specimen illustrated by the author. A small depression on the dorsum that matches that in the original figure perfectly. Erünal-Erentöz (1958, p. 40) discussed "Le specimen unique provident du Néogène de Karaman", so we can be certain this is the holotype. Cochlis burdigalensis (Mayer, 1864) from the early Miocene Aquitaine Basin of France is similar in size and also has a wide umbilicus, but specimens at hand (NHMW collection) demonstrate that the French species is thinnershelled, the columella is thinner, and the funicle although wide is much flatter, hardly filling the wide umbilicus, whereas in the Turkish shells the columella and funicle are thick in most specimens, the funicle almost filling the umbilicus in many specimens. Furthermore, the parietal callus in C. burdigalensis is much narrower than in the Turkish species. Cochlis sallomacensis (Tournoüer, 1873) from the Atlantic Serravallian of France is quite different, much smaller, thinner shelled, and with the funicle developed only in the abapical half of the umbilicus leaving the adapical half deeply hollow. As in C. burdigalensis, the parietal callus is rather narrow. Of the Pliocene Cochlis species, the Turkish shell is most similar to C. raropunctata obliquicallosa Pedriali & Robba, 2005, an Italian early Pliocene Zanclean subspecies, which is also thick-shelled and has the funicle fused abapically with the anterior parietal lobe. However, the Pliocene subspecies has a much narrower funicle and a regularly spotted colour pattern.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Cochlis sp. 2

Plate 11, figs 2, 3; Plate 79, fig. 5

Dimensions and material – Maximum height 36.0 mm. Localities 2 & 3: JvdV/20, RGM 783 931/30, YI 247/50+; locality 6: JvdV/9, RGM 783 865/16; localities 7 & 8: NHMW 1874/0058/1352/20, JvdV/21, RGM 777 867/1 (ex JvdV collection), RGM 783 903/50+; locality 10: YI 250/22; locality 12: JvdV/50+; locality 13: NHMW 1874/0058/1349/1, 1874/0058/1350/1, 1874/0058/1351/30, JvdV/50+, RGM 783 658/50+, MTA 2013/019/10, YI 240/50+.

Discussion - This Cochlis species is characterised by its relatively small shell, which is less robust than that of C. curta. The funicle is well-developed and delimited but narrow, occupying about 20-25% of the width of the umbilicus and placed just abapically to the mid-umbilicus. The parietal callus is narrow and poorly expanded. The basal fasciole is narrow and rounded to sharply-edged abaxially. Most specimens have a colour pattern of regular small dots (Pl. 79, fig. 5), although some shells with larger dots are present. Despite several attempts to photograph the protoconch, none of the SEM photographs clearly illustrated the protoconch/teleoconch boundary. These shells are similar to several of the species illustrated by Pedriali & Robba (2005) from the Italian Pliocene such as Cochlis raropunctata (Sassi, 1927). Without further information on the protoconch and opercular characters a more precise assignment is not possible.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Cochlis sp. 3

Plate 11, figs 4, 5; Plate 79, fig. 6

1958 *Natica millepunctata* Lamarck – Erünal-Erentöz, p. 38, pl. 5, figs 4-6.

Dimensions and material – Maximum height 40.0 mm. Localities 2 & 3: JvdV/12, YI 248/7; localities 7 & 8: JvdV/25, RGM 777 868/1 (ex JvdV collection); locality 10: YI 249/11; locality 11: JvdV/10; locality 12: JvdV/2; locality 13: YI 241/8; locality 17: NHMW 1874/0058/1353/1, 1874/0058/1354/1, NHMW 1874/0058/1355/40, JvdV/50+, RGM 783 736/50+, MTA 2013/020/5, YI 243/50+; locality 18: JvdV/1.

Discussion – This species of *Cochlis* is characterised by its medium-sized robust shell. The funicle is well-developed and delimited, medium-sized, occupying about one third of the width of the umbilicus and placed just abapically to the mid-umbilicus. The parietal callus is narrow and poorly expanded, but thickened. The basal fasciole is rounded. Most specimens of this species have a colour pattern of regular medium-sized dots (Pl. 79, fig. 6). As with the preceding species it was not possible to identify the protoconch/teleoconch boundary. It is possible that these two forms represent a single species, as some shells are difficult to assign to one or the other, especially when juvenile.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Genus Tectonatica Sacco, 1890

Type species – Natica tectula Sacco, 1890, by monotypy. Pliocene, Europe.

Tectonatica tectula (Sacco, 1890) Plate 11, fig. 6

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- *1890c Natica (Tectonatica) tectula Sacc., Sacco, p. 33.
- 1891a Natica (Tectonatica) tectula Sacc., Sacco, p. 81, pl. 2, fig. 53.
- 1956 Natica tectula Sacco Moroni, p. 106, pl. 9, fig. 55 (not seen).
- 1979 *Tectonatica tectula* (Bonelli, 1826) Martinell, p. 136, pl. 4, figs 6-8.
- 1980 Tectonatica tectula Sacco 1891 [sic] (Bonelli m.s.)
 Pavia, p. 259 (partim, pl. 7, figs 9, 13 only) [non pl. 7, figs 10, 11 = Tectonatica astensis (Sacco, 1890)].
- 1988 *Tectonatina tectula* (Bonelli, 1826 [*sic*]) González Delgado, p. 135, pl. 5, figs 5-7.
- 1992 Natica (Tectonatica) tectula Sacco 1891 [sic] Bonelli m.s. – Cavallo & Repetto, p. 68, fig. 126 [not in text = 125 lapsus; not operculum = Tectonatica prietoi (Hidalgo, 1873)].
- 1996 Natica (Tectonatica) tectula Sacco 1891 [sic] Bonelli m.s.– Pedriali, p. 8, pl. 2, figs 11-13, pl. 3, fig. 1.
- 1997 Tectonatica tectula (Sacco, 1890) Lacroce, p. 27, pl. 2, fig. 6 (not seen).
- 1999 Tectonatica tectula Sacco, 1891 [sic] Forli et al.,
 p. 115, pl. 2, fig. 5.
- 2008 Tectonatica tectula (Sacco, 1890) Pedrilai & Robba, p. 110, pl. 2, figs 7-9, 19, 20, pl. 3, figs 9, 22, 23.
- 2010 Tectonatica tectula (Sacco, 1890) Sosso & dell'Angelo, p. 26, unnumbered figure p. 35 third row right.
- 2011 *Tectonatica tectula* (Sacco, 1890) Landau *et al.*, p. 16, pl. 5, fig. 10.
- non 1958 Natica (Tectonatica) tectula Bonelli Sorgenfrei, p. 190, pl. 38, fig. 122 (= Tectonatica miopusilla Kautsky, 1925).

Dimensions and material – Maximum height 7.0 mm. Locality 6: JvdV/41; localities 7 & 8: NHMW 1874/0058/1364/3, JvdV/50+, RGM 784 051/2; locality 10: YI 252/2; locality 17: NHMW 1874/0058/1362/1, 874/0058/1363/7, JvdV/50+, RGM 783 984/50+, YI 251/33.

Discussion – This small but relatively solid naticid is characterised by having a multispiral protoconch composed of 2.75-3 whorls, by having the umbilicus almost completely filled by a large flattened funicular callus, by having a subquadrate, thickened parietal callus without the anterior lobe developed and by the operculum having a single marginal groove. The Turkish shells fit well with this description, although we have yet again been unable to identify the protoconch/teleoconch boundary convincingly.

Tectonatica tectula (Sacco, 1890) is distinguished from its Italian Pliocene congeners *T. astensis* (Sacco, 1890) and *T. prietoi* (Hidalgo, 1873) by having the umbilicus the most completely filled with callus.

The early-middle Miocene North Sea Basin shells sometimes reported as *Tectonatica tectula* (*i.e.* by Sorgenfrei, 1958) differ from *T. tectula* in having the umbilicus less filled with funicle and in the character of the operculum, which in *T. tectula* has a single fine shallow groove bounding the smooth marginal area whereas in *T. miopusilla* there are two grooves (A.W. Janssen, 1984a, pl. 58, fig. 3).

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean (Tortonian) Po Basin, Italy (Pedriali & Robba, 2008). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1988; Landau *et al.*, 2011); western Mediterranean, Estepona Basin (NHMW collection); central Mediterranean (Pavia, 1980; Pedriali, 1996; Forli *et al.*, 1999; Pedriali & Robba, 2008). Late Pliocene: central Mediterranean (Cavallo & Repetto, 1992; Pedriali & Robba, 2008; Sosso & dell'Angelo, 2010).

Subfamily Poliniceinae Finlay & Marwick, 1937 Genus *Euspira* Agassiz *in* Sowerby, 1837

Type species – *Natica glaucinoides* J. Sowerby, 1812 (*non* Deshayes, 1832), by subsequent designation (Bucquoy *et al.*, 1883). Eocene, Europe.

Euspira guillemini (Payraudeau, 1826)

Plate 12, fig. 4; Plate 62, fig. 5

- *1826 Natica guillemini Payraudeau, p. 119, pl. 5, figs 25, 26.
- 1997 *Euspira guillemini* (Payraudeau, 1826) Giannuzzi-Savelli *et al.*, p. 194, figs 786-788, p. 220, fig. 822.
- 2009 Euspira guillemini (Payraudeau, 1826) Pedriali & Robba, p. 392, pl. 1, figs 10, 11, pl. 3, fig. 7, pl. 4, figs 7-9.

Dimensions and material – Maximum height 8.6 mm. Localities 2 & 3: YI 253/1; locality 6: JvdV/10; locality 17: NHMW 1874/0058/1505/1, 1874/0058/1506/2, JvdV/3, RGM 783 573/5, RGM 794 514/1.

Discussion – Euspira guillemini (Payraudeau, 1826) is the smallest *Euspira* species present in the Karaman assemblages. Indeed, the Turkish Miocene specimens are considerably smaller that the mean height of just over 10 mm given by Pedriali & Robba (2009, p. 393). Apart from its small size, it is characterised by its rather elevated spire, broad and strongly depressed funicle, an umbilicus bearing a broad inner furrow and no internal spiral sculpture. The species is most easily recognised by its paucispiral protoconch consisting of about 1.5 smooth whorls with a large nucleus. The protoconch measurements of the Turkish shells (dp = $660 \ \mu m$, dp1 = $495 \ \mu m$, dn = $280 \ \mu m$; Pl. 62, fig. 5) are slightly smaller than those given by Pedriali & Robba (2009, p. 393; dp = $0.74-0.90 \ \mu m$, dn = $0.25-0.28 \ \mu m$).

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Pliocene (unspecified): central Mediterranean, Italy (Pedriali & Robba, 2009). Pleistocene (unspecified): central Mediterranean, Italy (Pedriali & Robba, 2009). Recent: northeastern Atlantic from Great Britain to Canary Islands, Mediterranean (Pedriali & Robba, 2009).

Euspira helicina helicina (Brocchi, 1814)

Plate 11, fig. 9; Plate 12, figs 1-3; Plate 62, figs 6, 7

- *1814 Nerita helicina nob., Brocchi, p. 297, pl. 1, fig. 10.
- 1856 Natica helicina Brocch. Hörnes, p. 525 (partim, pl. 47, fig. 7 only) [non fig. 6 = Euspira protracta (Eichwald, 1830)].
- 1880 Natica helicina Brocchi Fontannes, p. 115, pl. 7, fig. 11.
- 1890c Natica (Naticina) catena var. helicina (Brocch.) Sacco, p. 70, pl. 2, fig. 43.
- 1890c Natica (Naticina) catena var. subobturata Sacc., Sacco, p. 70.
- 1890c Natica (Naticina) catena var. ovatoconica Sacc., Sacco, p. 70.
- 1890c Natica (Naticina) catena var. pseudofuniculosa Sacc., Sacco, p. 74.
- 1890c Natica (Naticina) catena var. perconica Sacc., Sacco, p. 74.
- 1890c Natica (Naticina) catena var. elatiuscula Sacc., Sacco, p. 74.
- 1890c Natica (Naticina) catena var. depressiuscula Sacc., Sacco, p. 74.
- 1890c Natica (Naticina) catena var. lineofasciolata Sacc., Sacco, p. 75.
- 1890c Natica (Naticina) catena var. basibrunneata Sacc., Sacco, p. 75.
- 1890c Natica (Naticina) catena var. pseudorufa Sacc., Sacco, p. 75
- 1890c Natica (Naticina) catena var. pseudocinerea Sacc., Sacco, p. 75.
- 1903 Natica (Naticina) catena da Costa Dollfus et al.,
 p. 19, pl. 35, fig. 7 [non Euspira catena (da Costa, 1778)].
- 1904 Natica (Naticina) catena var. subobturata Sacc., Sacco, p. 103, pl. 22, figs 31, 32.
- 1904 Natica (Naticina) catena var. ovatoconica Sacc., Sacco, p. 103, pl. 22, fig. 34.
- 1904 Natica (Naticina) catena var. pseudofuniculosa Sacc., Sacco, p. 103, pl. 22, fig. 35.
- 1904 Natica (Naticina) catena var. perconica Sacc.,Sacco, p. 103, pl. 22, fig. 36.
- 1904 Natica (Naticina) catena var. elatiuscula Sacc.,

Sacco, p. 103, pl. 22, figs 37-39.

- 1904 Natica (Naticina) catena var. depressiuscula Sacc., Sacco, p. 103, pl. 22, fig. 40.
- 1904 Natica (Naticina) catena var. basibrunneata Sacc., Sacco, p. 103, pl. 22, fig. 41.
- 1904 Natica (Naticina) catena var. pseudocinerea Sacc., Sacco, p. 103, pl. 22, fig. 42.
- 1919 Natica (Lunatia) helicina (Brocchi) Cossmann & Peyrot, p. 432, no. 254, pl. 11, figs 39-41, pl. 12, figs 29, 54.
- 1925 *Lunatia helicina* Brocchi Cossmann, p. 132, pl. 1, figs 4, 5.
- 1952a Polinices (Lunatia) catena f. helicina Brocchi, 1814 – Glibert, p. 243, pl. 1, fig. 4.
- ?1952b Polinices (Lunatia) catena f. helicina Brocchi, 1814 – Glibert, p. 69, pl. 5, fig. 8.
- 1958 *Natica (Lunatia) catena* var. *helicina* (Brocchi) Erünal-Erentöz, p. 42, pl. 6, fig. 3.
- 1960 Polinices (Euspira) catena var. helicina (Brocchi, 1814) – Kojumdgieva & Strachimirov, p. 120, pl. 33, figs 10, 11.
- 1966 Natica (Lunatia) catena helicina Brocchi, 1814 Strausz, p. 228 (partim, pl. 48, figs 13-16, pl. 49, figs 6-8).
- 1967 Lunatia catena (da Costa, 1778) Palla, p. 962, pl.
 72, fig. 4 [non Euspira catena (da Costa, 1778)].
- 1967 *Lunatia catena* f. *helicina* (Brocchi) Pelosio, p. 125, pl. 37, figs 6, 7.
- 1969 Polinices (Euspira) helicinus helicinus (Brocchi, 1814) – A.W. Janssen, p. 163 (partim, pl. 4, figs 18-21, pl. 5, figs 1-3 only) [non pl. 4, fig. 17 = Euspira prietoi (Hidalgo, 1873)].
- 1969 *Lunatia catena helicina* (Brocchi) Mastrorilli, p. 118, pl. 6, figs 12, 13, 16.
- 1970 Polynices (Euspira) catena helicina (Brocchi) Bałuk, p. 118, pl. 13, fig. 17.
- 1974 *Euspira catena helicina* (Brocchi, 1814) Malatesta, p. 238, pl. 18, fig. 6.
- ?1975 Euspira helicina (Brocchi) Fekih, p. 60, pl. 22, fig. 3.
- 1976 *Lunatia catena helicina* (Brocchi) Caprotti, p. 9, pl. 12, fig. 4.
- 1985 Polinices (Euspira) helicina helicina (Brocchi, 1814) – Atanacković, p. 133, pl. 30, figs 6, 7.
- 1992 *Euspira catena* (da Costa, 1778) Cavallo & Repetto, p. 68, fig. 124 (*lapsus*; texts and figures of 124 and 126 have been reversed) [*non Euspira catena* (da Costa, 1778)].
- 1996 *Euspira catena* f. *helicina* (Brocchi, 1814) Pedriali, p. 10, pl. 3, figs 6, 7.
- 1997 Polinices catena (da Costa, 1778) Lacroce, p. 28, pl. 2, fig. 8 [non Euspira catena (da Costa, 1778)].
- 1997 Polinices fusca (Blainville, 1825) Lacroce, p. 28, pl. 2, fig. 9 [non Euspira fusca (Blainville, 1825)].
- 1997 Naticarius tigrinus (Defrance) Ruiz Muñoz, p. 172 (partim, pl. 33, fig. 10 only) (non Defrance, 1825).
- 2001 Euspira helicina (Brocchi, 1814) Silva, p. 259,

pl. 11, figs 1, 2.

- 2003 Polinices (Polinices) redemptus (Michelotti 1847)
 İslamoğlu & Taner, p. 51, pl. 4, fig. 1 [non Polinices redemptus (Michelotti, 1847)].
- 2004 Euspira fusca (Blainville, 1825) Repetto & Lacroce, p. 198, pl. 1, fig. 3 [non Euspira fusca (Blainville, 1825)].
- 2008 *Euspira catena* (da Costa, 1778) Chirli p. 52 (*partim*, pl. 18, figs 1-3, 4, 6, 7 only) [*non Euspira catena* (da Costa, 1778)].
- 2009 Euspira helicina helicina (Brocchi, 1814) Pedriali & Robba, p. 393, pl. 1, figs 12, 13, 16-18, pl. 3, fig. 8, pl. 4, fig. 10.
- 2010 Euspira helicina helicina (Brocchi, 1814) Sosso & dell'Angelo, p. 26, unnumbered figure p. 35 bottom left.
- 2011 Euspira helicina helicina (Brocchi, 1814) Landau et al., p. 16, pl. 6, fig. 2.
- non 1907 Natica helicina Broc. Ravn, p. 294, pl. 3, fig. 11 [? = Euspira mioaperta (Kautsky, 1925)].
- non 1921 Natica (Lunatia) helicina (Brocchi) Sacco Harmer, p. 683 (partim, pl. 54, fig. 5 only) [= Euspira hemiclausa (J. de C. Sowerby, 1824)].
- non 1946 Polinices (Euspira) helicinus (Brocchi, 1814) Beets, p. 61, pl. 3, figs 17, 18 [?= Euspira mioaperta (Kautsky, 1925)].
- non 1955 Polynices (Lunatia) helicina (Brocchi) 1814 Rossi Ronchetti, p. 161, fig. 82 [= Tectonatica prietoi (Hidalgo, 1873)].
- non 1972a Lunatia helicina helicina (Brocchi, 1814) Nordsieck, p. 69, pl. 16, fig. 78 [?= Euspira mioaperta (Kautsky, 1925)].
- non 1978 Nerita helicina Brocchi, 1814 Pinna & Spezia, p. 156, pl. 42, fig. 3 [= Tectonatica prietoi (Hidalgo, 1873)].
- non 2001 Euspira agg. helicina (Brocchi, 1814) Wienrich, p. 425, pl. 68, fig. 9, pl. 85, figs 5-8, pl. 86, figs 1, 2 [? = Euspira mioaperta (Kautsky, 1925)].

Dimensions and material – Maximum height 32.0 mm. Localities 2 & 3: JvdV/1; locality 7 & 8: JvdV/1, RGM 776 858/1 (ex JvdV collection), RGM 776 859/1 (ex JvdV collection); locality 13: JvdV/2, NHMW 1874/0058/1365/1, 1874/0058/1367/1, 1874/0058/1366/1, 1874/0058/1368/1, 1874/0058/1369/1, 1874/0058/1370/3; YI 254/1; locality 17: NHMW 1874/0058/1370/1.

Discussion – In their excellent review of the Italian Pliocene Poliniceinae Pedriali & Robba (2009) characterised *Euspira helicina* (Brocchi, 1814) and distinguished it from *Euspira catena* (da Costa, 1778), with which it has often been confused, or considered a subspecies of. Rossi Ronchetti (1955, fig. 82) and A.W. Janssen (1969, pl. 4, fig. 17) illustrated a specimen as the 'holotype'. However, Brocchi (1814) did not designate the holotype and the specimen illustrated represents quite a different species, *Tectonatica prietoi* (Hidalgo, 1873) (Pedriali & Robba, 2009, p. 398). The main difference between the two species lies in the structures within the umbilicus. *Euspira helicina helicina* has a subobsolete funicle, a moderately deep to deep inner furrow of variable width and no inner spiral sculpture. *Euspira catena* has no funicle at all and no inner furrow, but has spiral sculpture within the umbilicus (Pedriali & Robba, 2009, p. 383, table 1). They also differ in the size of their protoconchs. *Euspira helicina helicina* has a protoconch consisting of 2.5-2.75 whorls, whereas *E. catena* has a smaller protoconch consisting of 1.75-2.0 whorls.

According to Pedriali & Robba (2009), *E. helicina helicina* disappeared at the end of the Pleistocene to be replaced by the chronosubspecies *E. helicina fusca* (Blainville, 1825), which has the same protoconch and shell morphometrics, but differs in being larger, in having a wider umbilicus with a broader and shallower spiral furrow and spiral sculpture within the umbilicus.

The shells here ascribed to *E. helicina helicina* are rather large compared to the dimensions given by Pedriali & Robba (2009, p. 398) for the Italian Pliocene specimens. The inner furrow is also rather shallow making them somewhat closer to *E. helicina fusca*, but they have no spiral sculpture within the umbilicus. The protoconch consists of 2.5 whorls, the nucleus bears interrupted spiral threads on the abapical half, after which the whorls are smooth (dp = 930 μ m, dp1 = 240 μ m, dn = 100 μ m; Pl. 62, fig. 6a). The protoconch measurements are within the range given by Pedriali & Robba for the Italian Pliocene shells (2009, p. 398). *Euspira helicina helicina* seems to be uncommon in the Turkish assemblages.

The status of Euspira protracta (Eichwald, 1830) is very confusing. This species was described by Eichwald (1830) from the Badenian (middle Miocene) of the Polish-Carpathian foredeep. Later authors, such as Hörnes (1856) and Strausz (1966), considered this taxon to be a synonym of Euspira helicina (Brocchi, 1814). Anderson (1960) and A.W. Janssen (1969) resurrected the name for shells from the Miocene of the North Sea Basin, and discussed differences between their shells and typical Euspira helicina. This was also accepted by Pedriali & Robba (2009), who reported differences in protoconch size (smaller protoconch with half a whorl less) for this North Sea species. Thus, all these authors studied Miocene shells from the North Sea Basin but never those from the Paratethys. However, it is not at all clear that the North Sea Basin species is conspecific with the Paratethyan E. protracta, and the North Sea Basin species might better be treated as Euspira mioaperta (Kautsky, 1925). Bałuk (1995) was the first to redefine the use of Euspira protracta as a full species but again uncritically listed the reference by A.W. Janssen (1969) in his synonymy. Typical Paratethyan specimens of E. protracta differ from E. helicina quite clearly in their elongate shells and somewhat gradate spire.

Euspira helicina is also present in the middle Miocene of the Paratethys, but a reliable evaluation of the many records in the literature is difficult without a deep revision. Therefore, we have listed only a few selected references.

Distribution – Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Pedriali &

Robba, 2009); Proto-Mediterranean (Burdigalian): Colli Torinesi, Italy (Sacco, 1890c, 1904), (late Burdigalian): Antalya Basin, Turkey (İslamoğlu & Taner, 2003). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): ?Belgium (Glibert, 1952b), Germany (A.W. Janssen, 1969). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1919), (Langhian): Loire Basin, France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856), Bosnia (Atanacković, 1985), Bulgaria (Kojumdgieva & Strachimirov, 1960), Poland (Bałuk, 1970); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Dollfus et al., 1903); Proto-Mediterranean (Tortonian): Po Basin, Italy (Sacco, 1890c, 1904; Pedriali & Robba, 2009). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); eastern Mediterranean, Estepona Basin, Spain (NHMW collection); western Mediterranean, Estepona Basin, Spain (BL collection), Roussillon Basin, France (Fontannes, 1880); central Mediterranean, Italy (Pelosio, 1967; Chirli, 2008), ?Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1890c, 1904; Palla, 1967; Mastrorilli, 1969; Malatesta, 1974; Caprotti, 1976; Cavallo & Repetto, 1992; Pedriali, 1996; Lacroce, 1997; Repetto & Lacroce, 2004; Pedriali & Robba, 2009; Sasso & dell'Angelo, 2010).

Genus Polinices de Montfort, 1810

Type species – Polinices albus de Montfort, 1810 (= *Nerita mammilla* Linnaeus, 1758), by original designation. Recent, Indo-Pacific.

Polinices redemptus (Michelotti, 1847)

Plate 11, fig. 7; Plate 79, fig. 7

- *1847 Natica redempta mihi, Michelotti, p. 157, pl. 6, figs 6, 6¹.
- 1856 Natica redempta Micht. Hörnes, p. 522, pl. 47, fig. 3.
- 1890c Polinices proredempta Sacc., Sacco, p. 93, pl. 2, fig. 71.
- 1890c Polinices proredempta var. subnaticoides Sacc., Sacco, p. 94, pl. 2, fig. 72.
- 1890c Polinices proredempta var. tauromamilla Sacc., Sacco, p. 94, pl. 2, fig. 73.
- 1890c Polinices redempta (Micht.) Sacco, p. 95, pl. 2, fig. 74.
- 1890c Polinices redempta var. dertoconvexa Sacc., Sacco, p. 96, pl. 2, fig. 75.
- 1890c Polinices redemptoaurantia Sacc., Sacco, p. 96, pl. 2, fig. 76.
- 1903 Natica (Pollinices) [sic] redempta Michelotti Dollfus et al., p. 18, pl. 35, fig. 1.
- 1904 *Polinices redempta* (Micht.) Sacco, p. 105, pl. 23, fig. 7.

- 1919 Natica (Polinices) proredempta Sacco Cossmann & Peyrot, no. 250, pl. 12, figs 23-26.
- 1923 Natica (Poliniceps) redempta Micht. var. Friedberg, p. 433, pl. 26, figs 6, 7.
- 1923 Natica (Poliniceps) Staszici Friedberg, p. 435, pl. 26, figs 8, 9.
- 1925 Natica (Polynices) proredempta Sacco Cossmann, p. 126, pl. 2, figs 17, 18.
- 1942 Polinices (Polinices) redemptus (Michelotti) Wenz, p. 209, pl. 1, fig. 3.
- 1952a *Polynices (Polynices) redempta* Michelotti, sp. 1847 Glibert, p. 252, pl. 2, fig. 5.
- 1954a Natica (Polynices) redempta Micht. Friedberg, p. 435, pl. 26, figs 6, 7.
- 1958 Natica (Polynices) redempta var. dertoconvexa Sacco – Erünal-Erentöz, p. 41, pl. 6, fig. 2.
- 1960 Polinices (Polinices) redempta var. dertoconvexa Sacco 1890 – Kojumdgieva & Strachimirov, p. 120, pl. 33, fig. 6.
- 1962 Natica (Polynices) redempta Michelotti Strausz,
 p. 115 (partim, pl. 47, figs 29, 30 only) ?31, 32 (non figs 19-28).
- 1962 Natica (Polynices) redempta staczici Friedberg, 1928 – Strausz, p. 115, pl. 47, figs 33-35, pl. 48, figs 1-4.
- 1963 Polinices (Polinices) redemptus (Micht.) Venzo & Pelosio, p. 58, pl. 34, figs 39-42.
- 1966 Natica (Polynices) redempta Michelotti, 1847 Strausz, p. 231 (partim, pl. 47, figs 29, 30 only) ?31, 32 (non figs 19-28).
- 1966 Natica (Polynices) redempta staczici Friedberg,
 1928 Strausz, p. 232, pl. 47, figs 33-35, pl. 48,
 figs 1-4.
- 1973 Polinices (Polinices) redemptus (Michelotti) Marasti, p. 87, pl. 20, figs 6, 7.
- 1984 *Polinices proredempta* Sacco, 1890 Ferrero Mortara *et al.*, p. 37, pl. 4, fig. 1.
- 1984 *Polinices* (*Polinices*) *redemptus* (Michelotti, 1847) Ruggieri & Davoli, p. 55, pl. 1, fig. 19.
- 1990 *Polinices (Polinices) redemptus* (Michelotti, 1847) Davoli, p. 58, pl. 5, fig. 10.
- 1995 Polinices redemptus Risso, 1826 Bałuk, p. 198, pl. 15, figs 7, 8.
- 1998 Polinices proredemptus Sacco Schultz, p. 58, pl. 22, fig. 9.
- 2002 *Polinices redemptus* (Michelotti, 1847) Harzhauser, p. 88, pl. 5, figs 5, 6.
- 2011 Polinices redemptus (Michelotti, 1847) Landau et al., p 16, pl. 6, fig. 5.
- 2011 *Euspira redempta* (Michelotti, 1847) Caprotti, p. 52, figs 2M-P.
- non 1966 Natica (Polinyces) redempta Michelotti, 1847 – Strausz, p. 231 (partim, pl. 47, figs 19-28 only) ?31-32 [= Polinices pseudoredemptus (Friedberg, 1923)].

Dimensions and material – Maximum height 47.7 mm. Localities 2 & 3: YI 238/1; localities 7 & 8: NHMW 1874/0058/1357/4, JvdV/21; locality 9: RGM 783 819/1; locality 11: JvdV/4; locality 12: JvdV/4; locality 13: NHMW 1874/0058/1357/3, JvdV/1; locality 17: NHMW 1874/0058/1356/1, 1874/0058/1357/19, JvdV/50+, RGM 777 869/1 (ex JvdV collection), RGM 783 734/44, MTA 2013/021/10, YI 239/50+; locality 18: JvdV/2. Exact locality unknown: AÜ LE-K-213/1.

Discussion - Whilst Polinices species are characterised by their strong umbilical callus, only some species have the umbilicus completely filled by it. The taxonomy of this European Miocene group of species of Polinices de Montfort, 1810 with callus completely filling the umbilicus has been controversial. Polinices redemptus (Michelotti, 1847) was based on late Miocene Tortonian material from Montegibbio, Italy. Sacco (1890c) separated the middle Miocene Tethyan and Paratethyan shells from the Tortonian species under the name Polinices proredemptus, which was said to differ from P. redemptus in having a more globular shell and the columellar callus less strongly developed, not always completely filling the umbilicus. He noted the absence of any colour pattern. Cossmann & Peyrot (1919, p. 426) followed this opinion, adding that P. proredemptus also differed from P. redemptus in having a more oblique outer lip and a more strongly abaxially slanting columella. Cossmann & Peyrot (1919) examined specimens from other European Tortonian deposits (Portugal, Paratethys) and concluded that all these late Miocene forms were conspecific with specimens from Montegibbio.

Friedberg (1923, p. 433) recognised a further species in the middle Miocene Paratethys, *Polinices staszici*, differing from *P. redemptus* in having a callus that only partially fills the umbilicus.

Glibert (1952a, p. 252) and Bałuk (1995, p. 198) took a contrary view and recognised a single species, *P. re-demptus*, which is very variable not only in size, but in general shape and height of spire.

Unfortunately few of the specimens examined have well preserved protoconchs and the transition between the protoconch and teleoconch is unclear in all specimens, making it difficult to count the number of protoconch whorls. Nevertheless, we have a topotype of Polinices redemptus with a well-preserved protoconch. The protoconch consists of 2.5-3 whorls, with a medium-sized nucleus, diameter 200 μ m. We have specimens from the middle Miocene of Moulin Débat, Salles, France and the late Miocene of Cacela, Algarve, Portugal (NHMW collection). Both have a protoconch of about 2.5 whorls and a medium-sized nucleus, diameter about 180 μ m. In view of the similarity in dimensions, we follow Glibert and Bałuk and consider European Tortonian specimens to be a single variable species. Bałuk (1995, p. 198) noted the variability in the colour pattern, which consists of medium-sized dots or spots dark on a light background or vice versa. Our specimens from Karaman show a similar colour pattern of close-set dots of variable size (Pl. 79, fig. 7).

We also recognise a second species of *Polinices* with the callus completely filling the umbilicus, occurring in the middle Miocene Paratethys, *P. pseudoredemptus* (Fried-

berg, 1923). This species is smaller than P. redemptus, with a much more elevated spire and most specimens have a strongly developed callus pad completely filling the umbilicus. As in P. redemptus, there is some degree of variability in the shape and development of the callus. We have examined a specimen from Várparlota, Hungary with a well-preserved protoconch (NHMW collection). It consists of 2.5 whorls, diameter 780 μ m, with a small nucleus, diameter 90 μ m. The junction with the teleoconch is sharply delimited. Bałuk (1995, p. 198) suggested P. pseudoredemptus was a brackish-water species. In his original description Friedberg (1923, p. 434) compared his species to P. miocolligens (Sacco, 1890) from the middle Miocene of Italy. The latter is of similar size, but the spire is less elevated. The holotype, illustrated by A.W. Janssen (1969, pl. 4, fig. 1) and Ferrero Mortara et al. (1984, pl. 4, fig. 4), is quite similar to small specimens of P. redemptus and this name is possibly a synonym. The Miocene North Sea Basin specimens ascribed to P. miocolligens by A.W. Janssen (1969, 1984a) are strongly dorso-ventrally compressed and have a pad of columella callus, which does not fill the umbilicus. We have specimens from Winterswijk, Miste with well-preserved protoconchs (NHMW collection), consisting of three depressed whorls, diameter 1000 μ m, with a very small nucleus, diameter 65 μ m. Although we have not seen the protoconch of the Italian specimens, we very much doubt that the North Sea Basin shells are conspecific.

Polinices redemptus is a typically Miocene species, which survived into the early Pliocene only along the Atlantic and Mediterranean coasts of southern Iberia (Landau *et al.*, 2011), without penetrating further into the Mediterranean. The Pliocene specimens from the Guadalquivir and Estepona basins have a colour pattern of scales rather than spots, each outlined in orange, similar to that figured by Sacco (1890c, pl. 2, fig. 74, 76; 1904, pl. 23, fig. 7).

Caprotti (2011, p. 54) placed *P. redemptus* in the genus *Euspira* Agassiz *in* J. Sowerby, 1837, and quoted Pedriali & Robba (2009) as having synonymised *Polinices* with *Euspira*. Pedriali & Robba (2009, p. 388) did no such thing, and clearly listed the shell characters of each of these genera.

Distribution - Early Miocene: Paratethys (Burdigalian): Austria, (Harzhauser, 2002); Proto-Mediterranean (Burdigalian): Colli Torinesi (Sacco, 1890c; Ruggieri & Davoli, 1984; Davoli, 1990). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1919; Glibert, 1963), (Langhian): Loire Basin, France (Glibert, 1952a, 1963); Paratethys (Langhian-Serravallian): Poland (Friedberg 1923; Bałuk, 1995), Vienna Basin, Austria (Hörnes, 1856; Schultz, 1998), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1962, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Dollfus et al., 1903), southern Spain (Wenz, 1942); Tethys (Tortonian and Messinian): Po Basin, Italy (Sacco, 1890c; Venzo & Pelosio, 1963; Marasti, 1973; Davoli, 1990; Caprotti, 2011). Early Plio**cene**: northeastern Atlantic, Guadalquivir Basin, Spain (Landau *et al.*, 2011); western Mediterranean, Estepona Basin (NHMW collection).

Genus Neverita Risso, 1826

Type species – Neverita josephinia Risso, 1826, by mono-typy. Recent, Mediterranean.

Neverita olla (de Serres, 1829)

Plate 11, fig. 8; Plate 62, fig. 8

- *1829 Natica olla Nobis, de Serres, p. 102, pl. 1, figs 1, 2.
 1845 Natica glaucinoides var. A semiglobosa Grateloup, pl. 5, figs 9, 10.
- 1845 Natica glaucinoides var. B depressa Grateloup, pl. 5, figs 11, 12.
- 1847 Natica olla Serres Michelotti, p. 156, pl. 6, figs 1, 2.
- 1856 Natica Josephinia Risso Hörnes, p. 523, pl. 47, figs 4, 5 [non Neverita josephinia (Risso, 1826)].
- 1879 Natica Josephinia Risso Fontannes, p. 117, pl. 7, fig. 12 [non Neverita josephinia (Risso, 1826)].
- 1890c Natica (Neverita) josephinia Risso Sacco, p. 83, pl. 2, fig. 54 [non Neverita josephinia (Risso, 1826)].
- ?1890c Natica (Neverita) josephinia var. antiqua Sacc., Sacco, p. 85, pl. 2, fig. 55.
- ?1890c Natica (Neverita) josephinia var. priscodepressa Sacc., Sacco, p. 86, pl. 2, fig. 56.
- 1890c Natica (Neverita) josephinia var. clausodepressa Sacc., Sacco, p. 87, pl. 2, fig. 57.
- 1890c Natica (Neverita) josephinia var. clausoelata Sacc., Sacco, p. 87, pl. 2, fig. 58.
- 1890c Natica (Neverita) josephinia var. poliniceoides Sacc., Sacco, p. 87, pl. 2, fig. 59.
- 1890c Natica (Neverita) josephinia var. pliospiralata Sacc., Sacco, p. 88, pl. 2, fig. 60.
- 1903 Natica (Neverita) josephinia Risso Dollfus et al., p. 18, pl. 35, fig. 2 [non Neverita josephinia (Risso, 1826)].
- 1903 Natica (Neverita) josephinia var. pliospiralata Sacco – Dollfus et al., p. 18, pl. 35, fig. 3.
- 1904 Neverita josephina var. rotundiformis Sacc., Sacco, p. 103, pl. 23, fig. 1.
- 1904 Neverita josephina var. planorbiformis Sacc., Sacco, p. 103, pl. 23, fig. 2.
- 1904 Neverita josephina var. subfasciolata Sacc., Sacco, p. 103, pl. 23, fig. 3.
- 1904 Neverita josephina var. subdetecta Sacc., Sacco, p. 103, pl. 23, fig. 4.
- 1904 Neverita josephina var. subplioglaucina Sacc., Sacco, p. 103, pl. 23, fig. 5.
- 1907 Natica Josephinia Risso Ravn, 291, pl. 3, fig. 7 [non Neverita josephinia (Risso, 1826)].
- 1912 Natica Josephinia var. Manhartensis Schaffer, p. 166, pl. 54, figs 15, 16.
- 1919 Natica (Neverita) olla M. de Ser. Cossmann & Peyrot, no. 248, pl. 12, figs 5-7.

- 1919 *Natica (Neverita) pliospiralata* Sacco Cossmann & Peyrot, p. 421, pl. 12, figs 19, 20.
- 1919 Natica (Neverita) subglaucinoides d'Orb. Cossmann & Peyrot, p. 421, pl. 11, figs 53, 54, pl. 12, figs 11-15.
- 1919 Natica (Neverita) subdetecta d'Orb Cossmann & Peyrot, p. 423, pl. 12, fig. 36.
- 1923 Natica (Neverita) Josephina Risso Friedberg, p. 424, pl. 26, fig. 1 [non Neverita josephinia (Risso, 1826)].
- 1925 Natica (Neverita) olla M. de Serres Cossmann, p. 116, pl. 1, figs 25, 26.
- 1925 Natica (Neverita) josephinia Risso Kautsky, p. 71, pl. 6, fig. 23 [non Neverita josephinia (Risso, 1826)].
- 1938 Natica (Neverita) Josephinia v. clausodepressa Sacco – Stchepinsky, p. 55, pl. 6, fig. 8.
- 1942 Neverita olla (Serres) Wenz, p. 209, pl. 1, fig. 4.
- 1952a Polynices (Neverita) olla de Serres, sp. 1829 Glibert, p. 249, pl. 1, fig. 8.
- 1952b *Polynices (Neverita) olla* de Serres, sp. 1829 Glibert, p. 72, pl. 5, fig. 11.
- 1954 Polynices (Neverita) olla Serr. Strausz, p. 76, pl. 6, fig. 132.
- 1955 Natica (Neverita) josephinia Risso Miosescu, p. 134, pl. 11, figs 17, 19 [non Neverita josephinia (Risso, 1826)].
- 1958 Natica (Neverita) josephinia Risso Erünal-Erentöz, p. 43, pl. 6, figs 4-6 [non Neverita josephinia (Risso, 1826)].
- 1958 Natica (Neverita) Josephinia (Risso) Sorgenfrei,
 p. 194, pl. 39, fig. 126 [non Neverita josephinia (Risso, 1826)].
- 1958 Polinices josephinia Risso Hölzl, p. 207, pl. 18, fig. 18 [non Neverita josephinia (Risso, 1826)].
- 1960 *Polinices (Neverita) olla* (Serres 1829) Kojumdgieva & Strachimirov, p. 121, pl. 33, fig. 14.
- 1960b *Polinices (Neverita) olla* (M. de Serres 1829) Anderson, p. 81, pl. 1, fig. 3.
- 1962 Polinices olla de Serr. Hölzl, p. 152, pl. 9, fig. 3.
- 1962 Natica (Neverita) josephinia olla Serres Strausz, p. 232, pl. 49, figs 9-12.
- 1963 Neverita josephinia Risso, 1826 Papani & Pelosio, p. 15, pl. 2, fig. 6 [non Neverita josephinia (Risso, 1826)].
- 1963 Natica josephinia Risso Caretto, p. 21, pl. 1, fig.
 26 [non Neverita josephinia (Risso, 1826)].
- 1963 Polinices (Neverita) josephinius (Risso) Venzo & Pelosio, p. 85, pl. 34, figs 43-45 [non Neverita josephinia (Risso, 1826)].
- 1963 Neverita olla manhartensis Schff. Steininger, p. 49, pl. 10, fig. 10.
- 1963 Polinices olla De Serr. Báldi, p. 88, pl. 5, fig. 11.
- 1964 Polinices olla De Serr. Râileanu & Negulescu, p. 175, pl. 13, fig. 10.
- 1966 Natica (Neverita) josephinia olla Serres, 1829 Strausz, p. 232, pl. 49, figs 9-12.
- 1967 Neverita josephinia Risso, 1826 Palla, p. 961, pl.
 72, fig. 3 [non Neverita josephinia (Risso, 1826)].
- 1969 Polinices (Neverita) josephinia olla (Serres 1829)

-A.W. Janssen, p. 162, pl. 4, fig. 16.

- 1970 Neverita (Neverita) josephinia Risso Caprotti, p.
 162, pl. 5, fig. 5 [non Neverita josephinia (Risso, 1826)].
- 1973 *Polinices (Neverita) josephinia olla* (de Serres, 1829) Báldi, p. 274, pl. 33, figs 2-4.
- 1973 Polynices (Neverita) olla (Serres) 1829 Bohn-Havas, p. 1051, pl. 4, fig. 13.
- 1974 Neverita (Neverita) josephinia Risso Caprotti, p. 23, pl. 1, fig. 6 [non Neverita josephinia (Risso, 1826)].
- 1974 Neverita josephinia Risso, 1826 Malatesta, p. 241, pl. 18, fig. 9 [non Neverita josephinia (Risso, 1826)].
- 1975 Natica (Neverita) josephinia (Risso) Fekih, p. 61, pl. 22, fig. 4 [non Neverita josephinia (Risso, 1826)].
- 1975 *Natica (Neverita) pliospirata* Sacco Fekih, p. 61, pl. 22, fig. 8.
- 1979 Neverita josephina Risso, 1826 Martinell, p. 125, pl. 3, figs 7, 8 [non Neverita josephinia (Risso, 1826)].
- 1982 Neverita josephinia alla [sic] (M. Serres, 1829) –
 Švagrovský, p. 33, pl. 10, fig. 4.
- 1984a Neverita josephinia olla (des Serres, 1829) A.W. Janssen, p. 198, pl. 56, fig. 3.
- 1984a Neverita josephinia Risso Martinell & Domènech, p. 8, pl. 5, fig. 14 [non Neverita josephinia (Risso, 1826)].
- 1985 Neverita josephinia Risso Martinell & Domènech, pl. 1, figs 2, 3 [non Neverita josephinia (Risso, 1826)].
- 1985 *Polinices (Neverita) olla* (de Serres, 1829) Atanacković, p. 132, pl. 30, figs 3-5.
- 1988 Neverita josephinia Risso, 1826 Chirli, p. 18, pl.
 5, fig. 1 [non Neverita josephinia (Risso, 1826)].
- 1988 Neverita josephinia Risso, 1826 González-Delgado, p. 132, pl. 4, figs 2-5 [non Neverita josephinia (Risso, 1826)].
- 1990 Neverita josephinia olla (des [sic] Serres, 1829) Moths, p. 20, pl. 5, fig. 6.
- 1990 Neverita josephinia Risso, 1826 Davoli, p. 60, pl. 2, fig. 15 [non Neverita josephinia (Risso, 1826)].
- 1992 Neverita josephinia Risso, 1826 Cavallo & Repetto, p. 70, fig. 129 [non Neverita josephinia (Risso, 1826)].
- 1995 Neverita josephinia Risso, 1826 Bałuk, p. 199, pl. 15, figs 4, 5 [non Neverita josephinia (Risso, 1826)].
- 1996 Neverita josephinia Risso, 1826 Pedriali, p. 14, pl. 4, fig. 1 [non Neverita josephinia (Risso, 1826)].
- 1996 Neverita josephinia f. clausodepressa (Sacco, 1891) Pedriali, p. 16, pl. 4, fig. 2.
- 1997 Neverita josephinia Risso, 1826 Lacroce, p. 31, pl. 2, figs 13, 14 (not seen).
- 1998 Polinices (Neverita) olla (Serres) Schultz, p. 58, pl. 22, fig. 10.
- 1998 Neverita olla (de Serres, 1829) Solsona, p. 286,
pl. 18, figs 2, 4, 6, pl. 21, figs 1-3.

- 2001 Neverita olla (de Serres, 1829) Silva, p. 266, pl.
 11, figs 3, 4.
- 2001a Neverita semiglobosa (Grateloup, 1845) Lozouet et al., p. 44, pl. 18, fig. 8.
- 2001 Neverita josephinia olla (Serres, 1829) Wienrich, p. 429, pl. 69, fig. 3, pl. 87, fig. 1.
- 2002 *Neverita josephinia* (Risso, 1826) Harzhauser, p. 88, pl. 5, figs 12, 13.
- 2008 Neverita josephinia Risso, 1826 Chirli & Richard, p. 28, pl. 4, fig. 6 [non Neverita josephinia (Risso, 1826)].
- 2008 Neverita josephinia Risso, 1826 Chirli, p. 57, pl. 19, figs 6-19 [non Neverita josephinia (Risso, 1826)].
- 2009 Neverita olla (de Serres, 1829) Pedriali & Robba, p. 404, pl. 2, figs 5-9, pl. 3, figs 14, 15, pl. 4, fig. 17.
- 2009 Neverita josephinia (Risso, 1826) Mikuž, p. 18, pl. 4, figs 54, 55 [non Neverita josephinia (Risso, 1826)].
- 2010 Neverita olla (de Serres, 1829) Sosso & dell'Angelo, p 26, unnumbered figure. top left p. 36.
- 2010 Neverita josephinia olla (de Serres, 1829) Moths et al., p. 38, pl. 11, fig. 10.
- 2011 Neverita olla (de Serres, 1829) Landau et al., p 16, pl. 6, fig. 6.
- 2011 Neverita olla (de Serres, 1829) Caprotti, p. 52, figs 2C-F.

Dimensions and material – Maximum height 22.5 mm. Localities 2 & 3: JvdV/6; localities 7 & 8: JvdV/7; locality 11: JvdV/1, YI 236/2 + 1 juvenile; locality 10: YI 237/1; locality 17: NHMW 1874/0058/1360/1, 1874/0058/1361/42, JvdV/31, RGM 783 735/5, 794 515/1, MTA 2013/022/11, YI 235/36; locality 18: JvdV/8.

Discussion – Most previous authors have separated the Miocene to Pliocene shells, using the name *Neverita olla* (de Serres, 1826), from the Recent *N. josephinia* Risso, 1826 on the basis of teleoconch characters. Glibert (1952a) performed a morphometric analysis using the height and diameter of the shell and height and width of the aperture. He concluded they were two distinct species, although he later demoted *N. olla* to a subspecies of the living form (Glibert, 1963). Other authors have recognised a single species ranging from late Eocene to Recent, *N. josephinia* (Sacco, 1890c; Malatesta, 1974).

The protoconch characters, however, clearly distinguish two species. The protoconch of the Recent species *Neverita josephinia* is paucispiral, with 1.5 whorls and a large nucleus (dn = 300 μ m), whereas that of the Miocene-Pliocene species *N. olla* is multispiral, with 2.75 whorls and a very small nucleus (dn = 90 μ m; Solsona, 1998; Silva, 2001; Pedriali & Robba, 2009). Turkish shells have a protoconch of 2.6 whorls (dp = 655 μ m, dp1 = 190 μ m, dn = 80 μ m; Pl. 62, fig. 8), very similar in size to that reported by Pedriali & Robba (2009, p. 410). This conclusively separates the Miocene to Pliocene species *N. olla* from *N*. josephinia. Although they could be considered chronosubspecies, as recognised recently by Moths et al. (2010), shells with different protoconch morphology are usually considered distinct at full species level. This difference in protoconch morphology suggests that the Recent species has a lecithotrophic larval stage, whilst the Miocene/ Pliocene species protoconch suggests a planktotrophic larval stage. Apart from the Turkish material, we have examined specimens from: the middle Miocene of Italy (NHMW collection); middle Miocene Alpes-Maritimes of France and Algarve, Portugal; early Pliocene of the Guadalquivir Basin, Mondego Basin, Estepona Basin and Italy. The two species can be separated in all this material on the basis of their protoconch characters. Material at hand with a well-preserved protoconch from the early Pleistocene, Calabrian of Torrente Arda, Piacenza, Italy (NHMW collection) corresponds with the modern species (1.5 whorls, diameter 560 μ m, with a large nucleus diameter 310 μ m; NHMW collection) suggesting that N. olla became extinct at the end of the Pliocene, to be replaced in the early Pleistocene Mediterranean by N. josephinia.

Neverita semiglobosa (Grateloup, 1845) (= N. subglaucinoides d'Orbigny, 1852, see Lozouet et al., 2001a, p. 45) from the Atlantic early Miocene, Aquitaine Basin of France is said to differ from N. olla in having a less depressed shell with a more sinuous outer lip, which is less oblique, and a more concave columella (Cossmann & Peyrot, 1919, p. 422). Specimens at hand from Le Peloua, Gironde, France (NHMW collection) have a protoconch comprising 2.6-2.7 whorls, diameter 780 μ m, with a small nucleus, diameter 90 μ m. These dimensions are similar to those of N. olla, with which these shells are probably conspecific. The same conclusion was reached by Pedriali & Robba (2009).

In the Karaman assemblages *N. olla* is found mainly in the sandy deposits, and specimens do not reach the large size attained by some of the Pliocene populations.

Distribution – ?Early Oligocene: Italy (Sacco, 1890c). Late Oligocene: Paratethys (Egerian): Hungary Paratethys (Aquitanian): Hungary (Báldi, 1973). Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1919; Lozouet et al., 2001a); Paratethys (Aquitanian): Hungary (Báldi, 1963, 1973), (Aquitanian and Burdigalian): Austria (Schaffer, 1912; Harzhauser, 2002); Proto-Mediterranean (Burdigalian): Colli Torinesi (Sacco, 1890c; 1904). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Germany (Kautsky, 1925; Anderson, 1960b; A.W. Janssen, 1969; Wienrich, 2001; Moths et al., 2010), Netherlands (A.W. Janssen, 1984a), Denmark (Ravn, 1907; Sorgenfrei, 1958). Middle Miocene: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France, (Cossmann & Peyrot, 1919), (Langhian): Loire Basin, France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Poland (Friedberg, 1923; Bałuk, 1995), Vienna Basin, Austria (Hörnes, 1856; Schultz, 1998), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hun-

gary (Strausz, 1954, 1962, 1966; Bohn-Havas, 1973), Romania (Moisescu, 1955), Slovenia (Mikuž, 2009), Bosnia (Atanackovič, 1985); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Dollfus et al., 1903), southern Spain (Wenz, 1942); Tethys (Tortonian and Messinian): Po Basin, Italy (Sacco, 1904; Venzo & Pelosio, 1963; Davoli, 1990; Caprotti, 2011), Tunisia (Stchepinsky, 1938). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González-Delgado, 1988; Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (NHMW collection), northeastern Spain (Martinell, 1979; Martinell & Domènech, 1984a, 1985; Solsona, 1998), Roussillon Basin, France (Fontannes, 1879; Chirli & Richard, 2008); central Mediterranean, Italy (Chirli, 2008), Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1890c, 1904; Papani & Pelosio, 1963; Caretto, 1963; Palla, 1967; Caprotti, 1970, 1974; Malatesta, 1974; Chirli, 1988; Cavallo & Repetto, 1992; Pedriali, 1996; Lacroce, 1997; Pedriali & Robba, 2009; Sasso & dell'Angelo, 2010).

Subfamily Sininae Woodring, 1928 Genus Sinum Röding, 1798

Type species – Helix haliotoidea Linnaeus, 1758, by subsequent designation (Dall, 1915). Recent, Indo-Pacific.

Sinum striatum (de Serres, 1829) Plate 12, fig. 5

- *1829 Sigaretus striatus Nobis, de Serres, p. 127, pl. 3, figs 13, 14.
- 1856 Sigaretus haliotoideus Linn. Hörnes, p. 513, pl. 46, fig. 27 [non Sinum haliotoideum (Linnaeus, 1758)].
- 1890c Sigaretus (Cryptostoma) striatum (de Serres) Sacco, p. 102, pl. 1, fig. 71.
- 1890c Sigaretus (Cryptostoma) striatum var. striolatissima Sacc., Sacco, p. 104, pl. 1, fig. 72.
- 1890c Sigaretus (Cryptostoma) striatum var. circumdepressa Sacc., Sacco, p. 104, pl. 1, fig. 73.
- 1890c Sigaretus (Cryptostoma) striatum var. perelliptica Sacc., Sacco, p. 104, pl. 1, fig. 74.
- 1903 Sigaretus striatus var. turonensis Récluz Dollfus et al., p. 17, pl. 34, fig. 19, pl. 36, fig. 22.
- 1904 Sigaretus (Cryptostoma) striatum var. pliodepressa Sacc., Sacco, p. 104, pl. 23, fig. 9.
- 1904 Sigaretus (Cryptostoma) striatum var. ornatissima Sacc., Sacco, p. 104, pl. 23, fig. 10.
- 1919 *Sigaretus striatus* M. de Serres Cossmann & Peyrot, p. 440, no. 257, pl. 12, figs 43, 44, 51.
- 1923 Sigaretus striatus de Serres Friedberg, p. 423, pl. 25, fig. 10.
- 1938 Sigaretus striatus v. circumdepressa Sacco Stchepinsky, p. 55, pl. 6, fig. 9.

- 1950 Sigaretus bifasciatus Récluz Nicklès, p. 82, fig.
 122.
- 1952a Sigaretus (Sigaretus) striatus M. de Serres, 1829 Glibert, p. 261, pl. 3, fig. 1.
- 1955 Sinum striatum de Serres Miosescu, p. 135, pl. 11, fig. 21.
- 1959 Sinum striatum M. de Serres Zbyszewski, p. 92, pl. 10, fig. 16.
- 1960 Sinum (Sinum) striatum (Serres 1829) Kojumdgieva & Strachimirov, p. 122, pl. 33, fig. 15.
- 1962 Sigaretus striatus Serres Strausz, p. 125, text-fig. 148.
- 1966 Sigaretus striatus Serres, 1829 Strausz, p. 233, text-fig. 111.
- 1970 Sinum (Sinum) striatum de Serres Caprotti, p. 163, pl. 5, fig. 6.
- 1973 Sinum (Sinum) striatum (M. de De Serres, 1829) Steininger, p. 413, pl. 4, fig. 13.
- 1974 Sinum (Sinum) haliotoideum (Linné, 1758) Malatesta, p. 242, pl. 19, fig. 2 ([non Sinum haliotoideum (Linnaeus, 1758)].
- 1975 Sigaretus striatus var. circumdepressa Sacco Fekih, p. 62, pl. 22, fig. 9.
- 1976 Sinum (Sinum) striatum De Serres Caprotti, p. 9, pl. 12, fig. 6.
- 1979 *Sinum (s.s.) striatum* (De Serres, 1829) Martinell, p. 130, pl. 3, figs 11, 12.
- 1988 Sinum (Sinum) haliotoideum (Linne, 1758) González-Delgado, p. 133, pl. 4, figs 9, 10 [non Sinum haliotoideum Linnaeus, 1758].
- 1988 Sinum (Sinum) haliotoideum (Linneo, 1758) Chirli, p. 18, pl. 5, fig. 2 [non Sinum haliotoideum Linnaeus, 1758].
- 1991 Sinum haliotoideum (Linnaeus, 1758) Poppe & Goto, p. 120, pl. 17, figs 21, 22 [non Sinum haliotoideum (Linnaeus, 1758)].
- 1992 *Sinum striatum* De Serres, 1829 Cavallo & Repetto, p. 70, fig. 130.
- 1995 Sinum striatum (De Serres, 1829) Bałuk, p. 200, pl. 15, fig. 1.
- 1996 *Sinum haliotoideum* (L., 1758) Pedriali, p. 16, pl. 4, fig. 7.
- 1997 Sinum bifasciatum (Récluz, 1851) Giannuzzi-Savelli et al., p. 202, fig. 831.
- 1997 Sinum (Sinum) haliotoideum (Linné, 1758) Lacroce, p. 32, pl. 2, figs 15, 16 [non Sinum haliotoideum (Linnaeus, 1758)].
- 1998 Sinum striatum (De Serres, 1829) Solsona, p.
 291, pl. 17, figs 5, 6, pl. 20, figs 11, 12.
- 1998 Sinum (Sinum) striatum (Serres) Schultz, p. 60, pl. 23, fig. 4.
- 2001 *Sinum striatum* (De Serres, 1829) Silva, p. 270, pl. 11, figs 5, 6, 16.
- 2009 *Sinum striatum* (De Serres, 1829) Pedriali & Robba, p. 413, pl. 2, figs 18-20, pl. 3, fig. 20, pl. 4, fig. 24.

Dimensions and material – Maximum diameter 28.6 mm. Locality 17: NHMW 1847/0058/1658/1, RGM 783 843/1 (incomplete).

Discussion – Sinum striatum (de Serres, 1829) is extremely rare in the Turkish assemblages, as it is represented by one complete and one incomplete specimen plus a few fragments. The name used for this well-known species varies between authors. For some the fossil *Sinum striatum* is conspecific with the Recent *S. haliotoideum* (Linnaeus, 1758) (Malatesta, 1974; Cavallo & Repetto, 1992), whilst others considered the diagnosis given by Linnaeus too ambiguous (Fontannes, 1879; Sacco, 1890). Kabat (1991) revised the Linnaean Naticidae and described and figured a lectotype for *S. haliotoideum*. According to Kabat, this is a tropical Indopacific species, different from the Atlantic and Mediterranean form, which has much finer spiral sculpture. He proposed *S. striatum* as the first available name for the European species.

Solsona (1998, p. 292) reported some variability in the number of protoconch whorls, between 2.25-3, with the last half whorl increasing in size rapidly, resulting in protoconchs with an extra half whorl and a greater diameter of up to 1.2 mm. We have observed this same variability within other populations examined (late Miocene, Tortonian of Cacela, Algarve, Portugal; early Pliocene of the Estepona Basin, Spain; early-late Pliocene, Piacenzian, Mondego Basin, Portugal, NHMW collection).

Sinum patulum (Grateloup, 1845) from the Atlantic early Miocene, Aquitaine Basin of France differs in being smaller, less depressed, with a more elevated spire. Juvenile specimens at hand from Le Peloua and Le Castaing, Gironde, France (NHMW collection) have a protoconch with a similar number of whorls, 2.25-2.5, of similar dimensions (diameter 870-1040 μ m, with a small nucleus, diameter 150 μ m). The specimens identified as Sinum aquense (Récluz) by Janssen (1984a, p. 200, pl. 56, fig. 4), from the middle Miocene North Sea Basin, may not be conspecific with the French Aguitanian shells. A juvenile specimen from Winterswijk, Miste (NHMW collection) in which the protoconch is not obscured by the succeeding teleoconch whorl has a protoconch of three whorls of greater dimensions (diameter 1550 μ m, with a small nucleus, diameter 160 μ m).

Distribution – Early Miocene: Paratethys (Burdigalian): Austria (Steininger, 1973). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1919), Loire Basin, France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Poland (Friedberg, 1923; Bałuk, 1995), Vienna Basin, Austria (Hörnes, 1856; Schultz, 1998), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1962, 1966), Romania (Moisescu, 1955); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela, Portugal (Dollfus, Cotter & Gomes, 1903); Proto-Mediterranean (Tortonian): Tunisia (Stchepinsky, 1938). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1988), Morocco (Lecointre, 1952); western Mediterranean, Estepona Basin (NHMW collection); northeastern Spain (Martinell, 1979; Solsona, 1998); France (Fontannes, 1879); central Mediterranean, Italy (Sacco, 1890c; Glibert 1963; Malatesta,

1974; Cavallo & Repetto, 1992), Tunisia (Fekih, 1975). **Early-late Pliocene**: northeastern Atlantic, Mondego Basin, Portugal (Zbyszewski, 1959; Silva, 2001); central Mediterranean, Italy (Sacco, 1890c; Caprotti, 1970, 1976; Chirli, 1988). **Pliocene** (indet.): central Mediterranean, Italy (Pedriali, 1996; Lacroce, 1997; Pedriali & Robba, 2009). **Recent**: southern part of the western Mediterranean, probably limited to the Alboran Sea, shallow sandy coasts (Poppe & Goto, 1991); coast of West Africa (Nicklès, 1950).

Superfamily Trivioidea Troschel, 1863 Family Triviidae Troschel, 1863 Subfamily Triviinae Troschel, 1863 Genus *Trivia* Broderip, 1837

Type species – Cypraea europaea Montagu, 1808 [= *Trivia monacha* (da Costa, 1778)], by subsequent designation (Gray, 1847). Recent, Europe.

Trivia antiquosphaera Sacco, 1894 Plate 12, fig. 6

- *1894a *Trivia europaea* var. *antiquosphaera* Sacc., Sacco, p. 47, pl. 3, fig. 28.
- 1932 *Trivia antiquosphaera* Sacco Schilder, p. 21.
- 1962 Trivia europaea Montagu Strausz, p. 157, pl. 76, figs 4, 5 [non Montagu, 1803 = T. monacha (da Costa, 1778)].
- 1966 *Trivia europaea* Montagu, 1808 Strausz, p. 237, pl. 76, figs 4, 5 [*non* Montagu, 1808 = *T. monacha* (da Costa, 1778)].
- 1984 *Trivia europaea* var. *antiquosphaera* Sacco, 1894 – Ferrero-Mortara *et al.*, p. 153, pl. 27, fig. 5.
- 1995 *Trivia (Trivia) antiquosphaera* (Sacco, 1894) Bałuk, p. 191, pl. 14, fig. 4.
- non 1952a Trivia antiquosphaera Sacco, 1894 Glibert, p. 265, pl. 3, fig. 6 [? = Niveria pseudavellana (Sacco, 1894)].

Dimensions and material – Height 4.8 mm. Locality 13: NHMW 1874/0058/1285/1.

Discussion – The shell from the Karaman Basin is identical to the one illustrated by Bałuk (1995, pl. 14, fig. 4) as *Trivia (Trivia) antiquosphaera* Sacco, 1894. *Trivia antiquosphaera* is a rather small species, and the Turkish specimen is somewhat different from those illustrated by Glibert (1952a, pl. 3, fig. 6) from the Atlantic Langhian of the Loire Basin, France, in being smaller, less globose, in having fewer, narrower and more widely spaced ribs on the dorsum, the ribs more irregular and many of them are interrupted, and in having the posterior end more produced, with the adapical extremity of the outer lip strongly overhanging the apex in ventral view. One of the specimens illustrated by Glibert (1952a, pl. 3, fig. 6c-d) has a weak median sulcus. Fehse (2002a), in a list of corrections to Bałuk's work, suggested this shell was conspecific with the Miocene North Sea Basin species Trivia zimmermanni Koch, 1862, described from Germany. Anderson (1960, p. 226) considered T. zimmermanni a nomen dubium, due to the very poor state of the type material, and suggested it was possibly the same as Trivia hamburgensis Schilder, 1929. Trivia hamburgensis was illustrated well by Schilder (1929, pl. 2, fig. 6) and Anderson (1960a, pl. 19, fig. 150) and has a slightly different shell from that found in Poland and the Karaman Basin, with a rounder outline, the posterior end hardly produced, and the ribs more regular and almost all continuous over the dorsum. In the same paper Schilder (1929, pl. 2, fig. 7) described a further German Miocene species from Dingden, Trivia westphalica, which is much more similar in shape and sculpture to the Karaman specimens. Anderson (1960a) considered T. hamburgensis to be a subspecies of T. westphalica. A.W. Janssen (1969) considered T. westfalica [sic] and T. hamburgensis to be distinct species. Schilder & Schilder (1971) considered both of these taxa to be subspecies of T. zimmermanni. We have not seen any of these German specimens.

The correction made by Fehse is perplexing, as both Bałuk's shell and our Turkish specimen fit well with the redescription offered by Schilder (1932, p. 21) and the type of *T. zimmermanni* is an internal mould. Moreover, there is a specimen in the NHMW collection from Borsodbotá, Hungary, which was identified by Dirk Fehse as *T. antiquosphaera*, and two further shells from the early Miocene, Aquitanian of St. Martin d'Oney, Aquitain Basin of France, also identified as this species by Dirk Fehse. These two lots are identical to our Turkish shell. We therefore identify all these shells as *T. antiquosphaera*. If the North Sea Basin shells are eventually concluded to be conspecific, and Koch's (1862) *T. zimmermanni* is considered to be a *nomen dubium*, Sacco's name has priority.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian): Aquitaine Basin, France (NHMW collection); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1894a). Middle Miocene: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1995), Hungary (Strausz, 1962, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Niveria Jousseaume, 1884

Synonym: *Sulcotrivia* Schilder, 1933a (see Fehse & Landau 2003b, p. 95).

Type species – Cypraea nivea Gray, 1825 [= *Niveria nix* (Schilder, 1922)], by original designation. Recent, Caribbean.

Niveria dautzenbergi (Schilder, 1932)

Plate 12, fig. 7

1924 *Trivia Michelottii* Dollfus et Dautzenberg – Cossmann & Peyrot, p. 387, no. 691, pl. 11, figs 17, 18.

- *1932 Trivia dautzenbergi Schilder, p. 23 [nom. nov. pro Trivia michelottii Dollfus & Dautzenberg, 1886 in Cossmann & Peyrot, 1924 (partim); non Trivia Michelottii Dollfus & Dautzenberg 1886 (= Cypraea grayi Michelotti, 1847)].
 - 1952a Trivia dautzenbergi Schilder, 1932 Glibert, p. 271, pl. 3, fig. 10.

Dimensions and material – Height 7.0 mm. Locality 13: NHMW 1874/0058/1286/1.

Discussion – *Niveria dautzenbergi* (Schilder, 1932) is characterised by having a relatively wide dorsal sulcus bisecting the dorsal ribs, and a marked thickening of the terminations of the ribs, which develop on either side of the dorsal sulcus (see Glibert, 1952a, pl. 3, fig. 10c). There could be a case for placing this shell in the genus *Pusula* Jousseaume, 1884, which is characterised by a wide dorsal sulcus and thickenings of the ribs at either side of the sulcus, but in *N. dautzenbergi* the sulcus, although relatively wide, is not as broad and well developed as in most *Pusula* species.

The single shell from Turkey is smaller and somewhat more spherical than the specimen illustrated by Glibert (1952a) from the middle Miocene Langhian Loire Basin, France. However, we have numerous specimens of *N. dautzenbergi* from the Messinian 'Redonian' of the Loire Basin, and within this lot are smaller shells of comparable size and shape.

Remnants of colour pattern are present in the Turkish shell along the centre of the dorsum, consisting of small spots at either extremity and a larger spot at either side of the dorsal sulcus mid-dorsum. A similar colour pattern is seen in the Recent Caribbean species *Pusula pediculus* (Linnaeus, 1758).

Distribution – Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1923), (Langhian): Loire Basin, France (Glibert, 1952a); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (NHMW collection).

Niveria dimidiatoaffinis (Sacco, 1894)

Plate 12, fig. 8

- 1837 *Cypraea affinis* Dujardin, p. 304, pl. 19, fig. 12 (*non* Gmelin, 1791).
- 1852 *Cypraea affinis* Duj. Hörnes, p. 72, pl. 8, fig. 14 (*non* Gmelin, 1791).
- *1894a Trivia affinis var. dimidiatoaffinis Sacc., Sacco, p. 51.
- 1912 *Trivia affinis* Duj. Friedberg, p. 149, pl. 8, fig. 9 (*non* Gmelin, 1791).
- 1924 Trivia affinis Dujardin Cossmann & Peyrot, p. 385, no. 689, pl. 10, figs 10, 43-45 (non Gmelin, 1791).
- 1938 Trivia affinis Dujardin Peyrot, p. 171, pl. 4, figs

1, 10, 71, 73, 75 (non Gmelin, 1791).

- 1952a Trivia dimidiatoaffinis Sacco Glibert, p. 271, pl. 3, fig. 9.
- 1954 *Trivia affinis* Duj. Csepreghy-Meznerics, p. 32, pl. 3, figs 30, 31(*non* Gmelin, 1791).
- 1956 *Trivia affinis* Duj. Csepreghy-Meznerics, p. 433, pl. 4, fig. 3 (*non* Gmelin, 1791).
- 1960 Trivia affinis (Dujardin 1835) Kojumdgieva & Strachimirov, p. 126, pl. 34, fig. 9 (non Gmelin, 1791).
- 1962 Trivia affinis dimidiatoaffinis Sacco Strausz, p. 157, pl. 76, figs 1-3.
- 1966 Trivia affinis dimidiatoaffinis Sacco, 1894 Strausz, p. 236, pl. 76, figs 1-3.
- 1968 Trivia affinis (Dujardin 1835) Zelinskaya et al.,
 p. 180, pl. 42, figs 13, 14 (non Gmelin, 1791).
- 1969a Trivia affinis (Dujardin 1835) Csepreghy-Meznerics, p. 23, pl. 6, figs 23, 25 (non Gmelin, 1791).
- 1995 Trivia (Sulcotrivia) dimidiatoaffinis (Sacco, 1894)
 Bałuk, p. 192, pl. 14, figs 1-3.

Dimensions and material – Maximum height 12.3 mm. Localities 2 & 3: YI 263/1; locality 13: NHMW 1874/0058/1287/1, 1874/0058/1288/29, JvdV/1, YI/ 262/9; locality 17: NHMW 1874/0058/1289/1, JvdV/3, RGM 783 957/1 + 10 fragments.

Discussion – *Niveria dimidiatoaffinis* (Sacco, 1894) is the only relatively common triviid in the Turkish assemblages, where it is found most often in the clayey deposits. It is characterised by its rather narrow ribs, which are hardly swollen at their termination at the dorsal sulcus. The rib terminations at the sulcus tend to be alternating in position. *Niveria dautzenbergi* (Schilder, 1932), which also occurs in the same clayey deposits, albeit far less frequently, is smaller, the dorsal sulcus is more irregular and the termination of the ribs at the sulcus are more swollen. *Niveria pseudoasulcata* (Sacco, 1894) has a wider and deeper, but shorter dorsal sulcus and the rib terminations on either side of the shell coincide, and are not swollen. As can be seen in the distribution data, *N. dimidiatoaffinis* is a widely distributed middle Miocene species.

Distribution – Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1924), (Langhian): Loire Basin, France (Peyrot, 1938; Glibert, 1952a); Paratethys (Langhian-Serravallian): Poland (Friedberg, 1912, 1951; Bałuk, 1995), Austria (Hörnes, 1852), Hungary (Csepreghy-Meznerics, 1954, 1956, 1969a; Strausz, 1962, 1966), Bulgaria (Kojumdgieva & Strachimirov, 1960), Ukraine (Zelinskaya *et al.*, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Eratoidae Gill, 1871 Subfamily Eratoinae Gill, 1871 Genus *Erato* Risso, 1826

Type species – Voluta cypraeola Brocchi, 1814, by monotypy. Pliocene, Italy.

Erato subcypraeola d'Orbigny, 1852

Figure 20/1; Plate 12, figs 9, 10

- 1834 Marginella cypraeola Grateloup, p. 100 [non Erato cypraeola (Brocchi, 1814)].
- 1845 Marginella cypraeola Grateloup, pl. 42, figs 33, 34 [non Erato cypraeola (Brocchi, 1814)].
- *1852 Erato subcypraeola d'Orbigny, p. 51. (nom. nov. pro Marginella cypraeola Grateloup, 1845, pl. 42, figs 33, 34; non Voluta cypraeola Brocchi, 1814).
- 1894a Erato (Erato) laevis var. subcypraeola (d'Orb.) Sacco, p. 58, pl. 3, fig. 62.
- 1924 Erato (Eratopsis?) subcypraeola (d'Orbigny) Cossmann & Peyrot, p. 392, no. 694 (partim, pl. 11, figs 48-51 only) [non figs 44, 45 = Eratopsis barrandei Hoernes & Auinger, 1879; non figs 46, 47 = Erato cf. asulcata Sacco, 1894].
- 1933b *Erato (Erato) subcypraeola* d'Orbigny (1852) Schilder, p. 249, 254, 272, text- fig. 64.
- 1954 Erato laevis Don. Strausz, p. 24, 43, pl. 7, fig.
 149 (non Donovan, 1804).
- 1969a *Eratopsis barrandei planulosa* (Bon.) Csepreghy-Meznerics, p. 23, pl. 6, figs 9, 13 (*non Erato planulosa* Sacco, 1894).
- 1971 *Erato (Erato) subcypraeola subcypraeola* Böttger, 1884 – Schilder & Schilder, p. 13, 159.
- 1995 Erato (Eratopsis) subcypraeola Böttger, 1884 Bałuk, p. 189 (partim, pl. 13, figs 1, 2 only) (non fig. 3 = Cypraeerato yolandae Fehse & Grego, 2012).
- 2012 Erato subcypraeola d'Orbigny, 1852 Fehse & Grego, p. 19, pl. 1, fig. 5, pl. 4, figs 1-5.
- non 1934 Erato (Erato) subcypraeola (d'Orbigny) Zilch, p. 249, pl. 14, fig. 69 (= Erato kimakowiczi Boettger, 1884).
- non 1956 Erato (Erato) subcypraeola D'Orbigny Csepreghy-Meznerics, p. 395, pl. 4, fig. 6 [= Eratopsis barrandei Hoernes & Auinger, 1879).
- non 1962 Erato subcypraeola Orbigny Strausz, p. 157, pl. 75, fig. 25 (= Eratopsis barrandei Hoernes & Auinger, 1879).
- non 2001a Eratopsis subcypraeola (d'Orbigny, 1852) Lozouet et al., p. 42, pl. 16, fig. 3 (= Erato transiens Boettger, 1884).

Dimensions and material – Maximum height 5.8 mm. Localities 2 & 3: JvdV/1; localities 7 & 8: NHMW 1874/0058/1293/2, RGM 783 910/1, YI 270/2; locality 13: NHMW 1874/0058/1290/1, 1874/0058/1291/1, 1874/0058/1292/49, JvdV/10, YI 266/16; locality 17: NHMW 1874/0058/1293/2, JvdV/1.

Discussion – Erato subcypraeola d'Orbigny, 1852 has a rather stocky solid shell, which distinguishes it from *Erato transiens* Boettger, 1884, with which it coexists in the Turkish assemblages, as *E. transiens* is more elongated at the anterior end. The sculpture is variable, with some specimens completely covered in small pustules, whereas others are almost completely smooth. The



Figure 20. Enlargement of the three eratoid species found in the Karaman assemblages to show detail of labral and columellar dentition.

- 1. Erato subcypraeola d'Orbigny, 1852, NHMW 1874/0058/1291, locality 13, Pınarlar Yaylası, Akpınar, height 5.2 mm.
- 2. Erato transiens Boettger, 1884, NHMW 1874/0058/1298, locality 17, Seyithasan, height 8.1 mm.
- 3. Hespererato cf. cocconii Schilder, 1933, NHMW 1874/0058/1302, locality 13, Pınarlar Yaylası, Akpınar, height 6.9 mm.

Turkish specimens tend to be rather weakly pustulose. The strength and length of the dorsal sulcus is also highly variable. For further discussion see Fehse & Grego (2012, p. 19).

Distribution – Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1924); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1894a; Schilder, 1933b). Middle Miocene: Paratethys (Langhian-Serravallian): Hungary (Csepreghy-Meznerics, 1969a; Strausz, 1954; Fehse & Grego, 2012), Romania (Fehse & Grego, 2012); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Erato transiens Boettger, 1884

Figure 20/2; Plate 12, figs 11-14

- 1852 Erato laevis Don. Hörnes, p. 79, pl. 8, fig. 16 (non E. laevis Donovan, 1804).
- *1884 Erato transiens Boettger, p. 137.
- 1914 Erato cf. spiralis Dod. Friedberg, p. 143, pl. 8, fig. 4 (non E. spiralis Sacco, 1894).
- 1929 Erato cf. elongata Seg. Schilder, p. 12, text-fig.5 (non E. elongata Seguenza, 1880).
- 1933b Erato (Erato) transiens transiens Boettger (1884) – Schilder, pp. 250, 259, 273, figs 69-71.
- 1956 *Erato laevis punctata* Csepreghy-Meznerics, p. 395, pl. 4, figs 4, 5.
- 1960 Erato (Erato) laevis (Donovan, 1799 [sic]) Ko-

jumdgieva & Strachimirov, p. 125, pl. 34, fig. 10 (non E. laevis Donovan, 1804).

- 1962 Erato laevis auctorum Strausz, pl. 74, figs 13, 14.
- 1966 *Erato laevis* auctorum (? *non* Donovan, 1799 [*sic*]) Strausz, p. 235, pl. 74, figs 13, 14.
- 1969a Erato laevis Don. Csepreghy-Meznerics, p. 23, pl. 6, figs 10, 12 (non E. laevis Donovan, 1804).
- 1971 Erato (Erato) transiens transiens Böttger, 1884 Schilder & Schilder, p. 14, 163.
- 1995 Erato (Erato) elongata Seguenza, 1880 Bałuk,
 p. 189 (partim, pl. 12, fig 4 only) (non E. elongata Seguenza, 1880; non figs 5, 6 = Erato spiralis Sacco, 1894).
- 2003a *Erato* cf. *transiens* Boettger, 1884 Fehse & Landau, p. 19, fig. 1/3a-c, fig. 2/3d.
- 2012 *Erato transiens* Boettger, 1884 Fehse & Grego, p. 22, text-fig. B, pl. 1, fig. 7, pl. 8, figs 1-5.
- non 1934 Erato (Erato) transiens Boettger Zilch, p. 249, pl. 14, fig. 70 (= Erato laevilabiata Sacco, 1894).
- non 2001b Hespererato transiens (Boettger, 1884) Lozouet et al, p. 54, pl. 4, figs 1-4 (= Erato hemmoorensis Schilder, 1929).

Dimensions and material – Maximum height 11.2 mm. Localities 7 & 8: NHMW 1874/0058/1297/7, JvdV/3, RGM 783 906/1; locality 13: NHMW 1874/0058/1295, 1874/0058/1298-1874/0058/1300/4, 1874/0058/1296/27, YI 267/3; locality 17: JvdV/21, RGM 783 983/8, YI 269/26. *Discussion* – Our shells from Turkey are similar in shape to the Mediterranean Pliocene species *Erato elongata* Seguenza, 1880. Although both species have a similar elongate, slender shell shape, *E. elongata* can easily be distinguished from the middle Miocene species *E. transiens* by their columellar folds. *Erato elongata* has only 1-2 weak folds abapically on the columella (Fehse & Landau, 2002, fig. 10), whereas *E. transiens* has 3-5 folds abapically on the columella (Fehse & Grego, 2012, pl. 1, fig, 7; this work, Fig. 20/2).

Also similar is the middle Miocene Paratethyan and late Miocene Proto-Mediterranean species *Erato spiralis* Sacco, 1894, but this species has coarser labral denticles and columellar folds than *E. transiens*.

Distribution – Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Germany (Schilder, 1919). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1852; Fehse & Grego, 2012), Poland (Friedberg, 1914; Bałuk, 1995; Fehse & Grego, 2012), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Hörnes, 1852; Csepreghy-Meznerics, 1956, 1969a; Strausz, 1962, 1966; Fehse & Grego, 2012), Romania (Fehse & Grego, 2012); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Hespererato Schilder, 1933

Type species – Erato vitellina Hinds 1844, by original designation. Recent, eastern Pacific.

Hespererato cf. cocconii Schilder, 1933

Figure 20/3; Plate 12, figs 15, 16

- cf. *1933b *Hespererato cocconii* Schilder, pp. 249, 254, 258, 262, fig. 43.
- cf. 1933b Erato (Erato) elongata etrusca Schilder, pp. 250, 254, 259, 264, fig. 82.
- cf. 1971 *Hespererato cocconii* Schilder, 1933 Schilder & Schilder, p. 14, 105.
- cf. 1971 Erato (Erato) elongata etrusca Schilder, 1933 Schilder & Schilder, p. 14, 113.
- cf. 2002 *Hespererato cocconii* Schilder, 1933 Fehse & Landau, p. 29, figs 13, 19, 22, 37/8.
- cf. 2004 *Hespererato cocconii* Schilder, 1933 Landau & Fehse, p. 4, pl. 1, fig. 8.
- cf. 2008 Erato voluta (Montagu, 1803) Chirli, p. 48 (partim, pl. 17, fig. 5 only) [non Erato voluta (Montagu, 1803)].
- cf. 2011 Hespererato cocconii Schilder, 1933 Landau et al., p. 17, pl. 6, fig. 13.

Dimensions and material – Maximum height 8.0 mm. Localities 2 & 3: YI 265/2; locality 6: JvdV/5; localities 7 & 8: NHMW 1874/0058/1304/2, JvdV/3; locality 10: YI 268/2; locality 13: NHMW 1874/0058/1301/1, 1874/0058/1302/1, 1874/0058/1303/34, JvdV/20, YI 264/26.

Discussion - The genus Hespererato Schilder, 1933 in-

cludes species that are inflated and have a very simple dentition, terminal ridge and fossula. *Hespererato cocconii* Schilder, 1933 typifies the characters of this genus. The specimens from Turkey are almost identical in shape, size and labral dentition to the Pliocene species *H. cocconii*. The only difference is that most but not all Pliocene shells have a vertical row of very small denticles extending the whole length of the columella, developed to a variable degree (Fehse & Landau, 2002, fig. 13), whereas the Turkish shells only have a single abapical columellar fold, the rest of the columella being smooth. A smooth columella is unusual in Italian Pliocene shells we have examined, but is not so uncommon in the early Pliocene Estepona populations.

Hespererato marqueti Fehse & Landau, 2002, from the Atlantic late Miocene Messinian (Redonian) of the Loire Basin, France, differs in being always smaller, with a relatively broader, squatter shell and a higher spire. The density of the labral teeth is lower. The folds on the anterior part of the base are always absent, and the columellar teeth are always sub-obsolete. For further discussion see Fehse & Landau (2002, p. 31).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Superfamily Cypraeoidea Rafinesque, 1815 Family Cypraeidae Rafinesque, 1815 Subfamily Zonariinae Schilder, 1932 Genus *Schilderia* Tomlin, 1930

Type species – Cypraea utriculata Lamarck, 1810, by original designation. Pliocene, Italy.

Schilderia transsylvanica (Schilder, 1927) Plate 13, figs 1-4

- *1927 Zonaria (Zonaria) transsylvanica Schilder, Schilder, p. 115.
- Monetaria brocchii (Deshayes, 1844) Bałuk, p. 186 (partim, pl. 10, figs 1, 2 only) [non pl. 9, figs 4, 5 = Prozonarina brocchii (Deshayes, 1844)].
- 2001 *Schilderia transsylvanica* (Schilder, 1925) Fehse, p. 5, unnumbered figure bottom (holotype).
- 2002b Schilderia cf. transsylvanica (Schilder, 1925) Fehse, pl. 1, fig. 1.
- 2002b Schilderia transsylvanica (Schilder, 1925) Fehse, pl. 1, fig. 2.

Dimensions and material – Maximum length 24.3 mm. Localities 2 & 3: YI 280/4; localities 7 & 8: JvdV/1; locality 11: JvdV/4, RGM 794 036/6; locality 13: YI 279/1; locality 17: NHMW 1847/0058/1305-1847/0058/1314/10, 1847/0058/1315/50+, JvdV/50+, RGM 783 740/50+, MTA 2013/023/10, YI 274/50+; locality 18: JvdV/5; locality 17a: NMHW 1847/0058/1587/13.



Figure 21. Terminology used here to describe shell characters in the Cypraeoidea.

collection number	Length	width	height	LT	СТ
NHMW 1847/0058/1305	22.6	13.8	11.4	16	14
NHMW 1847/0058/1306	22.6	14.0	11.7	18	12
NHMW 1847/0058/1307	19.0	13.2	10.6	16	12
NHMW 1847/0058/1308	21.5	14.7	11.5	17	14
NHMW 1847/0058/1309	20.1	14.2	11.7	16	12
NHMW 1847/0058/1310	22.7	15.0	12.4	15	13
NHMW 1847/0058/1311	22.0	14.9	12.0	15	12
NHMW 1847/0058/1312	22.2	14.9	12.4	16	14
NHMW 1847/0058/1313	23.9	15.9	13.2	18	14
NHMW 1847/0058/1314	22.6	15.0	12.5	15	14

Table 3. Measurements of Schilderia transsylvanica (Schilder, 1927).

Revised description – Shell small, solid, ovate-pyriform, posteriorly swollen, spire involute, covered by adapical callus. Sides rounded, moderately callused. Callus ascending to about one-third total height, its highest point at dorsal hump. Venter flattened, slightly convex in profile. Aperture weakly sigmoidal, slightly widened abapically. Siphonal canal abaxially asymmetrical, weakly recurved, externally surrounded by narrow callus collar. Anal canal weakly bent adaxially, externally surrounded by thick adapical callus. Terminal ridge well-developed.

Fossula smooth, very poorly developed and delimited. Columellar teeth stout, parallel, well-spaced, 12-14 in number, weakening posteriorly, ending abruptly at basal and columellar planes, not extending onto venter nor into aperture. There are 15-18 labral teeth, regularly-spaced, extending half width of lip. Orange-brown colour marking preserved bordering dorsal callus adjacent to siphonal and anal canals. Well-preserved shells with narrow, slightly serpentine axial groove in dorsal callus slightly to left of mid-line. *Discussion* – *Schilderia transsylvanica* (Schilder, 1927) is extremely common in the Seyithasan deposits, where it occur in hundreds. Although always small, there is quite some variability in the size of the adult specimens, some fully grown adults only reaching 16.0 mm in length. These smaller adults have the shell shape of the holotype illustrated by Fehse (2001, p. 5). In larger specimens the sides become more callused and the posterior outline is broader.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Fehse, 2001, 2002b); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Schilderia labrocostata (Schilder, 1927)

Plate 13, figs 5, 6

- *1927 Zonarina (Globulina) labrocostata Schilder, p. 114.
- 2001 Schilderia labrocostata (Schilder, 1925) Fehse,
 p. 4, unnumbered figure bottom (holotype), p. 5
 unnumbered figure top (holotype).
- 2002b Schilderia labrocostata (Schilder, 1925) Fehse, pl. 1, fig. 6.

Dimensions and material – Maximum length 24.5 mm. Locality 13: JvdV/1; locality 17: NHMW 1847/0058/1519/1, 1847/0058/1520/1, 1847/0058/1527/1, YI 278/3.

Revised description - Shell small, solid, ovate-pyriform, posteriorly swollen, spire involute, covered by adapical callus. Sides rounded, moderately callused. Callus ascending to about one-third total height, its highest point at dorsal hump. Venter flattened, slightly convex in profile. Aperture very weakly sigmoidal, slightly widened abapically. Siphonal canal abaxially asymmetrical, weakly recurved. Anal canal weakly bent adaxially. Terminal ridge well-developed, broadening internally. Fossula well developed, concave, coarsely denticulate at inner edge, teeth on inner and outer edges extending a short distance onto fossula, but most not fusing, leaving deepest part of fossula smooth. Columellar teeth stout, parallel, 16-18 in number, weakening posteriorly, ending abruptly at basal and columellar planes, not extending onto venter but extending a short distance into aperture, 22-25 on bevelled

inner edge of outer lip, not extending over lip. Orangebrown colour dorsal spot preserved, placed medially to spire.

Discussion – In the Seyithasan assemblage small cypraeids can be found in their hundreds, almost all of which are *Schilderia transsylvanica* (Schilder, 1927). Amongst these little cypraeids a small number belong to quite a different species, which can be separated easily from the more common species by its outer lip with denser denticulation and, most importantly, the character of the fossula. *Schilderia transsylvanica* has a very weakly defined, smooth fossula, whereas *Schilderia labrocostata* (Schilder, 1927) has a relatively deep spoon-shaped fossula with teeth on the inner and outer edges, the denticles extending onto the fossula, but leaving the central portion smooth.

Specimens of *Schilderia labrocostata* from the middle Miocene Paratethys of Romania (NHMW collection) match these Turkish shells closely in the character of their dentition and fossula. The posterior portion in the Seyithasan specimens is slightly less swollen than in the Romanian shells, but the specimen from Pinarlar Yaylasi (JvdV collection) is identical in shape to the Paratethyan shells.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Fehse, 2001, 2002b); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Zonarina Sacco, 1894

Type species – Cypraea pinguis longovulina Sacco, 1894 (*= Cypraea pinguis* Grateloup, 1845), by original designation. Miocene, France and Italy (for type designation see Dolin & Lozouet, 2004, p. 39).

Zonarina hoernesiana (Sacco, 1894)

Plate 13, fig. 7; Plate 14, figs 1, 2

- 1852 *Cypraea fabagina* Lam. Hörnes, p. 65, pl. 7, fig. 6 (*non* Lamarck, 1810).
- *1894a Zonaria hoernesiana Sacc., Sacco, p. 15 (nom. nov. pro Cypraea fabagina Lam. in Hörnes, 1852, non Lamarck, 1810).

collection number	Length	width	height	LT	СТ
NHMW 1847/0058/1519	24.2	16.1	12.8	16	22
NHMW 1847/0058/1520	24.5	16.0	12.6	16	23
NHMW 1847/0058/1527	31.2	21.0	16.4	18	25
JvdV	25.1	16.9	12.9	17	22

Table 4. Measurements of Schilderia labrocostata (Schilder, 1927).

collection number	Length	width	height	LT	СТ
NHMW 1847/0058/1521	35.9	23.2	18.2	21	17
RGM 794 054	35.5	22.6	18.3	20	15
RGM 794 055	31.3	20.6	15.6	21	15
NHMW 1847/0058/1522	34.7	22.1	17.8	20	16
NHMW 1847/0058/1523	34.6	21.4	17.0	21	-
NHMW 1847/0058/1524	35.3	21.5	18.2	21	16
NHMW 1847/0058/1525	32.3	21.5	17.1	20	16

Table 5. Measurements of Zonarina hoernesiana (Sacco, 1894).

1927 Zonarina (Zonarina) intusplicata Schilder, p. 115.
2001 Zonarina (Prozonarina) annularia hoernesiana Sacco, 1894 – Fehse, p. 19, unnumbered figure top.

Dimensions and material – Maximum length 35.9 mm. Locality 17: NHMW 1847/0058/1521-1847/0058/1525/5, 1847/0058/1526/4, RGM 794 054/1 (ex JvdV collection), RGM 794 055/1 (ex JvdV collection), RGM 794 040/7, YI 282/3.

Revised description - Shell medium-sized, ovate-pyriform, of medium-thickness, weakly posteriorly swollen, spire involute, covered by adapical callus. Sides rounded, moderately callused. Callus ascending to about half total height, its highest point at dorsal hump. Venter flattened, slightly convex in profile. Aperture very weakly sigmoidal, slightly widened abapically. Siphonal canal abaxially asymmetrical, weakly recurved, externally surrounded by narrow callus collar. Anal canal weakly bent adaxially, externally surrounded by thick adapical callus. Terminal ridge well-developed, tooth-like at inner edge. Fossula small, moderately developed, smooth in central portion, very weakly denticulate at inner edge. There are 15-17 parallel columellar teeth; anterior teeth stout, rapidly weakening and narrowing posteriorly, not extending onto venter, extending weakly a variable distance into aperture; 20-21 regularly-spaced labral teeth, extending half width of lip. Orange-brown dorsal spot and mottled dorsal colour pattern preserved.

Discussion – Fehse (2001, p. 19 placed *Zonarina intusplicata* Schilder, 1925 [*sic*] in synonymy with *Zonarina* (*Prozonarina*) *annularia hoernesiana* Sacco, 1894. The character of the dentition and fossula are identical to that of the holotype of *Zonarina* (*Zonarina*) *intusplicata* Schilder, 1927 [= *Zonarina hoernesiana* (Sacco, 1894)] illustrated by Fehse (2001, p. 19, unnumbered figure), although the shape of the Turkish shells is slightly more elongate and less swollen posteriorly. We provisionally agree that they are conspecific.

Distribution – **Middle Miocene**: Paratethys, Langhian-Serravallian, Austria (Hörnes, 1852; Fehse, 2001); ProtoMediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Zonarina provincialis (Mathéron, 1842) Plate 15, figs 1, 2

- *1842 *Cypraea provincialis* Mathéron, p. 256, pl. 40, figs 22, 23.
- 1866 *Cypraea brocchi* [*sic*] Deshayes Fischer, p. 244 [*non Prozonarina brocchii* (Deshayes, 1844)].
- 1931 Schilderia provincialis Math. Schilder, p. 89, pl. 1, fig. 9.
- 1958 *Cypraea (Bernayia) fabagina* Lamarck Erünal-Erentöz, p. 44, pl. 6, figs 7, 8 (*non* Lamarck, 1810).
- 1958 Cypraea (Bernayia) fabagina var. apiceproducta Cossmann et Peyrot – Erünal-Erentöz, p. 45, pl.
 6, figs 9, 10 [non Fossacypraea apiceproducta (Cossmann & Peyrot, 1924)].
- 1971 Zonarina (Zonarina) provincialis provincialis (Matheron, 1842) – Schilder & Schilder, p. 42, 147.

Dimensions and material – Maximum length 58.5 mm. Localities 2 & 3: YI 273/1; locality 6: NHMW 1847/0058/1489/4; localities 7 & 8: JvdV/3; locality 9: JvdV/2, RGM 783 820/2; locality 12: JvdV/17; locality 13: NHMW 1847/0058/1316-1847/0058/1325/10, 1847/0058/1325/19, JvdV/50+, RGM 783 642-643/37, MTA 2013/024/5, YI 272/26. Exact locality unknown: AÜ LE-K-215/2.

Revised description – Shell medium to large, solid, ovate, broadly sub-rhomboidal, greatly posteriorly swollen just posterior to apex, spire involute, covered by adapical callus. Sides rounded, strongly callused posteriorly, callus ascending to mid-height, its highest point at spire. Venter flattened, slightly convex in profile. Aperture relatively wide, widening further anteriorly, curved posteriorly. Siphonal canal protruding, abaxially asymmetrical, weakly recurved, externally surrounded by thick callus collar. Anal canal hardly protruding, weakly bent adaxially, externally surrounded by thick adapical callus. Terminal ridge

collection number	length	width	Height	LT	СТ
NHMW 1847/0058/1316	43.2	29.4	20.4	18	5
NHMW 1847/0058/1317	41.6	30.4	20.6	18	5
NHMW 1847/0058/1318	42.1	30.4	19.7	18	5
NHMW 1847/0058/1319	41.9	31.4	22.1	18	6
NHMW 1847/0058/1320	42.0	30.8	21.5	20	7
NHMW 1847/0058/1321	46.3	35.0	23.1	19	7
NHMW 1847/0058/1322	40.2	29.2	20.1	18	7
NHMW 1847/0058/1323	51.3	36.9	25.9	20	7
NHMW 1847/0058/1324	54.0	40.4	26.6	21	6
NHMW 1847/0058/1325	57.9	43.1	29.6	20	7

Table 6. Measurements of Zonarina provincialis (Mathéron, 1842).

narrow. Fossula poorly developed and delimited, with anterior columellar teeth of variable strength crossing fossula, subobsolete in mid-fossula. Five to seven anterior columellar teeth weakening posteriorly, mid- and posterior columellar teeth obsolete, or almost so. Outer lip very broad, with 18-20 coarse labral teeth, restricted to inner lip margin. Spire colour spot present in some specimens Well-preserved shells show marginal callus covering about half of dorsum and a narrow, slightly serpentine axial groove in the dorsal callus slightly to left of mid-line.

Discussion - This species reaches a large size in the Karaman clayey assemblages, where the largest shell found is 58.5 mm in length. The shell is characterised by its broad, ovate sub-rhomboidal shape, its depressed dorsum, its relatively wide aperture, its strongly callused outer lip, especially in the posterior half, bearing 18-20 relatively coarse teeth restricted to the bevelled inner edge, its coarse, strongly developed anterior columellar teeth, which weaken rapidly adapically and in many specimens are obsolete along the posterior half, and its broad, flat fossula bearing ridges extending from the anterior columellar teeth, ending in denticles of variable strength along the inner fossular edge. The Turkish shells generally become broader as they get larger and there is some degree of variability, mainly in columellar dentition. This can be restricted to just a few coarse teeth anteriorly, or be present, albeit weakly, along the entire columellar length. The description above fits most closely with that of Schilderia provincialis (Matheron, 1842) given by Schilder (1931, p. 89), which according to Schilder (1931) occurs also in the Miocene of Italy and the Paratethys.

Several cypraeid species occur in the European Miocene with a flat fossula and the posterior part of the columella smooth. *Zonaria provincialis* was said to differ from *Zonarina laterrimata* (Sacco, 1894) (= *Zonaria fabagina* var. *exbrocchii* Sacco, 1894, *nov. nom. pro Cypraea brocchii* Hörnes, 1852 *non* Deshayes, 1844) from the

middle Miocene Paratethys in being smaller, more oval than quadrate, and with a wider aperture, which is more recurved in the posterior portion (Schilder, 1931, p. 90). Shell size cannot be used to distinguish the two species. The illustration of the holotype by Hörnes (1852, pl. 7, fig. 3) and the specimen illustrated by Fehse (2001, p. 23) show a shell of very similar shape to the Turkish shells, except that the anterior terminal is less produced than in the Karaman shells and teeth at the inner edge of the fossula seem to be well-developed, whereas in the Turkish shells only some specimens have such teeth, and then only weakly developed. It may well be that with more Paratethyan material it will become clearer that these small differences fall within intraspecific variability, in which case Sacco's name would enter into synonymy. Ferrero Mortara et al. (1984, pl. 25, fig. 5) illustrated a shell from the Miocene of Italy as Zonarina fabagina var. laterimata. This shell is more oval in outline than either the Turkish or Paratethyan shells and seems to have well-developed, elongate anterior columellar teeth, which extend across the fossula. It is unlikely that this Italian shell is conspecific. Zonarina tauromagna (Sacco, 1894) from the middle Miocene of Italy was illustrated only in dorsal view, and looks extremely similar in profile. Unfortunately this species was not reillustrated by Ferrero Mortara et al. (1984), but according to Schilder (1932) it also has a narrower aperture and the inner edge of the fossula is smooth instead of denticulate as in Z. provincialis.

Distribution – **Early Miocene**: western Proto-Mediterranean Sea (Aquitanian): Provence, France (Mathéron, 1842); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Schilder, 1931). **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Schilder, 1931); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Fischer, 1866; Erünal-Erentöz, 1958).

collection number	length	width	height	LT	СТ
NHMW 1847/0058/1327	47.6	31.8	24.5	24	21
NHMW 1847/0058/1328	44.9	30.2	21.2	22	19
NHMW 1847/0058/1329	51.0	31.7	23.0	24	22
NHMW 1847/0058/1330	44.9	31.2	21.3	25	20
NHMW 1847/0058/1331	44.2	29.0	22.3	23	12+
NHMW 1847/0058/1332	47.4	30.5	22.3	23	21
NHMW 1847/0058/1333	49.1	33.3	23.0	22	21
NHMW 1847/0058/1334	41.6	25.0	19.1	23	24
NHMW 1847/0058/1335	38.8	24.2	18.7	21	19

Table 7. Measurements of Zonarina cf. tauroporcellus (Sacco, 1894).

Zonarina cf. tauroporcellus (Sacco, 1894)

Plate 15, figs 3, 4

- ?*1894a Cypraea (Zonaria) fabagina? var. tauroporcellus Sacc., Sacco, p. 22, pl. 2, fig. 16.
- ? 1984 Zonaria fabagina? var. tauroporcellus Sacco 1894
 Ferrero Mortara et al., p. 148, pl. 24, fig. 4.
- ?. 2001 Zonarina (Prozonarina) decorticata cf. tauroporcellus Schilder, 1923 – Fehse, p. 28, unnumbered figure bottom.

Dimensions and material – Maximum length 49.7 mm. Localities 2 & 3: JvdV/4; locality 6: JvdV/2; locality 17: NHMW 1847/0058/1327-1847/0058/1335/9, 1847/0058/1336/4, JvdV/8, RGM 783 741/5, YI 271/4.

Revised description - Shell medium-sized, solid, elongate ovate, moderately posteriorly swollen just posterior to apex, spire involute, covered by adapical callus. Sides rounded, strongly callused posteriorly, callus ascending above mid-height, its highest point at spire. Venter flattened, slightly convex in profile. Aperture relatively narrow, almost straight, hardly widening anteriorly, weakly curved posteriorly. Siphonal canal protruding, abaxially asymmetrical, weakly recurved, externally surrounded by thick callus collar. Anal canal slightly protruding weakly bent adaxially, externally surrounded by thick adapical callus. Terminal ridge narrow. Fossula poorly developed and delimited, smooth in most specimens, but with one or two anterior columellar teeth extending a short distance across fossula in a few, not reaching inner edge. There are 19-24 narrow columellar teeth, weaker mid-columella, not extending onto venter nor into aperture. Outer lip broad, with 21-25 fine labral teeth, restricted to inner lip margin. Spire colour spot present in some specimens. Well-preserved shells have marginal callus covering most of dorsum.

Discussion – Zonarina cf. *tauroporcellus* (Sacco, 1894) is closely similar to *Zonarina provincialis* (Matheron, 1842), but differs in being more elongately ovate in outline, rather than sub-rhomboidal. This difference in shape is due to

a marked thickening of the lateral callus in Z. provincialis at the posterior end, especially on the left side. The callus is also thickened in the same region in Z. cf. tauroporcellus, but not as strongly. The aperture is narrower in Z. cf. tauroporcellus, and does widen markedly anteriorly as in Z. provincialis. The teeth in Z. cf. tauroporcellus are finer, and developed along the whole columellar edge in most specimens, whereas the anterior columellar teeth in Z. provincialis are quite stout, but quickly weakening, and are subobsolete in the mid- and posterior zones in most specimens. The anterior columellar teeth in Z. provincialis extend across the fossula and end at the inner edge, whereas the anterior teeth in Z. cf. tauroporcellus cross the fossula in only a few specimens and never reach the inner edge. Lastly, labral teeth are finer and more numerous in Z. cf. tauroporcellus (21-25 vs. 18-20). The two are, nevertheless, closely similar species, which seem to occur in the Turkish assemblages in different habitats; Z. provincialis is found only in the clayey deposits, whereas Z. cf. tauroporcellus occurs in the sandy outcrops.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Zonarina phyletica (Schilder, 1923) Plate 16, figs 1, 2, ?3

*1923 Cypraea phyletica Schilder, p. 102, fig. 2.
2001 Zonarina (Zonarina) exglobosa phyletica Schilder, 1923 – Fehse, p. 25, unnumbered figure (holotype).

Dimensions and material – Maximum length 78.0 mm. Locality 17: NHMW 1847/0058/1337-1847/0058/1340/4, 1847/0058/1341/2, 1847/0058/1648-1847/0058/1649/2, JvdV/12, RGM 794 540/1 (ex JvdV collection), YI 281/2.

Revised description – Shell large, of medium thickness, ovate to rotund, posteriorly swollen, spire involute, covered by adapical callus. Sides rounded, weakly cal-

collection number	length	width	height	LT	СТ
RGM 794 540	61.1	38.7	32.2	22	22
NHMW 1847/0058/1337	60.8	41.7	32.3	22	20
NHMW 1847/0058/1338	63.3	43.5	33.0	21	20
NHMW 1847/0058/1339	58.2	39.6	31.2	23	22
NHMW 1847/0058/1340	67.8	45.4	33.8	24	23
JvdV	78.0	50.8	40.94	21	15
NHMW 1847/0058/1648	63.9	42.5	34.7	24	18
NHMW 1847/0058/1649	60.4	42.9	31.8	21	16

Table 8. Measurements of Zonarina phyletica (Schilder, 1923).

lused, callus extending to two-thirds height over dorsum. Venter flattened, slightly convex in profile. Aperture of medium width, almost straight, anterior third weakly dilated. Siphonal canal weakly protruding, abaxially asymmetrical and abapically orthogonally truncated. Anal canal moderately protruding. There are 20-23 columellar teeth, 5-6 anterior teeth stouter, teeth extending over columellar plane deeply within aperture, not extending over basal angulation onto venter. Terminal ridge elevated, bordering siphonal channel, ending in tooth at inner edge. Fossula poorly delimited, concave anteriorly, with denticulate inner edge, covered by ridges extending from anterior columellar teeth. Outer lip of medium width, with 20-23 labral teeth restricted to bevelled inner portion of lip.

Discussion - The specimens from Karaman agree closely with the shell illustrated by Schilder (1923, fig. 2), although the maximum size is greater than that stated for the Paratethian specimens. This is the largest cypraeid in the Turkish assemblages and it is characterised by its rather egg-shaped shell, the columellar teeth are elongated, extending across the columellar plane, but not onto the venter. The fossula is moderately well-delimited, wide, moderately deep, with ridges in most specimens, with teeth developed at the inner edge. The terminal ridge is composed of an upper and a lower denticle. The outer lip teeth are stout and restricted to the inner edge. The marginal callus is moderately thickened and broadly expanded over 2/3 height of the dorsum. The dorsum has a finely mottled colour pattern preserved, similar to that seen in Schilder's (1923, fig. 2) specimen.

One very large specimen is present from the Akpınar deposits (Pl. 16, fig. 3; length 78.0 mm), which differs

slightly from those found at Seyithasan in being even larger, the columellar teeth are subobsolete mid-shell, the fossula is smooth and the inner fossular teeth are subobsolete. We consider this shell to be a large gerontic specimen. Zonarina grandis Schilder, 1927 from the middle Miocene Atlantic of the Loire Basin, France is very similar indeed, and seems to have roughly the same number and form of columellar and labral teeth (see Fehse, 2001). Schilder (1927, p. 142) compared his new species to Cypraea tigris Linnaeus, 1758 and commented that the character of the anterior end was more like that of C. phyletica, but he did not formally compare the two species. One constant feature that separates the two species is the character of the anterior portion of the outer lip, which has a semicircular excavated and bevelled section in Z. phyletica that is absent in Z. grandis. According to the original description, the fossula in Z. grandis is smooth with prominent inner teeth, whereas it is ridged in most specimens of Z. phyletica, as discussed above.

Distribution – **Middle Miocene**: Paratethys, Langhian-Serravallian, Austria (Schilder, 1923; Fehse, 2001), Hungary (Schilder, 1923); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Zonarina sp.

Plate 14, fig. 3

Dimensions and material – Length 47.3 mm. Locality 13: NHMW 1847/0058/1528/1.

Description – Shell large, solid, ovate to weakly subrhomboidal, weakly posteriorly swollen just posterior to

collection number	Length	width	height	LT	СТ
NHMW 1847/0058/1528	47.3	32.6	24.0	23	21

Table 9. Measurements of Zonarina sp.

apex, in lateral profile somewhat flattened, spire involute, covered by adapical callus. Sides rounded, strongly callused posteriorly, callus ascending to mid-height, its highest point at spire. Venter flattened, slightly convex in profile. Aperture relatively narrow, hardly wider anteriorly, curved posteriorly. Siphonal canal protruding, relatively narrow, abaxially asymmetrical, weakly recurved, externally surrounded by thick callus collar. Anal canal hardly protruding, weakly bent adaxially, externally surrounded by thick adapical callus. Terminal ridge narrow, ending in tooth at inner margin. Fossula poorly developed and delimited, with anterior columellar teeth extending across fossula, ending as teeth at inner edge. There are 21 thin, elongate columellar teeth, anterior columellar teeth regularly weakening posteriorly, mid- and posterior columellar teeth developed interior to basal plane, extending deep within aperture over columellar plane. Outer lip broad, 23 labral teeth restricted to inner lip margin.

Discussion - Amongst the numerous large specimens of Zonarina provincialis (Mathéron, 1842) specimens found in the clayey Pınarlar Yaylası deposits is one shell that we cannot include within the intraspecific variability of Z. provincialis. It differs from Z. provincialis in having a less sub-rhomboidal, more ovate shell profile. The anterior terminal is less produced, more recurved and the siphonal canal is narrower. The aperture is narrower, hardly widening anteriorly and the columella is less excavated anteriorly than in Z. provincialis. The fossula and fossular dentition are more strongly developed and the columellar teeth are developed along the entire length and extend deep into the aperture. The character of the outer lip teeth is similar in the two, but the lip is evenly rounded in Zonarina sp. and does not have the posterior swelling seen in Z. provincialis. This shell is also closely similar to Zonarina cf. tauroporcellus (Sacco, 1894), but is more ovate. Zonaria cf. tauroporcellus is less broadly rhomboidal than Z. provincialis, but more so than Zonarina sp. The fossula in Z. cf. tauroporcellus is flat, whereas it is slightly concave and more strongly delimited in Zonarina sp. and there are no denticles at the inner edge in Z. cf. tauroporcellus. The venter is flatter and the basal plane is more angular in Z. cf. tauroporcellus

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Zonarina cf. *dertamygdaloides* (Sacco, 1894) Plate 14, fig. 4

fig

cf. *1894a	Zonaria fabagina var. dertamvgdaloides Sacc.
	Sacco, p. 23, pl. 2, fig. 17.
cf. 1984	Zonaria fabagina var. dertamygdaloides Sacco –
	Ferrero Mortara et al., p. 148, pl. 25, fig. 2.
non 2001	Zonarina (Zonarina) dertamygdaloides dertamyg-
	daloides Sacco, 1894 - Fehse, p. 20, unnumbered

Dimensions and material – Maximum length 36.4 mm. Locality 13: NHMW 1847/0058/1686-1847/0058/1689/4.

Description - Shell medium sized, solid, elongate-ovate, weakly posteriorly swollen just posterior to apex, in lateral profile markedly flattened, spire involute, covered by adapical callus. Sides rounded, strongly callused, especially posteriorly, callus ascending to three-quarters height. Venter slightly convex in profile. Aperture relatively narrow, straight, hardly wider anteriorly, weakly curved posteriorly. Siphonal canal protruding, relatively narrow, abaxially asymmetrical, weakly recurved, externally surrounded by thick callus collar. Anal canal hardly protruding weakly bent adaxially, externally surrounded by thick adapical callus. Terminal ridge narrow. Fossula hardly developed, anterior columellar teeth not extending across fossula. 6-8 anterior columellar teeth weakening posteriorly, mid- and posterior columellar teeth very weak or obsolete, not extending over sharp columellar plane. Outer lip relatively broad, 19-23 labral teeth restricted to inner lip margin.

Discussion – Four shells from the clayey deposits of Pinarlar Yaylasi represent a small to medium-sized *Zonarina* species with an elongate-ovate profile and a somewhat depressed dorsum. The aperture is narrow and almost straight, the fossula is hardly distinguishable from the rest of the columella, only the anterior columellar teeth are clearly developed (although this is variable) and the labral teeth are small and restricted to the inner edge of the outer lip. In their dorsal compression and thickened marginal callus they are similar to *Zonarina provincialis* (Mathéron, 1842), but smaller and more elongate, and less broadly sub-rhomboidal. Also similar to *Zonarina* cf. *tauroporcellus* (Sacco, 1894), but again smaller and

collection number	length	width	height	LT	СТ
NHMW 1847/0058/1686	32.1	22.7	15.2	19	8+
NHMW 1847/0058/1687	33.7	22.5	15.9	23	7
NHMW 1847/0058/1688	34.2	22.8	16.5	22	6
NHMW 1847/0058/1689	36.4	25.6	17.6	-	-

Table 10. Measurements of Zonarina cf. dertamygdaloides (Sacco, 1894)

ovate as opposed to more narrowly sub-rhomboidal. All three species share the characters of a poorly developed fossula, only the anterior columellar teeth clearly developed and having the labral teeth restricted to the lip edge. These shells are very similar to if not conspecific with the shell illustrated by Ferrero-Mortara et al. (1984, pl. 25, fig. 2) as Zonaria fabagina var. dertamygdaloides Sacco, 1894, described from the late Miocene of Italy. Fehse (2001) illustrated the type of Zonarina austriaca Schilder 1927 (not 1925 as stated), from the middle Miocene Paratethys of the Vienna Basin under the name Zonarina (Zonarina) dertamygdaloides dertamygdaloides Sacco, 1894. This shell is clearly not conspecific with the Italian shells or Turkish specimen illustrated here (Pl. 14, fig. 4) differing in having a more globose shell with a far less depressed dorsum and a more protruding anterior end, the teeth are coarser and the labral teeth extend halfway across the outer lip, whereas in true Z. dertamygdaloides they are restricted to the inner edge. Unfortunately the decision to synonymise the two was not explained by Fehse (2001). Zonarina badensis Schilder, 1927 (for illustration of type see Fehse, 2001, p. 21 unnumbered figure as Zonarina (Zonarina) dertamygdaloides badensis Schilder, 1925 [sic]) from the middle Miocene Paratethys is more similar to Z. dertamygdaloides, but seems to have a less depressed dorsum, so that the posterior curve of the shell is evenly rounded and does not have the depression at the position of the spire. The columellar dentition seems even more weakly developed than in Z. dertamygdaloides. The shell illustrated by Fehse (2001, p. 22) as Zonarina (Zonarina) subelongata subelongata (d'Orbigny, 1852) from the early Miocene of France seems similar in apertural characters, but differs in having a more slender sub-cylindrical shell and again lacks the depression at the spire.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Superfamily Tonnoidea Suter, 1913 (1825) Family Tonnidae Suter, 1913 (1825) Genus *Malea* Valenciennes, 1832

Type species – Cassis ringens Swainson, 1822, by subsequent designation (Herrmannsen, 1847). Pliocene-Recent, tropical American Pacific.

Malea orbiculata (Brocchi, 1814)

Plate 17, fig. 1

- *1814 *Buccinum orbiculatum* nob., Brocchi, p. 647, pl. 15, fig. 22.
- 2004b *Malea orbiculata* (Brocchi, 1814) Landau *et al.*, p. 39, pl. 1, fig. 2 (with additional synonyms).
- 2009a *Malea orbiculata* (Brocchi, 1814) Landau *et al.*, p. 64, pl. 1, figs 7-10 (with additional synonyms).
- 2011 Malea orbiculata (Brocchi, 1814) Landau et al.,
 p. 18, pl. 7, fig. 5 (with additional synonyms).

Dimensions and material – Maximum height 68.7 mm. Localities 7 & 8: JvdV/9; locality 12: JVDV/1; locality 17: NHMW 1847/0058/0642-1847/0058/0643/2, JvdV/4, RGM 794 541/1 (ex JvdV collection), YI 351/1 + 1 fragment.

Discussion – As discussed by Landau *et al.* (2004a, p. 40), Brocchi (1814) figured a juvenile specimen, which does not have the thickened outer lip or the strong columellar armour so characteristic of the adult shell. This led Deshayes (1833, p. 194) to describe an adult specimen under the name *Dolium denticulatum*. The Karaman Basin shells do not differ from specimens found in numerous northeastern Atlantic and Mediterranean Miocene and Pliocene localities, as discussed by Landau *et al.* (2004a, p. 40).

Distribution – **Early Miocene**: Paratethys (Burdigalian): Hungary (Kókay, 1967). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1924); Paratethys (Langhian-Serravallian): Poland (Bałuk, 1975), Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1884; Harzhauser, 2004a; Landau et al., 2009a), Hungary (Csepreghy-Meznerics, 1954; Strausz, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Algarve (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1890c). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1988; Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (Landau et al., 2004b), northeastern Spain (Martinell, 1979; Solsona, 1998, 1999), Rousillon Basin, France (Fontannes, 1879); central Mediterranean, Italy (Sacco, 1890c; Cavallo & Repetto, 1992; Chirli, 2008). Late Pliocene: central Mediterranean, Italy (Sacco, 1890c; Glibert, 1963a; Caprotti, 1970; Damarco, 1992).

Family Cassidae Latreille, 1825 Subfamily Cassinae Latreille, 1825 Genus *Cassis* Scopoli, 1777

Type species – Buccinum cornutum Linnaeus, 1758, by subsequent designation (Dall, 1909). Recent, Indo-West Pacific.

Cassis postmamillaris Sacco, 1890

Plate 17, figs 2-4; Plate 79, fig. 8

- *1890b Cassis postmamillaris Sacc., Sacco, p. 16, pl. 1, fig. 11.
- 1958 *Cassis (Cassis) postmamillaris* Sacco Erünal-Erentöz, p. 48, pl. 7, fig. 3.
- 2009a *Cassis postmamillaris* Sacco, 1890 Landau *et al.*, p. 64, pl. 2, figs 1-4 (with additional synonyms).

Dimensions and material – Maximum height 136.0 mm.

Localities 2 & 3: JvdV/4, RGM 783 913/4; locality 6: JvdV/5, RGM 783 847/1; localities 7 & 8: JvdV/1, RGM 783 896/1; locality 9: RGM 783 836/1; locality 13: NHMW 1847/0058/0714-1847/0058/0715/2, JvdV/2, RGM 783 644-783 645/4; locality 17: NHMW 1847/0058/0687-1847/0058/0713/26, 1847/0058/1628-1847/0058/1634/7, JvdV/36, RGM 777 870/1 (ex JvdV collection), RGM 783 745-783 749/10, MTA 2013/025/6, YI 21/29. Exact locality unknown: AÜ LE-K-216/1.

Discussion – Cassis postmamillaris Sacco, 1890 is characterised by three rows of relatively widely spaced nodules, the shoulder row more strongly developed than the others, with the dorsal tubercle the most prominent. The parietal shield is massive and triangular in shape and the denticles within the outer lip are strongly developed (8-9 in number). It also has 10-12 denticles of varying size on the inner lip. This species occurs in the middle Miocene Proto-Mediterranean Sea and Paratethys. A colour pattern is visible under UV light in one juvenile shell, and consists of wavy vertical stripes (Pl. 79, fig. 8), similar to that seen in the Recent Caribbean species *Cassis flammea* (Linnaeus, 1758).

At least two further species occur in the Miocene Proto-Mediterranean Sea. The first, *Cassis bellardii* Michelotti, 1847 from the early Miocene Burdigalian of the Turin Hills, Italy has a large oval shell, with three rows of even sized nodules, a knobbly surface sculpture between these rows, and a rather thin parietal shield. The second, *Cassis pedemontana* Sacco, 1890, from the same Turin Hills deposits, is also ovate, has two relatively prominent rows of spiral tubercles adapically and two weaker rows abapically, but no sculpture between the rows on the last whorl, the parietal shield and outer lip are moderately thickened and the outer lip bears 14 moderate-sized denticles within. For further discussion see Landau *et al.* (2009a).

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Schultz, 1998; Landau *et al.*, 2009a), Slovak Republic, (Hörnes, 1852), Czech Republic, (Hörnes, 1852), Romania (Kojumdgieva & Strachimirov, 1960; Landau *et al.*, 2009a); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1890b).

Genus Cypraecassis Stutchbury, 1837

Type species – Buccinum rufum Linnaeus, 1758, by original designation. Recent, Indo-West Pacific.

Cypraecassis cypraeiformis (Borson, 1820) Plate 17, fig. 5

- *1820 Cassis cypraeiformis nobis, Borson, p. 229, pl. 1, fig. 20.
- 1951 Cassis cypraeiformis Bors. Friedberg, p. 113, pl. 6, fig. 4.

- 1955 Phalium (Cassidea) cypraeiformis Borson, 1820 Miosescu, p. 139, pl. 12, figs 1, 2.
- 1956 *Cypraecassis cypraeiformis* (Borson) Csepreghy-Meznerics, p. 396, pl. 4, figs 17, 18.
- 1958 *Phalium (Phalium) cypraeiformis* (Borson) Erünal-Erentöz, p. 45, pl. 6, fig. 11.
- 2003 *Cypraecassis cypraeiformis* (Borson, 1820) Ceranka & Złotnik, p. 494, fig. 2E.
- 2004b *Cypraecassis cypraeformis* (Borson, 1820) Landau *et al.*, p. 40, pl. 1, figs 3-6, pl. 2, fig. 1 (with additional synonyms).
- 2009a *Cypraecassis cypraeformis* (Borson, 1820) Landau *et al.*, p. 66, pl. 3, figs 3-5 (with additional synonyms).
- 2011 *Cypraecassis cypraeformis* (Borson, 1820) Landau *et al.*, p. 18, pl. 7, fig. 6 (with additional synonyms).

Dimensions and material – Maximum height 47.3 mm. Localities 2 & 3: JvdV/1; locality 13: NHMW 1847/-0058/1682/1; locality 17: NHMW 1847/0058/0644/1.

Discussion – As discussed by Landau et al. (2004b), we recognise a single Miocene-Pliocene species Cypraecassis cypraeiformis (Borson, 1820). Typical specimens of C. cypraeiformis from the middle Miocene, Atlantic, Proto-Mediterranean Sea and Paratethys have a relatively broad shell, strong axial sculpture with well-developed tubercles at the shoulder and a greatly thickened labial varix and basal callus, which extends onto the lateral wall to form a thick marginal callus. Shells in the late Miocene and Pliocene populations from the Mediterranean and adjacent Atlantic are typically more elongate than those from older assemblages. They also have weak nodules at the shoulder and a thinner labial varix and basal callus, which is clearly delimited but does not extend beyond the base. However, shells with ancestral characters can be found in Pliocene assemblages and vice versa. It seems, therefore, that there is no constant teleoconch character that separates the various nominal Neogene Cypraecassis taxa reliably. The differences in the prominence and thickness of the apertural armature are analogous to those seen between the Miocene and Pliocene forms of Semicassis laevigata (Defrance, 1817), the Miocene forms usually having a thicker outer lip and more developed parietal callus (see below under S. laevigata). For further discussion see Landau et al. (2004b, 2009a). We correct the spelling 'cypraeformis' used in many works including Landau et al. (2004b, 2009a, 2011). This misspelling was first seen in Sacco (1890b, p. 20) where it was used in his synonymy, although in the main species headings the spelling is correct.

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Borson, 1820; Sacco, 1890b). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1884; Glibert, 1963a; Landau *et al.*, 2009a), Poland (Friedberg, 1912; Bałuk, 1995; Ceranka & Złotnik, 2003), Hungary (Strausz, 1966; Csepreghy-Meznerics, 1956, 1969a), Czech Republic (Landau et al., 2009a), Romania (Moisescu, 1955); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: north-eastern Atlantic (Tortonian): Algarve (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1890b). Early Pliocene: north-eastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1988; Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (Landau et al., 2004b), Rousillon Basin, France (Fontannes, 1882); central Mediterranean, Italy (Sacco, 1890b; Pavia, 1975; Chirli, 2008). Late Pliocene: north-eastern Atlantic, Mondego Basin, Portugal (Zbyszewski, 1959; Silva, 2001); central Mediterranean, Italy (Sacco, 1890b; Caretto, 1963; Glibert, 1963a; Malatesta, 1974; Cavallo & Repetto, 1992), Sicily (Glibert, 1963a).

Subfamily Phaliinae Beu, 1981 Genus *Semicassis* Mörch, 1853

Type species – Cassia japonica Reeve, 1848, by subsequent designation (Harris, 1897). Miocene-Recent, Indo-West Pacific.

Semicassis laevigata (Defrance, 1817)

Plate 17, fig. 6

- *1817 Casque lisse, *Cassis laevigata*, Nob., Defrance, *in* Cuvier, p. 210.
- 1936 *Cassis (Semicassis) miolaevigata* Sacco Bogsch, p. 75, pl. 2, fig. 13.
- 1942 Semicassis (Semicassis) miolaevigata Sacco Wenz, p. 210, pl. 1, fig. 5.
- 1951 Cassis saburon Lam. Friedberg, p. 110, pl. 6, fig.3, text-fig. 31.
- 1955 Phalium (Cassidea) saburon Lamarck, 1822 Moisescu, p. 138, pl. 11, figs 14, 18.
- 1956 Phalium (Semicassis) miolaevigatum (Sacco, 1890) Rasmussen, p. 63, pl. 5, fig. 4.
- 1956 Semicassis miolaevigata (Sacco) Csepreghy-Meznerics, p. 396, pl. 4, figs 9-11.
- 1958 *Phalium (Semicassis) miolaevigatus* Sacco Erünal-Erentöz, p. 47, pl. 7, fig. 2.
- 1968 *Phalium saburon* (Lamarck, 1822) Zelinskaya *et al.*, p. 182, pl. 43, figs 5, 6.
- 1989 Semicassis miolaevigata (Sacco, 1890) Moths, p. 111, pl. 13, fig. 62.
- 2001 Semicassis (Semicassis) miolaevigata (Sacco, 1890) – Wienrich, p. 437, pl. 70, fig. 7, pl. 90, figs 1-2.
- 2003 Semicassis miolaevigata Sacco, 1890 Ceranka & Złotnik, p. 494, fig. 2A.
- 2004b *Semicassis laevigata* (Defrance, 1817) Landau *et al.*, pl. 3, figs 1, 2 (with additional synonyms).
- 2009a Semicassis laevigata (Defrance, 1817) Landau et al., p. 67, pl. 4, figs 1-2 (with additional synonyms).
- 2009 Semicassis (Semicassis) miolaevigata (Sacco, 1890) Mikuž, p. 17, pl. 3, figs 45, 46.

2011 Semicassis laevigata (Defrance, 1817) – Landau et al., p. 18, pl. 7, fig. 8 (with additional synonyms).

Dimensions and material – Maximum height 60.2 mm. Localities 2 & 3: JvdV/6; locality 6: NHMW 1847/0058/1486/2, JvdV/2, RGM 783 846/1, YI 23/2; localities 7 & 8: NHMW 1847/0058/0651-1847/0058/0653/3, JvdV/3, RGM 783 897/2; locality 9: RGM 783 835/1; locality 12: JvdV/6; locality 13: NHMW 1847/0058/0649-1847/0058/0650/2, 1847/0058/1681/1, JvdV/18, RGM 783 646/9, MTA 2013/026/6, YI 22/8; locality 17: NHMW 1847/0058/0645-1847/0058/0648/4, JvdV/2, RGM 783 750/1.

Discussion – Semicassis laevigata (Defrance, 1817) is not common in the Karaman deposits. All the specimens found are more similar to the *Semicassis miolaevigata* Sacco, 1890 morphotype, which is broader and thicker shelled than typical Pliocene Mediterranean shells of *Semicassis laevigata* (Defrance, 1817). The labral varix in the Karaman specimens is not markedly thickened, however, as is characteristic of the Miocene forms. Landau *et al.* (2004b, 2009a) considered all these forms to be conspecific, with a whole range of variability observed within the Paratethyan specimens, intergrading with typical Pliocene *S. laevigata*. For further discussion see Landau *et al.* (2004b, 2009a).

Distribution – Early Miocene: Paratethys (Burdigalian): Hungary (Harzhauser, 2004a); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1890b). Early-Middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (A.W. Janssen, 1984a), Germany (Moths, 1989; Wienrich, 2001). Middle Miocene: north-eastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1924; Glibert, 1963a); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Schultz, 1998; Harzhauser, 2002, 2004a; Landau et al., 2009a), Czech Republic (Hörnes, 1852; Harzhauser, 2004a), Poland (Friedberg, 1912; Bogsch, 1936; Bałuk, 1995; Bałuk & Radwański, 1996; Ceranka & Złotnik, 2003), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Bogsch, 1936; Strausz, 1966; Csepreghy-Meznerics, 1956, 1969a), Bosnia (Atanackovíc, 1963, 1985), Romania (Boettger, 1902; Moisescu, 1955; Hinculov, 1968; Ionesi & Nicorici, 1994; Landau et al., 2009a), Ukraine (Zelinskaya et al., 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: North Sea Basin (Tortonian): Denmark (Rasmussen, 1956; Schnetler, 2005); north-eastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867), southern Spain (Wenz, 1942); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1890b). Early Pliocene: North Sea Basin, England (Wood, 1872), Belgium (Marquet, 1997b); north-eastern Atlantic, Mondego Basin, Portugal (Zbyszewski, 1959, Silva, 2001), Guadalquivir Basin, Spain (González Delgado, 1988; Landau et al., 2011), Morocco (Lecointre, 1952); western Mediterranean,

Estepona Basin, Spain, (Landau *et al.*, 2004b), northeastern Spain ((Martinell, 1979; Solsona, 1998, 1999), Rousillon Basin, France (Fontannes, 1882); central Mediterranean, Italy (Sacco, 1890b; Caprotti, 1974; Cavallo & Repetto, 1992; Chirli, 2008), Tunisia (Fekih, 1975). Late Pliocene: central Mediterranean, Italy (Sacco, 1890b; Caprotti, 1970; Malatesta, 1974; Damarco, 1993). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1911).

Family Ranellidae J.E. Gray, 1854 Subfamily Cymatiinae Iredale, 1913 Genus *Charonia* Gistel, 1847

Type species – Murex tritonis Linnaeus, 1758, by monotypy. Recent, Indo-Pacific.

Charonia lampas (Linnaeus, 1758)

Plate 18, figs 1-3

- *1758 Murex lampas Linnaeus, p. 748.
- 1951 Triton nodiferum Lam. Friedberg, p. 125, pl. 7, fig. 3, text-fig. 37.
- 2004b *Charonia lampas* (Linnaeus, 1758) Landau *et al.*, p. 53, pl. 4, fig. 1 (with additional synonyms).
- 2009a *Charonia lampas* (Linnaeus, 1758) Landau *et al.*, p. 71, pl. 5, figs 5-7 (with additional synonyms).
- 2011 *Charonia lampas* (Linnaeus, 1758) Landau *et al.*, p. 19, pl. 8, fig. 1 (with additional synonyms).

Dimensions and material – Maximum height incomplete, 150+ mm. Locality 13: NHMW 1847/0058/0655/1 subadult, NHMW 1847/0058/0654/1 juvenile, JvdV/2, RGM 794 543/1 (ex JvdV collection), RGM 783 647/1, 783 702/1, YI 24/1 broken subadult specimen.

Discussion – As discussed by Landau *et al.* (2004b), *Charonia lampas* (Linnaeus, 1758) is an extremely variable species, with a wide geographical and chronological distribution. This has led to it receiving an enormous number of names, many based on juvenile specimens or sculptural variants. Beu (1998, 2010) reviewed the names attributed to this species extensively and considered there to be a single Eocene to Recent species.

Miocene specimens are generally smaller than Pliocene shells, and in turn Pliocene specimens are smaller than Recent shells. The maximum height in the Turkish assemblages is about 150 mm. For shells from the Italian Pliocene the maximum height is about 250 mm (Inzani, 1988, p. 26), whereas a few fully adult Recent specimens attain 320 mm (Poppe & Goto, 1991, p. 129) and sizes up to 550 mm have been recorded in the Mediterranean (Settepassi, 1970). This size difference between fossil and Recent shells is possibly due to the lower preservation of very large shells, compared with smaller ones.

Charonia seguenzae (Aradas & Benoit, 1870), which occurs in the Recent eastern Mediterranean (Beu, 2010, p. 125), has a much more slender shell, with a higher spire. The spiral sculpture consists of broad cords, which are

not nodular and the character of the labial and columellar dentition are quite different. It is distinguished from the western Atlantic-Azores and, rarely, West African species *C. variegata* (Lamarck, 1816) by its consistently taller and narrower shape and by slight but consistent apertural characters (Beu, 2010). *Charonia guichemerri* Lozouet, 1998 from the Atlantic early Miocene, Aquitanian of France differs from *C. lampas* in being more slender, with a higher spire and in having a spiral sculpture composed of broad spiral cords. It appears to be more closely related to *C. seguenzae* than to *C. lampas. Charonia veterior* Lozouet, 1999 from the early Oligocene of France differs from *C. guichemerri* and *C. lampas* by the character of its sculpture, which consists of numerous rows of regular nodules.

Distribution – Eocene: Italy (de Gregorio, 1880, 1894). Early Miocene: north-eastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1924; Lozouet, 1999; Lozouet et al., 2001a); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1873). Middle Miocene: Paratethys, Langhian-Serravallian, Vienna Basin, Austria (Hörnes, 1856; Hoernes & Auinger, 1884; Landau et al., 2009a), Poland (Friedberg, 1912; Bałuk, 1995); Pacific, Australia (Beu, 1988); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Caribbean, Dominican Republic; Pacific, Japan, New Zealand (Beu, 1988). Early Pliocene: north-eastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (Landau et al., 2004b); Rousillon Basin, France (Fontannes, 1880; Glibert, 1963a); central Mediterranean, Italy (Chirli, 2008). Late Pliocene: central Mediterranean, Italy (Bellardi, 1873; Sacco, 1904; Glibert, 1963a; Malatesta, 1974; Inzani, 1988; Damarco, 1992; Spadini, 1994); Caribbean, Dominican Republic (Beu, 2010). Late Pliocene/Pleistocene: Caribbean, Florida (Beu, 1998, 2010); Venezuela (Gibson-Smith, 1976). Pleistocene: north-eastern Atlantic, Balearic Islands (Cuerda Barceló, 1987); Morocco (Lecointre, 1952); central Mediterranean, Italy (Malatesta, 1974), Sicily (Glibert, 1963a); New Zealand (Powell, 1934 as Charonia capax euclioides Finlay, 1926). Recent: Circumglobal distribution, throughout much of the warm-temperate to subtropical realm, except the tropical Indo-West Pacific and Panamic western America (Beu, 1998).

Genus Cymatium Röding, 1798

Type species – Murex femorale Linnaeus, 1758, by subsequent designation (Dall, 1904). Pleistocene-Recent, western Atlantic.

Cymatium sp.

Plate 18, fig. 4

Dimensions and material – Maximum height (incomplete) 82.4 mm. Locality 13: RGM 794 542/1 (ex JvdV collection).

Discussion - In the JvdV collection is an incomplete specimen of a large ranellid, with a wide, concave sutural ramp, strong nodules at the shoulder, and on the last preserved whorl three of these shoulder nodules are more strongly developed than the others, giving the whorl a triangular shape. These are characteristics of the genus Cymatium Röding, 1798. Unfortunately, without the aperture we cannot be certain of this generic assignment. Cymatium Röding, 1798 (as restricted by Beu, 2010, p. 130) has a fossil and Recent distribution mainly restricted to the tropical American region, with one living species present in the waters around East Africa and the Gulf of Arabia. Guerreiro & Reiner (2000) reported Cymatium femorale (Linnaeus, 1758) living in the eastern Atlantic Cape Verde Islands. In the fossil record, Coulon (1933, p. 134) reported three fossil specimens of 'Triton femorale Lamk.' from the Mediterranean Pliocene of Monastir, Tunisia, North Africa. As remarked by Beu (2010) this record needs to be verified, but seems a little less likely to be a misidentification now that the genus is known to be present in the middle Miocene of Turkey. These records suggest the possibility that the East African species C. ranzanii (Bianconi, 1850) reached the Gulf of Arabia through the Mediterranean and Red Seas rather than by crossing the great width of the Indo-West Pacific region.

Distribution - Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Monoplex Perry, 1810

Type species – Monoplex australasiae Perry, 1811 (= Murex parthenopeus Salis Marschlins, 1793), by subsequent designation (Dall, 1904). Recent, cosmopolitan.

Monoplex corrugatus (Lamarck, 1816) Plate 18, figs 5-7

- *1816 Triton corrugatum Lamarck, p. 181.
- 1951 Triton affine Desh. - Friedberg, p. 128, pl. 7, fig. 6. 1958 Cymatium (Lampusia) affine (Deshayes) - Erünal-
- Erentöz, p. 48, pl. 7, figs 4, 4a. 1968 Cymatium affine (Deshayes, 1832) - Zelinskaya et al., p. 183, pl. 43, figs 9, 10.
- 2004b Cymatium (Monoplex) corrugatum (Lamarck, 1822) - Landau et al., p. 55, pl. 4, fig. 2 (with additional synonyms).
- 2009a Monoplex corrugatus (Lamarck, 1816) - Landau et al., p. 71, pl. 6, figs 1, 2 (with additional synonyms).
- 2011 Monoplex corrugatus (Lamarck, 1816) - Landau et al., p. 19, pl. 8, fig. 2 (with additional synonyms).

Dimensions and material - Maximum height 86.8 mm. Localities 2 & 3: JvdV/7, RGM 783 914/1, YI 26/6; locality 6: NHMW 1847/0058/1493/2, JvdV/6, RGM 783 848/1; localities 7 & 8: NHMW 1847/0058/0659/7, RGM 783 907/2; locality 12: JvdV/37, RGM 783 602/20; locality 13: NHMW 1847/0058/0656-1847/0058/0658/3, 1847/0058/0660/30, JvdV/50+, RGM 783 648-783 649/50+, MTA 2013/027/17; YI 27/50+; locality 17: NHMW 1847/0058/0659/25, JvdV/50+, RGM 783 751/22, MTA 2013/028/3, YI 25/35. Exact locality unknown: AÜ-LE-K-217/1.

Discussion – Monoplex corrugatus (Lamarck, 1816) is the most abundant ranellid in the Karaman deposits, found in both the clayey and sandy assemblages, where some specimens attain a large size. As seen in the series illustrated, the shells can be squat (Pl. 18, fig. 6) to relatively slender (Pl. 18, fig. 7).

Cossmann & Peyrot (1924) considered the Central European shells to be different from Monoplex affinis (Deshayes, 1833) (i.e. M. corrugatus) in having squatter shells, with a shorter siphonal canal and more strongly nodulose axial ribs. They proposed the name Eutritonium (Lampusia) friedbergi for the Paratethyan population. Monoplex corrugatus (Lamarck, 1816) is highly variable and more elongate specimens with longer siphonal canals indistinguishable from Italian Pliocene shells occur syntopically with squatter ones in the Turkish assemblages. Monoplex subcorrugatus (d'Orbigny, 1852), from the early Miocene Aquitanian and Burdigalian of the Aquitaine Basin, France (Lozouet et al., 2001a, p. 46, pl. 19, fig. 1a, b) seems likely to have been ancestral to M. corrugatus. It is similar to M. corrugatus in most characters, but differs in its smaller maximum size, wider shape, more prominent spiral cords, and much heavier, thicker varices. Lozouet et al. (2001a, p. 46) pointed out that nearly all the species proposed in Eutritonium and Ranularia by Cossmann & Peyrot (1924) are synonyms of M. subcorrugatus (E. aquitanicum, E. dolarioides, R. multicostata, R. duvergieri). For further discussion see Landau et al. (2004b, 2009a).

Distribution - Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1873). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (A.W. Janssen, 1984a). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1853; Hoernes & Auinger, 1884; Schultz, 1998; Landau et al., 2009a), Poland (Friedberg, 1912; Bałuk, 1995; Bałuk & Radwański, 1996), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Hörnes, 1853; Strausz, 1966; Csepreghy-Meznerics, 1950, 1969a), Czech Republic (Hörnes, 1853), Romania (Boettger, 1902), Ukraine (Zelinskava et al., 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: north-eastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1873; Montanaro, 1935). Early Pliocene: north-eastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011), Morocco (Lecointre, 1952); western Mediterranean, Estepona Basin, Spain (Landau et al., 2004b), northeastern Spain ((Martinell, 1979; Solsona, 1998), Rousillon Basin, France (Fontannes, 1880; Glibert, 1963a; Chirli & Richard, 2008); central Mediterranean, Italy (Bellardi, 1873; Malatesta, 1974; Cavallo & Repetto, 1992; Chirli, 2008), Tunisia (Fekih, 1975). Late Pliocene: central Mediterranean, Italy (Bellardi, 1873; Glibert, 1963a; Caprotti, 1970; Malatesta, 1974; Inzani, 1988; Damarco, 1992; Spadini, 1994; Inzani & Bertarelli, 1995). Pleistocene: north-eastern Atlantic, Morocco (Lecointre, 1952; Brébion, 1979); Balearic Islands (Cuerda Barceló, 1987). Recent: north-eastern Atlantic, Bay of Biscay to Angola, Canaries and Madeira, Mediterranean, commoner in the western part. All types of bottoms at depths 15-22 m (Poppe & Goto, 1991).

Monoplex heptagonus (Brocchi, 1814)

Plate 18, figs 8-10

- *1814 *Murex heptagonus* nob., Brocchi, p. 404, pl. 9, fig. 2.
- 1951 Triton heptagonum Brocc. Friedberg, p. 128, pl. 7, fig. 6.
- 2004b *Cymatium (Monoplex) heptagonum* (Brocchi, 1814) Landau *et al.*, p. 58, pl. 4, fig. 5, pl. 9, fig. 2 (with additional synonyms).
- 2009a *Monoplex heptagonus* (Brocchi, 1814) Landau *et al.*, p. 71, pl. 6, figs 3, 4 (with additional synonyms).
- 2011 *Monoplex heptagonus* (Brocchi, 1814) Landau *et al.*, p. 19, pl. 8, fig. 4 (with additional synonyms).

Dimensions and material – Maximum height 32.9 mm. Localities 2 & 3: JvdV/5; locality 6: JvdV/1, YI 28/1; localities 7 & 8: NHMW 1847/0058/0666/5, JvdV/3; locality 12: JvdV/10, RGM 783 603/3; locality 13: NHMW 1847/0058/0662-1847/0058/0664/3, 1847/0058/0665/26, JvdV/20, RGM 783 651/7, YI 30/43, MTA 2013/088/3; locality 17: NHMW 1847/0058/1640/12, JvdV/4, RGM 783 752/3, YI 29/1.

Discussion – Monoplex heptagonus (Brocchi, 1814) is distinguished from its congeners by its rather squat shape, its depressed scalate spire, its fewer axial ribs and by having only two varices. The denticles within the outer lip are bifid in most specimens, as opposed to simple in most other species, and the siphonal canal is straight and very narrow. Landau *et al.* (2004b, 2009a) considered the Paratethyan species *Triton wimmeri* (Hoernes & Auinger, 1884) to be a junior subjective synonym of *Monoplex heptagonus* (Brocchi, 1814).

For further discussion see Landau et al. (2004b, 2009a).

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Glibert, 1963a). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1853; Hoernes & Auinger, 1884), Poland (Friedberg, 1912; Bałuk, 1995), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Hörnes, 1853; Strausz, 1966; Csepreghy-Meznerics, 1950, 1969a), Romania (Hörnes, 1853; Landau *et al.*, 2009a); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1873; Glibert, 1963a). Early Pliocene: North Sea Basin, Coralline Crag, England (Wood, 1848, 1872, 1879; ?Harmer, 1914); north-eastern Atlantic, Guadalquivir Basin, Spain (Landau *et al.*, 2011); western Mediterranean, Estepona Basin, Spain (Landau *et al.*, 2004b), Morocco (Lecointre, 1952), Rousillon Basin, France (Fontannes, 1880); central Mediterranean, Italy (Bellardi, 1873; Sacco, 1904; Cavallo & Repetto, 1992; Chirli, 2008). Late Pliocene: north-eastern Atlantic, Mondego Basin, Portugal (Cox, 1936); central Mediterranean, Italy (Bellardi, 1873; Sacco, 1904; Glibert, 1963a; Inzani, 1988; Spadini, 1994).

Monoplex parthenopeus (von Salis Marschlins, 1793) Plate 18, figs 11, 12

- *1793 *Murex parthenopeus* von Salis Marschlins, p. 370, pl. 7, fig. 4.
- 2004b Cymatium (Monoplex) parthenopeum (von Salis Marschlins, 1798 [sic]) Landau et al., p. 60, pl. 4, fig. 6, pl. 9, fig. 3 (with additional synonyms).
- 2008 *Cymatium parthenopeum* (von Salis, 1793) Chirli, p. 95, pl. 35, figs 3-8.
- 2010 *Monoplex parthenopeus* (von Salis Marschlins, 1793) Beu, p. 166, pl. 40, figs 2, 8-9, pl. 41, figs 2, 4, pl. 42, figs 1, 5, 7 (with additional synonyms).
- 2011 Monoplex parthenopeus (von Salis Marschlins, 1793) Landau et al., p. 19, pl. 8, fig. 4.

Dimensions and material – Maximum height 74.4 mm. Localities 2 & 3: JvdV/1; locality 13: NHMW 1847/0058/0668/3, JvdV/3, RGM 794 066/1 (ex JvdV collection); locality 17: NHMW 1847/0058/0667/1, NHMW 1847/0058/0668/7, JvdV/2, YI 352/1 incomplete specimen.

Discussion – Monoplex parthenopeum (von Salis Marschlins, 1793) is easily distinguished from its congeners by being the largest European Neogene species of *Monoplex*, by having a thinner shell, a more globose shape, less angular and more regularly convex whorls, predominantly spiral sculpture, and fewer, weaker varices. Most specimens have two varices, a few have only the terminal varix present, and a few specimens throughout the world population have all varices present down the entire teleoconch. The siphonal canal is shorter, wider and more strongly abaxially recurved and the parietal and columellar callus are less strongly developed than in any of its European Neogene congeners. For further discussion see Landau *et al.* (2004b, p. 61).

Distribution – Early Miocene: western Atlantic, Caribbean (Baitoa Formation): Dominican Republic (Beu, 2010). Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Tethys (Tortonian): Po valley, Italy (Bellardi, 1873; Montanaro, 1935; Glibert, 1963a); western

Atlantic, Caribbean (Gatun Formation): Cativa, Panama, (Cercado & Gurabo Formations): Dominican Republic (Beu, 2010). Early Pliocene: north-eastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (Landau et al., 2004b), northeastern Spain (Martinell, 1979; Solsona, 1998), France (Fontannes, 1880; Glibert, 1963a); central Mediterranean, Italy (Chirli, 2008); western Atlantic, Caribbean, Florida (Olsson & Petit, 1964). Early-late Pliocene: central Mediterranean, Italy (Bellardi, 1873; Sacco, 1904; Glibert, 1963a; Caprotti, 1970; Malatesta, 1974; Inzani, 1988; Cavallo & Repetto, 1992; Damarco, 1992; Spadini, 1994); western Atlantic, Mexico (Beu, 2010). Late Pliocene: western Atlantic (Bowden Formation): Jamaica (Beu, 2010), Mexico (Beu, 2010). Pleistocene: eastern Atlantic, Balearic Islands (Cuerda Barceló, 1987); central Mediterranean, Sicily (Glibert, 1963a), Tunisia (Glibert, 1963a); western Atlantic, Caribbean, Florida (Petuch, 1994), Venezuela (Beu, 2010); south-western Pacific, New Zealand (Powell, 1934). Recent: eastern Atlantic (Spain to Angola) and western Atlantic (North Carolina to central Argentina), South Africa, East Africa, northern Indian Ocean, Red Sea, southern, eastern and western coasts of Australia, New Zealand, New Caledonia, Hawaii, southern and central Japan (Beu, 1998); *i.e.* along with the similar C. keenae (Beu, 1970) in the eastern Pacific, it occupies all the temperate and tropical oceans, other than the tropical central Pacific. Lives on all types of bottoms, depth 10-30 m (Poppe & Goto, 1991).

Monoplex sp.

Plate 18, fig. 13

Dimensions and material – Maximum height (incomplete) 33.9 mm. Locality 13: RGM 794 557/1 (ex JvdV collection).

Discussion – A single incomplete specimen of a distinctive species of *Monoplex*, similar to *M. doderleini* (d'Ancona, 1872), is present in the JvdV collection. An alternative suggested by the subdivided spiral cords is that this broken shell represents a *Cabestana* species of the Southern Hemisphere species-group of *C. tabulata* (Menke, 1843) and *C. felipponei* (Ihering, 1907) rather than of the Mediterranean-West African *C. cutacea* (Linnaeus, 1758) species-group (Alan Beu, personal communication, 2012). Unfortunately, the state of preservation is too poor to comment further.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Turritriton Dall, 1904.

Type species – Triton gibbosus Broderip, 1833, by original designation. Pliocene to Recent, eastern Pacific and western Atlantic.

Turritriton kobelti (von Maltzan, 1884) Plate 19, figs 1-3

- *1884 Triton Kobelti von Maltzan, p. 66.
- 1979 *Cymatium (Turritriton) gibbosum gomezi* Nordsieck & García-Talavera, p. 119, p. 25, fig. 13.
- 1980 *Cymatium kobelti* (von Maltzan, 1884) Saunders, p. 5, unnumbered central fig.
- 1987 *Cymatium (Turritriton) kobelti* (von Maltzan, 1884) Beu & Knudsen, p. 83, figs 4, 26-30, 33, 36-38.
- 2005 *Cymatium kobelti* (Maltzan, 1884) Rolán, p. 97, figs 404, 405.
- non 1987 Cymatium (Turritriton) cf. kobelti Beu & Knudsen, p. 85, figs 34, 35 [= Turritriton cf. gibbosum (Broderip, 1833) fide Beu, 2010].

Dimensions and material – Maximum height 20.1 mm. Locality 13: NHMW 1847/0058/0670-1847/0058/0672/3, YI 31/1.

Discussion – The presence of the genus *Turritriton* Dall, 1904 in the middle Miocene Paratethys was discussed by Landau *et al.* (2009a). There it is represented by the very rare species *Turritriton grundensis* (Hoernes & Auinger, 1884), recorded from the Austrian and Polish assemblages. It is with some surprise that we record the presence of *Turritriton kobelti* (von Maltzan, 1884) in the middle Miocene eastern proto-Mediterranean Karaman deposits. To our knowledge, this is the first fossil record of the species. Beu & Knudsen (1987) identified a single shell from the Pliocene Caribbean coast of Colombia as *Cymatium (Turritriton*) cf. *kobelti*, but this was later identified as *Turritriton* cf. *gibbosum* (Broderip, 1833) by Beu (2010, pl. 49, figs 6, 7).

Turritriton kobelti is extremely similar to the Pliocene to Recent, eastern Pacific and western Atlantic species Turritriton gibbosum (Broderip, 1833), and there are almost no consistent teleoconch differences. Turritriton kobelti reaches a markedly smaller adult size than T. gibbosum and squat, short-spired individuals, common in T. gibbosum, are not present in T. kobelti. However, their protoconchs differ consistently in size, shape, colour and sculptural details (Beu & Knudsen, 1987, figs 1-4). Unfortunately, our specimen from Karaman does not have the protoconch preserved, but the teleoconch is more nearly similar to that of T. kobelti than to T. gibbosum or T. grundensis (A. Beu, personal communication, 2011). Turritriton kobelti differs from T. grundensis in having a lighter, less stocky shell, with a taller spire, deeper sutures, more angular whorls and the varices are more alate at the shoulder than in T. grundensis.

Beu (2010) suggested that there are three species groups within *Turritriton*: the *T. domingensis-labiosus* group with a Caribbean and Tethyan distribution, the *T. grun-densis-gibbosus-kobelti* group limited to the middle Miocene Paratethys in Europe, and today limited to the eastern Pacific, western Atlantic and West Africa, and the Atlantic and Indo-West Pacific *T. tenuiliratus* group.

The presence of *T. kobelti* in the middle Miocene eastern Proto-Mediterranean Sea further supports a distinct ancestry for *T. gibbosus* and *T. kobelti* from the origin of *T. domingensis* (Gabb, 1873), as suggested by Beu (2010).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Recent**: Canary Islands, Cape Verde Islands, Senegal, south to Angola, western Mediterranean (Beu & Knudsen, 1987).

Genus Sassia Bellardi, 1873

Type species – Triton apeninnicum Sassi, 1827, by subsequent designation (Cossmann, 1903). Miocene-Pliocene, Europe.

Sassia apenninica (Sassi, 1827) Plate 19, fig. 4

- *1827 Triton apeninnicum Sassi, p. 480 (nomen protectum).
- 1956 *Charonia (Sassia) apenninica* Sassi Csepreghy-Meznerics, p. 397, pl. 4, figs 13-14.
- 2004b Sassia apenninica (Sassi, 1827) Landau et al., p. 62, pl. 5, fig. 1, pl. 10, fig. 3, text-fig. 3.1 (with additional synonym).
- 2009a Sassia apenninica (Sassi, 1827) Landau et al., p. 73, pl. 6, figs 6-7 (with additional synonyms).

Dimensions and material-Maximum height 28.6 mm. Locality 13: NHMW 1847/0058/0673/1, 1847/0058/0674/2.

Discussion - Sassia apenninica (Sassi, 1827) is extremely rare in the Karaman Basin, and has been found only in the clayey assemblages. It is also associated with muddy bottom deposits in the Italian and Spanish Pliocene assemblages. This species is characterised by its mediumsized shell, its multispiral protoconch bearing fine, reticulate sculpture, its carinate teleoconch whorls, its sharp nodular sculpture and relatively long siphonal canal. It is similar to the late Miocene and Pliocene Sassia tuberculifera (Bronn, 1831), but this species differs in being smaller, squatter, with a smaller aperture and a shorter siphonal canal. The spiral cords are more numerous and of more nearly equal strength and the intersections of the sculptural elements bear rounded tubercles, as opposed to short spines (i.e. narrow tubercles) in S. apenninica. For further discussion see Landau et al. (2004b).

We take the opportunity to point out that the shell described as *Bonellitia dertocrenata* by Sacco (1894b, p. 44, pl. 3, fig. 11; holotype reillustrated by Ferrero Mortara *et al.*, 1984, pl. 32, fig. 6), from the late Miocene Tortonian of Stazzano, Italy is not a cancellariid, but a juvenile *Sassia* species (Petit & Haraswych, 2005, p. 44). The shell consists of a multispiral protoconch with a reticulate pattern, similar to that seen in *Sassia tuberculifera* (Bronn, 1831), and 1.5 teleoconch whorls. It could well represent a very juvenile specimen of *S. tuberculifera*. Distribution - Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1873; Glibert, 1963a). Middle Miocene: north-eastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1924); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1853; Hoernes & Auinger, 1884; Glibert, 1963a; Landau et al., 2009a), Poland (Friedberg, 1928; Bałuk, 1995), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1966; Csepreghy-Meznerics, 1956, 1969a), Romania, (Boettger, 1906), Czech Republic, (NHMW collection); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1873; Sacco, 1904; Montanaro, 1935; Glibert, 1963a; Robba, 1968). Early Pliocene: western Mediterranean, Estepona Basin Spain (Landau et al., 2004b), northeastern Spain (Solsona, 1998), Rousillon Basin, France (Glibert, 1963a; Chirli & Richard, 2008), Morocco (Lecointre, 1952); central Mediterranean, Italy (Bellardi, 1873; Pelosio, 1967; Caprotti, 1974; Malatesta, 1974; Cavallo & Repetto, 1992; Chirli, 2008). Late Pliocene: western Mediterranean, northeastern Spain, (Martinell & Domènech, 1986); central Mediterranean, Italy (Bellardi, 1873; Glibert, 1963a; Caprotti, 1970; Marasti & Raffi, 1976; Inzani, 1988; Spadini, 1994).

Sassia turrita (Eichwald, 1830)

Plate 19, figs 5-8; Plate 62, fig. 9

- *1830 Tritonium turritum Eichwald, p. 225.
- 1845 *Triton Tarbellianum* Grat., Grateloup, pl. 29, figs 11, 14.
- 1951 *Triton tarbellianum* Grat. Friedberg, p. 127, pl. 7, figs 4-5.
- 1958 *Charonia (Sassia) tarbellianum* (Grateloup) Erünal-Erentöz, p. 50, pl. 7, figs 5–6.
- 1968 *Cymatium tarbellianum* (Grateloup, 1840) Zelinskaya *et al.*, p. 184, pl. 43, figs 13-14.
- 2007 *Charonia (Sassia) tarbellianum* Grateloup Tițã, p. 548, fig. 5d.
- 2009a Sassia turrita (Eichwald, 1830) Landau et al., p. 73, pl. 6, figs 8, 9, pl. 7, figs 1-3 (with additional synonyms).

Dimensions and material – Maximum height 43.1 mm. Localities 2 & 3: JvdV/1, YI 471/7; locality 6: JvdV/8; localities 7 & 8: NHMW 1847/0058/0684/2, RGM 783 908/1; locality 12: JvdV/42, RGM 783 604/10; locality 13: NHMW 1847/0058/0675-1847/0058/0678/4, 1847/-0058/0679/35, JvdV/50+, RGM 784 021/1, RGM 783 650/50+, MTA 2013/029/10; YI 32/50+. Exact locality unknown: AÜ-LE-K-218/1.

Discussion – Landau *et al.* (2009a) pointed out that the earliest name for this species is *Tritonium turritum* Eichwald, 1830, which has to replace the more widely used name *Triton tarbellianum* Grateloup, 1845. Although this species was not figured by Eichwald until 1852, a valid

description was published in his earlier publication (Eichwald, 1830, p. 225).

Sassia turrita (Eichwald, 1830) is common in the Karaman clayey assemblages. The same range of shell variability discussed by Landau *et al.* (2009a) can be seen in the Turkish specimens. Some of the shells with two rows of tubercles developed on spire whorls are somewhat similar to Sassia apenninica (Sassi, 1827), but they can always be distinguished by their protoconch. In *S. turrita* it is smooth, consisting of three whorls with a small nucleus (dp = 1.0 mm, hp = 910 μ m, dp/hp = 1.1, dp1 = 250 μ m, dn = 120 μ m; Pl. 62, fig. 9), whereas in *S. apeninnica* the protoconch has cancellate sculpture (see Landau *et al.*, 2004b, pl. 10, fig. 3). For further discussion see Landau *et al.* (2009a).

Distribution - Late Oligocene: North Sea Basin (Chattian): Germany (R. Janssen, 1978); Paratethys (Egerian): Hungary (Telegdi-Roth, 1914). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (van Voorthuysen, 1944; Glibert, 1963a; A.W. Janssen, 1984a), Belgium (Glibert, 1952b), Germany (Kautsky, 1925; Anderson, 1964; A.W. Janssen, 1969; Wienrich, 2001). Middle Miocene: north-eastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1924); Paratethys (Langhian-Serravallian): Poland (Friedberg, 1912; Bałuk, 1995), Vienna Basin, Austria (Hörnes, 1853; Hoernes & Auinger, 1884; Schultz, 1998; Landau et al., 2009a), Czech Republic (Hoernes & Auinger, 1884), Hungary (Csepreghy-Meznerics, 1956), Romania (Boettger, 1906, Tițã, 2007), Bulgaria (Kojumdgieva & Strachimirov, 1960), Ukraine (Zelinskaya et al., 1968; Landau et al., 2009a); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Family Bursidae Thiele, 1925a Genus Aspa H. Adams & A. Adams, 1853

Type species – Ranella laevigata Lamarck, 1822 (= *Buccinum marginatum* Gmelin, 1791), by monotypy. Miocene-Recent, Mediterranean and West Africa, early Pleistocene Caribbean, Costa Rica.

Aspa marginata (Gmelin, 1791)

Plate 19, fig. 9

- *1791 Buccinum marginatum Gmelin, 1791, p. 3486.
- 1951 Ranella marginata Bon. Friedberg, p. 123, pl. 7, fig. 1.
- 1958 Bursa (Ranella) marginata (Brocchi) Erünal-Erentöz, p. 50, pl. 7, figs 7, 8.
- 1968 Aspa marginata (Martini, 1777) Zelinskaya et al., p. 184, pl. 43, figs 17, 18.
- 2004b Bufonaria (Aspa) marginata (Gmelin, 1791) Landau et al., p. 69, pl. 5, figs 6, 7, pl. 10, fig. 2 (with additional synonyms).
- 2009a Aspa marginata (Gmelin, 1791) Landau et al., p.
 78, pl. 9, figs 1, 2 (with additional synonyms).

2011 Aspa marginata (Gmelin, 1791) – Landau et al., p. 19, pl. 8, figs 7, 8 (with additional synonyms).

Dimensions and material – Maximum height 57.8 mm. Localities 2 & 3: JvdV/5, YI 34/2; locality 12: JvdV/50+, RGM 783 615 & 783 953/50+; locality 13: NHMW 1847/0058/0680/1, 1847/0058/0681/28, JvdV/50+, RGM 783 652/22, MTA 2013/030/5, YI 33/32; locality 17: YI 35/1. Exact locality unknown: AÜ-LE-K-219/2.

Discussion - As discussed by Landau et al. (2004, p. 70), we consider the middle Miocene to Recent populations to represent a single species, Aspa marginata (Gmelin, 1791), forming part of an evolutionary lineage with Aspa subgranulata (d'Orbigny, 1852) ancestral to it. Like the Paratethyan middle Miocene populations, the Turkish specimens are clearly of the Pliocene-Recent form. Unlike the Paratethyan and many Pliocene Mediterranean and adjacent Atlantic assemblages, Aspa marginata is relatively uncommon in the Karaman deposits and found almost exclusively in the clayey deposits. This is surprising, as in the Pliocene assemblages it is found in large numbers at many localities associated with sandy environments (Landau et al., 2011). For further discussion see Landau et al. (2004b, 2009a). A neotype was designated by Beu (2010, p. 67, pl. 51, figs 1-3).

Distribution – Early Miocene: Paratethys (Burdigalian): Hungary (Steininger, 1973; Harzhauser, 2004a); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1873). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1853; Glibert, 1963a; Schultz, 1998; Landau et al., 2009a), Poland (Friedberg, 1912; Bałuk, 1995; Bałuk & Radwański, 1996), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Csepreghy-Meznerics, 1954; Strausz, 1966), Bosnia (Atanackovíc, 1985), Romania (Hoernes & Auinger, 1884; Boettger, 1906), Ukraine (Zelinskaya et al., 1968). Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: north-eastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867), France (Cossmann & Peyrot, 1924); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1873; Montanaro, 1935; Glibert, 1963a; Marasti, 1973). Early Pliocene: north-eastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1988; Landau et al., 2011); western Mediterranean, Estepona Basin (Landau et al., 2004b), northeastern Spain, (Martinell, 1979; Solsona, 1998), Rousillon Basin, France (Fontannes, 1879; Glibert, 1963a; Chirli & Richard, 2008), Morocco (Lecointre, 1952); central Mediterranean, Italy (Bellardi, 1873; Pelosio, 1967; Caprotti, 1974; Malatesta, 1974; Cavallo & Repetto, 1992; Chirli, 2008), Tunisia (Fekih, 1975). Late Pliocene: central Mediterranean, Italy (Bellardi, 1873; Glibert, 1963a; Palla, 1967; Caprotti, 1970; Malatesta, 1974), Sicily (Glibert, 1963a), Algeria (Glibert, 1963a). Early Pleistocene: Caribbean, Moin Formation, Costa Rica (Robinson, 1991; Beu, 2010). Recent: West Africa, Morocco to Angola; occasionally in the Canaries at depths 6-60 m (Poppe & Goto, 1991).

Family Personidae Gray, 1854 Genus *Distorsio* Röding, 1798

Type species – Murex anus Linnaeus, 1758, by subsequent designation (Pilsbry, 1922). Pliocene-Recent, Indo-West Pacific.

Distorsio cancellina (Lamarck, 1803) Plate 19, figs 10, 12

Plate 19, figs 10-12

- *1803 Murex cancellinus Lamarck, p. 225.
- 1821 Murex tortuosus nob., Borson, p. 306, pl. 1, fig. 4.
- 2004 Distorsio (Rhysema) tortuosa (Borson 1821) İslamoğlu, p. 152, pl. 3, fig. 1.
- 2004b *Distorsio cancellina* (Lamarck, 1803) Landau *et al.*, p. 71, pl. 6, figs 1–3 (with additional synonyms).
- 2009a *Distorsio cancellina* (Lamarck, 1803) Landau *et al.*, p. 79, pl. 9, figs 5-7 (with additional synonyms).

Dimensions and material-Maximum height 84.3 mm. Locality 13: NHMW 1847/0058/0682/1, 1847/0058/0683/1, JvdV/5, RGM 794 544/1 (ex JvdV collection), RGM 783 653/3, YI 36/1.

Discussion – Landau *et al.* (2004b) showed that the older name *Distorsio cancellina* (Lamarck, 1803) should be applied to this species, which has usually been recorded in the literature as *Distorsio tortuosa* (Borson, 1821), and designated a neotype.

Distorsio cancellina is a distinctive species, with its unusually wide, flat peripheral area, bordered by the widely separated third and fourth spiral cords. This character is shared with, but still more greatly developed in, the Recent West African species Distorsio smithi (von Maltzan, 1884). It therefore seems likely that D. cancellina was the immediate ancestor of D. smithi. Some specimens of D. *cancellina*, including the neotype and most material we have seen from early-middle Miocene rocks of the Aquitaine Basin, France, resemble the species group of Distorsio constricta (Broderip, 1833) (Pliocene to Recent, eastern Pacific) and D. mcgintyi (Emerson & Puffer, 1953) (Miocene to Recent, western Atlantic) in having a complexly sculptured, nodulose and 'wrinkled' inner lip callus, or ventral shield. It therefore appears likely that this now solely American species group extended its range to Europe during late Oligocene time. Specimens of Distorsio from late Oligocene (Chattian) rocks of Gaas, Landes, France (see Landau et al, 2004b, pl. 6, fig. 4) have a narrower apertural shield than D. cancellina, and represent a species more nearly similar to D. crassidens than to D. cancellina, but more material is required before the identity of European Oligocene specimens is clear. For further discussion see Landau et al. (2004b).

Distribution – **Early Miocene**: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1873; Pavia, 1976). **Early-middle Miocene**: North Sea Basin (late Burdigalian-Langhian): Netherlands (A.W. Janssen, 1984a), Germany (Anderson, 1964). Middle Miocene: north-eastern Atlantic (Aquitanian-Serravallian): Aquitaine Basin (Cossmann & Peyrot, 1924); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hoernes & Auinger, 1879), Bulgaria (Kojumdgieva & Strachimirov, 1960), Romania (Boettger, 1906; Landau et al., 2009a); Proto-Mediterranean Sea (Langhian): Kasaba Basin, Turkey (İslamoğlu, 2004), (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: north-eastern Atlantic (Tortonian): Cacela Basin, Portugal (NHMW collection.); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1873). Early Pliocene: western Mediterranean, Estepona Basin, Spain, (Landau et al., 2004b), Rousillon Basin, France (Fontannes, 1879); central Mediterranean, Italy (Bellardi, 1873; Pelosio, 1967; Malatesta, 1974; Chirli, 2008). Late Pliocene: north-eastern Atlantic, Mondego Basin (Cox, 1936, Silva, 2001); central Mediterranean, Italy (Bellardi, 1873; Glibert, 1963a; Damarco, 1993; Spadini, 1994).

Superfamily Ficoidea Meek, 1864 Family Ficidae Meek, 1864 Genus *Ficus* Röding, 1798

Type species – Ficus variegata Röding, 1798, by subsequent designation (Dall, 1906). Recent, Indo-West Pacific.

Ficus condita (Brongniart, 1823)

Plate 19, fig. 13; Plate 62, fig. 10

- *1823 *Pyrula condita* Brongniart, p. 75 (*partim*, pl. 6, fig. 4 only; not Pliocene specimens).
- 1846 *Pyrula condita* Brong. Grateloup, pl. 28, figs 9, 10.
- 1845 *Pyrula condita* var. *ventricosa* Grateloup, pl. 27, figs 8, 9.
- 1853 Pyrula condita Brong. Hörnes, p. 270, pl. 28, figs 4-6.
- 1853 Ficula condita Brong. Deshayes, p. 64, pl. 106, figs 4, 5.
- 1854 *Pyrula reticulata* Lamk. Beyrich, p. 778, pl. 18, figs 5, 6, 9, 10.
- 1890c Ficula condita (Brongn.) Sacco, p. 23, pl. 1, fig. 27.
- 1890c Ficula condita var. superplanata Sacc., Sacco, p. 24.
- 1890c Ficula condita var. compressa Sacc., Sacco, p. 24.
- 1890c Ficula condita var. semicostata Sacc., Sacco, p. 24.
- 1890c Ficula condita var. costulatissima Sacc., Sacco, p. 24.
- 1890c Ficula condita var. araneiformis Sacc., Sacco, p. 26, pl. 1, fig. 28.
- 1890c Ficula condita var. laxecostata Sacc., Sacco, p. 26, pl. 1, fig. 29.

- 1890c Ficula condita var. pseudogeometra Sacc., Sacco, p. 26, pl. 1, fig. 30.
- 1890c *Ficula condita* var. *proreticulata* Sacc., Sacco, p. 26, pl. 1, fig. 31.
- 1890c Ficula condita var. anteficoides Sacc., Sacco, p. 27, pl. 1, fig. 32.
- 1904 *Ficula condita* var. *superplanata* Sacc., Sacco, p. 101, pl. 22, fig. 11.
- 1904 Ficula condita var. compressa Sacc., Sacco, p. 101, pl. 22, fig. 12.
- 1904 Ficula condita var. semicostata Sacc., Sacco, p. 101, pl. 22, fig. 13.
- 1904 Ficula condita var. costulatissima Sacc., Sacco, p. 101, pl. 22, fig. 14.
- 1912 *Pyrula condita* Brong. Schaffer, p. 138, pl. 40, figs 25, 26, 28.
- 1912 Pyrula condita Brong. Friedberg, p. 118, pl. 6, fig. 6.
- 1914 *Pyrula condita* Brong. Telegdi-Roth, p. 29, pl. 4, fig. 9.
- 1923 Pyrula condita Brongniart Cossmann & Peyrot, no. 699, pl. 10, fig. 46.
- 1923 *Pyrula condita* var. *ventricosa* Grateloup Cossmann & Peyrot, no. 700, pl. 11, fig. 13.
- 1923 Pyrula subclathrata d'Orbigny Cossmann & Peyrot, no. 702, pl. 11, figs 9, 10.
- 1925 *Pyrula geometra* var. *berilla* de Greg. Kautsky, p. 87, pl. 7, fig. 11.
- 1944 Ficus (Ficus) condita (Brongniart) van Voorthuysen, p. 57, pl. 2, fig 12, pl. 3, figs 15, 16, pl. 4, figs 1-5.
- 1951 Pyrula condita Brong. Friedberg, p. 116, pl. 6, fig. 6, text-fig. 32.
- 1952a Pirula condita Brongniart, 1823 Glibert, p. 281, pl. 4, fig. 6.
- 1952b Pirula condita Brongniart, 1823 Glibert, p. 89, pl. 7, fig. 4.
- 1958 Pyrula condita Brongniart Erünal-Erentöz, p. 52, pl. 7, fig. 9.
- 1958 *Pyrula condita* Brongniart Sorgenfrei, p. 200, pl. 41, fig. 131.
- 1959 Ficus conditus Brong. Čtyroký, p. 75, pl. 1, figs
 1, 2.
- 1960 Ficus (Fulguroficus) conditus (Brongniart 1823) Kojumdgieva & Strachimirov, p. 132, pl. 36, fig. 3.
- 1962 *Pirula condita* (Brongiart) Hölzl, p. 162, pl. 9, fig. 10.
- 1962 Pirula condita Brongniart Strausz, p. 133, pl. 62, figs 4-6.
- 1964 Ficus conditus (Brongniart) Râileanu & Negulescu, p. 178, pl. 15, figs 4, 5.
- 1964 Ficus conditus (Brongniart 1823) Anderson, p. 235.
- 1966 Pirula condita Brongniart, 1823 Strausz, p. 254, pl. 62, figs 4-6.
- 1968 Ficus conditus (Brongniart 1823) Zelinskaya et al., p. 181, pl. 43, figs 1, 2.
- 1972a Ficus conditus (Brongniart, 1823) Nordsieck, p. 72, pl. 17, fig. 93.

- 1973 Ficus condita (Brongniart, 1823) Báldi, p. 284, pl. 36, figs 1, 2.
- 1973 Ficus conditus (Brongniart) 1823 Caprotti, p. 163 (partim, pl. 1, figs 1, 2, pl. 5, figs 1-2 only).
- 1978 Ficus condita (Brongniart, 1823) R. Janssen, p. 201.
- 1984a Ficus (Ficus) conditus (Brongniart, 1823) A.W. Janssen, p. 211, pl. 59, fig. 1.
- 1989 *Ficus conditus* (Brongniart, 1823) Moths, p. 111, pl. 12, fig. 61.
- 1995 Ficus (Ficus) condita (Brongniart, 1823) Bałuk,
 p. 204, pl. 17, figs 7-9.
- 1996 *Ficus condita* (Brongniart, 1823) Moths *et al*, p. 29, pl. 14, fig. 5.
- 1998 Ficus (Ficus) condita Brongniart Schultz, p. 62, pl. 24, fig. 7.
- 2001a Ficus conditus (Brongniart, 1823) Lozouet et al., p. 46.
- 2001 *Ficus (Ficus) conditus* (Brongniart, 1823) Wienrich, p. 439, pl. 70, fig. 11, pl. 90, fig. 6.
- 2004b *Ficus condita* (Brongniart, 1823) Landau *et al.*, p. 76, pl. 7, fig. 1, pl. 8, fig. 4.
- 2005 Ficus (Ficus) conditus (Brongniart, 1823) Schnetler, p. 94, pl. 5, fig. 8.
- 2010 *Ficus condita* (Brongniart, 1823) Moths *et al*, p. 35, pl. 34, figs 12, 13.
- 2011 Ficus conditus proreticulatus Sacco, 1891 Caprotti, p. 51, figs 1A-B.
- non 1823 Pyrula condita Brongniart, p. 75 (partim; Pliocene specimens) [= Ficus subintermedia (d'Orbigny, 1852)].
- ?non 1920 Ficula condita (Brongniart) Harmer, p. 515, pl. 46, fig. 12 [= Ficus subintermedia (d'Orbigny, 1852)].
- non 1973 Ficus conditus (Brongniart) 1823 Caprotti, p. 163 (partim; Pliocene specimens), pl. 2, fig. 6, pl. 3, figs 1-4, pl. 4, fig. 3, pl. 5, figs 4, 6 [= Ficus subintermedia (d'Orbigny, 1852)].
- non 1974 Ficus (Ficus) conditus (Brongniart), 1823 proreticulatus (Sacco), 1891 – Caprotti, p. 26, pl. 2, figs 7, 8 [= Ficus subintermedia (d'Orbigny, 1852)].
- non 1988 Ficus (Ficus) conditus (Brongniart, 1823) González Delgado, p. 140, pl. 6, figs 4-6 [= Ficus subintermedia (d'Orbigny, 1852)].
- non 2001 Ficus condita (Brongniart, 1823) Silva, p. 297, pl. 12, figs 13-16, pl. 13, figs 1-3 [= Ficus subintermedia (d'Orbigny, 1852)].
- non 2002 Ficus condita (Brongniart, 1823) Silva, pl. 2, figs 19-21 [= Ficus subintermedia (d'Orbigny, 1852)].
- non 2008 Ficus condita (Brongniart, 1823) Chirli, p. 75, pl. 28, figs 13-16, pl. 29, figs 1, 2 [= Ficus subintermedia (d'Orbigny, 1852)].

Dimensions and material – Maximum height 95.3 mm. Localities 2 & 3: JvdV/5, YI 39/5; locality 6: JvdV/1; locality 12: JvdV/1, RGM 783 954/1; locality 13: JvdV/1, MTA 2013/031/3, YI 37/10; locality 17: NHMW 1847/0058/0685/1, 1847/0058/1373/1, 1847/0058/0686/8, JvdV/7, RGM 783 753/2, YI 38/3 + 1 incomplete specimen; locality 18: JvdV/1. Exact locality unknown: AÜ-LE-K-220/1.

Discussion – Ficus condita (Brongniart, 1823) and the closely related Pliocene species *Ficus subintermedia* (d'Orbigny, 1852) were discussed at length by Landau *et al.* (2004b). Caprotti (2011) argued that these taxa should be separated at subspecies level, and further distinguished the late Miocene Tortonian specimens as *Ficus conditus proreticulatus* Sacco, 1891. According to Caprotti (2011) the type of *Ficus condita* (Brongniart, 1823) is from the Oligocene of Germany. This is not the case, and a lectotype from the Brongniart collection was chosen by Landau *et al* (2004b, pl. 7, fig. 1) from the early Miocene Burdigalian of the Aquitaine Basin, France.

As discussed by Landau et al. (2004b), the Miocene and Pliocene species differ in their protoconch characters; F. condita has a multispiral protoconch with a small nucleus (Pl. 62, fig. 10; Landau et al., 2004b, pl. 8, fig. 4), probably indicating planktotrophic development, whereas F. subintermedia has a paucispiral protoconch with a medium-sized nucleus suggesting lecitotrophic development. Taxa with distinct modes of larval development should, in our opinion, not be considered as subspecies. Caprotti (2011) gave no indication of the protoconch type of the Tortonian specimens from Stazzano in Italy, however, Tortonian specimens from Montegibbio, Italy (NHMW collection) have a multispiral protoconch typical of F. condita. Therefore, we reaffirm that the Miocene species F. condita and the Pliocene species F. subintermedia are distinct species.

Distribution - Early Oligocene (Rupelian): Colli Torinesi, Italy (Sacco, 1890c). Late Oligocene (Chattian): North Sea Basin (R. Janssen, 1978); Paratethys (Egerian): Hungary (Baldí, 1973); Germany (Hölzl, 1962). Early Miocene: north-eastern Atlantic (Aquitanian-Burdigalian): Aquitaine Basin, France (Peyrot, 1923; Lozouet et al., 2001a); Paratethys (Aquitanian): Austria (Schaffer, 1912; Harzhauser, 2002), Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1890c, 1904). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (van Voorthuysen, 1944; Nordsieck, 1972a; A.W. Janssen, 1984a), Belgium (Glibert, 1952b), Germany (Beyrich, 1854; Kautsky, 1925; Anderson, 1964; Moths, 1989; Wienrich, 2001; Moths et al, 1996, 2010), Denmark (Sorgenfrei, 1958; Schnetler, 2005). Middle Miocene: north-eastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Peyrot, 1923), (Langhian): Loire Basin, France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1853; Schultz, 1998), Poland (Friedberg, 1912; Bałuk, 1995), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1962, 1966), Ukraine (Zelinskaya et al., 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1890c; Caprotti, 2011).

'Group' Ptenoglossa Superfamily Triphoroidea Gray, 1847 Family Triphoridae Gray, 1847 Genus *Epetrium* Harris & Burrows, 1891

Type species – Triforis grignonensis Deshayes, 1864, by original designation (Jousseaume, 1884 as type species of *Stylia*; junior homonym of *Stylia* Robineau-Desvoidy, 1830 [Lepidoptera], replaced by *Epetrium* by Harris & Burrows, 1891). Eocene, France.

Epetrium **sp.** Plate 20, figs 1, 2

Dimensions and material – Maximum height 8.2 mm (incomplete). Locality 13: NHMW 1874/0058/1118-1874/0058/1119/2 fragments, 1874/0058/1120/3 fragments; JvdV/1.

Discussion – Five spire fragments of a very distinctive triphorid from the Akpinar deposits are at hand, representing a tall, slender species with straight-sided whorls. The sculpture is distinctly spiral, with spiral 1 and 3 strongly tubercular, 12 tubercles per whorl, and spiral 2 much finer. It is difficult to assign these fragments to a genus without knowing the apertural characters, but the shape and sculpture are similar to that of species of *Epetrium* Harris & Burrows, 1891. *Trituba* Jousseaume, 1884 also includes shells with a similar shape, but with predominantly axial sculpture rather than spiral as in *Epetrium* (Cossmann, 1906).

Sacco (1895a, p. 62, pl. 3, fig. 60) described a fragment of a similar species from the early Miocene Burdigalian of Italy as *Triforis (Epetrium?) taurorara*. This fragment, reillustrated by Ferrero Mortara *et al.* (1984, pl. 36, fig. 9), has the same basic sculpture, but differs in having spirals 1 and 3 even coarser, with only nine tubercles per whorl and spiral 2 even finer. We await more complete material before formal description of this probable new species.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Triphora (s. lat.) Blainville, 1828

Type species – Triphora gemmata Blainville, 1828, by original designation. Recent, Indo-West Pacific.

Triphora (s. lat.) sp.

Plate 20, fig. 3; Plate 62, fig. 11

Dimensions and material – Maximum height 6.4 mm. Locality 13: JvdV/1; locality 17: NHMW 1874/0058/1121/1, 1874/0058/1122/2, RGM 794 516/1, RGM 794 517/2.

Discussion – As far as we can ascertain, the scant *Tripho-ra* (*s. lat.*) material present in the Karaman assemblages belongs to a single species. It is characterised by having

a bicarinate multispiral protoconch, with a pustular first whorl (Pl. 62, fig. 11a). The teleoconch sculpture consists of three beaded cords, the middle one of which appears only on the sixth teleoconch whorl (Pl. 62, fig. 11b). We do not have an intact aperture, but on the last whorl a weak cord develops between the second and third beaded cords and three further smooth cords run along the base. Several European and West African Recent genera reviewed by Bouchet (1985) have this type of protoconch. The species included by Bouchet (1985) in the genus Cosmotriphora Olsson & Harbison, 1953 [C. melanura C. B. Adams, 1850, C. canarica (Nordsieck & Talavera, 1979) and C. pseudocanarica Bouchet, 1985] all differ in having more strongly beaded basal cords. Cheirodonta pallescens (Jeffreys, 1867) differs in having the third cord appearing later, on the 9th teleoconch whorl and the appearance of supernumerary cords on the last whorl below cords 2, 3 and 4. The genera Similiphora Bouchet, 1985 and Marshallora Bouchet, 1985 are indistinguishable based on their shell characters (Bouchet, 1984, p. 49). Similiphora triclotae Bouchet 1997 is immediately separated by having four beaded cords on the last whorl. In Similiphora similior (Bouchet & Guillemot, 1978) the second spiral cord appears only on the 8th teleoconch whorl and in Marshalloria adversa (Montagu, 1803) even later, on the 10th teleoconch whorl. Therefore, the fossil shells from Turkey can be separated from the living species discussed above in having the second spiral cord starting earlier and in having three strong cords on the last whorl with a very weak cord developed between cords 2 and 3. The Karaman species is likely to be the same species as that reported from the Paratethys as Triphora perversa (Linnaeus, 1758) by Bałuk (1975, p. 168, pl. 20, figs 3-5), which Bałuk (1975) described as having the second cord appearing on teleoconch whorls 3-6. Unfortunately the protoconchs of very few European fossil Miocene species are known and a revision of the genus is required before species can be assigned to genera. Triphora (s.lat.) papaveracea (Benoist, 1874) from the early Miocene of France has a similar protoconch, but the second cord seems to develop earlier. In view of the difficulties in distinguishing between triphorid genera based on conchological characters alone, we follow Lozouet et al. (2001a) in using Triphora (s. lat.).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Strobiligera Dall, 1924

Type species – Triphoris inflata var. *ibex* Dall, 1881, by original designation. Recent, Caribbean.

Strobiligera sp. Plate 20, fig. 4

Dimensions and material – Maximum height 8.9 mm. Locality 13: JvdV/1, locality 17: NHMW 1874/0058/1123/2.

Discussion – The genus *Strobiligera* Dall, 1924 is characterised by the uppermost spiral cord appearing last, as opposed to all other Atlantic and Mediterranean Recent triphorids, in which spiral no. 2 develops last (Bouchet, 1985). Unfortunately, the material available from Turkey is incomplete, but the top cord seems weakest on the earliest teleoconch whorl preserved. Moreover, the shell shape and sculpture are very similar to that of species placed in that genus from the early Pliocene of Estepona by Landau *et al.* (2006b).

The specimen from the Akpınar deposits has eight low, weakly convex teleoconch whorls preserved. The sculpture consists of four spiral bands of squarish beads, the two adapical bands narrower and weaker than the two abapical ones. The beads on the last whorl preserved become obsolete. *Strobiligera cristulata* (Sacco, 1895) and *Strobiligera bruguieri* (Michelotti, 1847) from the early Pliocene Mediterranean are very similar in shape, but have only three spiral rows of beads per whorl. The Karaman specimen also differs from *S. cristulata* in the shape of its beads (Chirli, 2009, pl. 8, figs 12-15).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Cerithiopsidae H. Adams & A. Adams, 1854 Subfamily Cerithiopsinae H. Adams & A. Adams, 1854 Genus *Cerithiella* Verrill, 1882

Type species – Cerithium metula Lovén, 1846, by original designation. Recent, Europe.

Cerithiella sp. Plate 20, fig. 5

Dimensions and material – Maximum height 12.7 mm. Locality 17: NHMW 1874/0058/1467/1, JvdV/5, YI 257/2.

Discussion – This Cerithiella species is characterised by its very straight-sided spire and dense reticulate sculpture, with four spiral cords on the spire whorls and five on the last whorl. Unfortunately, all the material available is incomplete and no protoconch I is preserved. Cerithiella jansseni Landau, La Perna & Marquet, 2006 (= C. genei auct. non Bellardi & Michelotti, 1840 in the North Sea Basin literature, see Landau et al., 2006b, p. 9) from the North Sea Basin and Cerithiella genei (Bellardi & Michelotti, 1840) from the Pliocene Mediterranean differ in having only 2-3 cords on spire whorls, and the whorl profile is angular at the abapical cord. Cerithiella kostejana Boettger, 1902 from the middle Miocene Paratethys of Romania and Hungary is very similar is shape, but has three spiral cords per whorl as opposed to four in the Turkish shells (Zilch, 1934, pl. 9, fig. 52; Bałuk, pl. 19, figs 26, 27). Cerithiella christinae Boettger, 1902 from the same Paratethyan deposits differs in profile, as the abapical portion of the later spire whorls overhangs the suture. The shell from the Atlantic early Miocene Aquitanian of France identified by Lozouet et al. (2001a, pl.

19, fig. 14) as *Cerithiella*? sp. has the same number of spiral elements, but has distinctly convex whorls. *Cerithiella incertula* Sacco, 1895 from the Pliocene of Italy has the same whorl shape, but again has only three spiral elements per spire whorl (Ferrero Mortara *et al.*, 1984, pl. 37, fig. 5).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Cerithiopsis (s. lat.) Forbes & Hanley, 1851

Type species – Murex tubercularis Montagu, 1803, by original designation. Recent, Europe.

Note – As discussed by Landau *et al.* (2006b, p. 10), Cerithiopsidae species cannot be identified with certainty without the protoconch and the genera and subgenera *Cerithiopsis*, *Cerithiopsidella*, *Cerithiopsidella* (*Vatopsis*) and *Dizoniopsis* cannot be distinguished on protoconch characters alone. Provisionally we consider them all in the genus *Cerithiopsis* (*s. lat.*).

Cerithiopsis (s. *lat.*) cf. *barleei* Jeffreys, 1867 Plate 63, figs 1, 2

- ? *1867 *Cerithiopsis Barleei* Jeffreys, p. 267.
- ? 1988 Cerithiopsis barleei Jeffreys, 1867 Graham, p. 369, fig. 259
- ? 1997b Cerithiopsis barleei Jeffreys, 1867 Marquet, p. 82, pl. 5, fig. 1.
- ? 1998a Cerithiopsis barleei Jeffreys, 1867 Marquet, p. 108, fig. 82.
- ? 2006b *Cerithiopsis barleei* Jeffreys, 1867 Landau *et al.* p. 12, pl. 3, fig. 2 (with additional synonyms).
- ? 2009 Cerithiopsis barleei Jeffreys, 1867 Chirli, p. 4, pl. 1, figs 8-15.
- ? 2010 Prolixodens barleei (Jeffreys, 1867) Cecalupo & Robba, p. 61, figs 2A-C, 5J, K.

Dimensions and material – Maximum height 3.0 mm. Locality 17: RGM 784 086/1, 784 087/6 fragments.

Discussion - The Turkish shells are very similar to Cerithiopsis (s. lat.) barleei Jeffreys, 1867, with similar protoconch sculpture consisting of prosocline riblets on the abapical half of the whorl, commencing on the second whorl. However, they differ in that the last protoconch whorl is carinate (Pl. 63, figs 1b, 2b), rather than evenly convex in C. barleei. None of the figured protoconchs of C. barleei in the fossil faunas (Marquet, 1997b, pl. 5, fig. 1, 1998a, fig. 82; Landau et al., 2006b, pl. 3, fig. 2b; Chirli, 2009, pl. 1, fig. 11) or in the Recent fauna (Gianuzzi-Savelli et al., 1999, fig. 36) has any carina on the last whorl or at the protoconch/teleoconch boundary. Moreover, the first two protoconch whorls in C. barleei are covered with close-set micropustules, which are not evident in the Turkish shells, although it is possible that the pustules are worn.

Cecalupo & Robba (2010) placed this species in the antipodean genus *Prolixodens* Marshall, 1978, based on its sculptured protoconch and the lack of basal sculpture in most species. We prefer to maintain it in *Cerithiopsis* (s. *lat.*) until more is known about this group.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Cerithiopsis (*s. lat.*) cf. *bilineata* (Hörnes, 1848) Plate 20, fig. 6

*? 1848 Cerithium bilineatum Hörnes, p. 21.
? 2006b Cerithiopsis (s. lat.) cf. bilineata (Hörnes, 1848) – Landau et al. p. 14, text-fig. 1, figs 1-3, pl. 4, fig. 2 (with additional synonyms).

Dimensions and material – Maximum height 3.2 mm. Localities 7 & 8: RGM 776 940 (ex JvdV collection).

Discussion – The identification is based on the teleoconch having two rows of tubercles per whorl. The problems associated with identifying this group of cerithiopsids was discussed at length by Landau *et al.* (2006b, p. 10, 14). Without the protoconch, which is missing in the Turkish specimen, specific assignment is impossible.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Cerithiopsis (s. lat.) jeffreysi Watson, 1885 Plate 63, fig. 3

- 1858 *Cerithiopsis pulchella* Jeffreys, p. 129, pl. 5, fig. 8 (*non C. pulchellum* C. B. Adams, 1850).
- *1885 *Cerithiopsis Jeffreysi* Wats., Watson, p. 90, pl. 4, fig. 2 (*nov. nom. pro Cerithiopsis pulchella* Jeffreys, 1858, *non C.pulchellum* C. B. Adams, 1850).
- 1982 *Cerithiopsis pulchella* Jeffreys, 1858 Fretter & Graham, p. 371, fig. 262 (*non C. pulchellum* C.B. Adams, 1850).
- 1988 Cerithiopsis pulchella Jeffreys, 1858 Graham,
 p. 369, fig. 259 (non C. pulchellum C.B. Adams, 1850).
- 1988 Dizoniopsis pulchella Jeffreys, 1858 Cecalupo,
 p. 36, pl. 2, fig. 3 (non C. pulchellum C.B. Adams, 1850).
- 1999 *Cerithiopsis jeffreysi* Watson, 1885 Gianuzzi-Savelli *et al.*, p. 36, figs 44-46.
- 2006 Cerithiopsis jeffreysi Watson, 1885 Peñas et al.,
 p. 74, figs 97-101.
- 2009 *Cerithiopsis jeffreysi* Watson, 1885 Chirli, p. 7, pl. 3, figs 1-5.
- non 1973 Cyrbasia pulchella (Jeffreys) Spada et al., p. 52, pl. 2, fig. 1.

Dimensions and material – Maximum height 2.4 mm. Locality 17: RGM 784 084/1.

Discussion – Cerithiopsis (s. lat.) jeffreysi Watson, 1885 is characterised by its rather narrow ribs and cords, resulting in a relatively open reticulate pattern, and by its smooth multispiral protoconch. Cecalupo (1988) considered C. jeffreysi and C. pulchella Jeffreys, 1858 to be different species. However, C. jeffreysi was introduced as a replacement name by Watson (1885) for C. pulchella Jeffreys, 1858, which is preoccupied by C. pulchellum C. B. Adams, 1850. Most subsequent authors have considered the two to be synonyms (Peñas et al., 2006; Chirli, 2009).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Early Pliocene**: central Mediterranean, Italy (Chirli, 2009). **Recent**: Atlantic coasts of Europe (Fretter & Graham, 1982) and Mediterranean (Gianuzzi-Savelli *et al.*, 1999; Peñas *et al.*, 2006).

Cerithiopsis (s. lat.) subulata (Wood, 1848) Plate 63, figs 4, 5

- *1848 *Cerithium tuberculare* var. *subulatum* Wood, p. 70, pl. 8, fig. 5.
- 2006b *Cerithiopsis* (*s.l.*) *subulata* (Wood, 1848) Landau *et al.*, p. 14, pl. 4, fig. 1 (with additional synonyms)
- 2009 *Cerithiopsis subulatus* (Wood, 1848) Chirli, p. 10, pl. 4, figs 11-15, pl. 5, figs 1-7.

Dimensions and material – Maximum height 3.6 mm. Locality 17: RGM 776 856/1 (ex JvdV collection), 784 085/1.

Discussion – Marquet (1997b) showed the North Sea Basin early Pliocene shells usually identified as *Cerithiopsis* (*s. lat.) tubercularis* (Montagu, 1803) were a separate species, with quite different protoconch sculpture. In *Cerithiopsis* (*s. lat.) subulata* (Wood, 1948) this sculpture consists of micropustules on protoconch I and axial riblets on the upper portion and reticulate pattern on the lower half on protoconch II, whereas in *C. (s. lat.) tubercularis* the protoconch is smooth, apart from micropustules adjacent to the suture. The protoconch and teleoconch characters of the Turkish shells are the same as those of the early Pliocene North Sea Basin and Mediterranean shells. For further discussion see Landau *et al.* (2006b, p. 14).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Early Pliocene**: North Sea Basin, Great Britain (Wood, 1848); Netherlands (van Regteren Altena *et al.*, 1965); Belgium (Glibert, 1958; Marquet, 1997b); western Mediterranean, Estepona Basin, Spain (Landau *et al.*, 2006b), central Mediterranean, Italy (Chirli, 2009).

Cerithiopsis (s. lat.) cf. tubercularis (Montagu, 1803) Plate 63, fig. 6

? *1803	Murex tubercularis Montagu, p. 270.
? 1999	Cerithiopsis tubercularis (Montagu, 1803) - Gi-
	anuzzi-Savelli et al., p. 38, figs 50-56.
? 2009	Cerithiopsis tubercularis (Montagu, 1803) - Chir-
	li, p. 11, pl. 5, figs 8-15, pl. 6, figs 1-11.
? 2010	Cerithiopsis tubercularis (Montagu, 1803) - Ce-
	calupo & Robba, p. 50, figs 1A-D, G-J, 2D-G.

Dimensions and material – Maximum height 2.4 mm. Locality 17: NHMW 1847/0058/1561/1.

Discussion - The specimen from the Karaman assemblages has the protoconch somewhat worn. It consists of about four convex whorls, similar to that seen in the Pliocene and Recent species Cerithiopsis (s. lat.) tubercularis (Montagu, 1803), but there is no trace of the sculpture of micropustules close to the suture that is present in C. tubercularis (Landau et al., 2006b; Fretter & Graham, 1982). As discussed by Landau et al. (2006b), the position taken by Bałuk (1975) in synonymising several Miocene species of Cerithiopsis with similar teleoconch characters, i.e. three rows of granules (C. astensis Cossmann, 1914; C. vignali Cossmann & Peyrot, 1922) with C. tubercularis, is conjectural, as none have the protoconch described. Similarly, none of the French Atlantic Miocene forms can confidently be assigned to this species (see Landau et al., 2006b). Therefore the unequivocal presence of C. tubercularis in the European Miocene is yet to be confirmed.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subfamily Seilinae Golikov & Starobogatov, 1975 Genus Seila A. Adams, 1861

Type species – Triphoris dextroversa A. Adams & Reeve, 1850, by original designation. Recent, Indo-Pacific.

Seila turritissima Sacco, 1895

Plate 63, fig. 7

- 1855 Cerithium trilineatum Phil. Hörnes, p. 413, pl. 42, fig. 19 (non Seila trilineata Philippi, 1836).
- *1895 Seila dertotrilineata forma turritissima Sacc., Sacco, p. 73 (nom. nov. pro Cerithium trilineatum Phil. in Hörnes, 1855; non Philippi, 1836).
- 1955 Seila trilineata Philippi, 1836 Strausz, p. 209, pl. 10, fig. 181 only (non Seila trilineata Philippi, 1836).
- Seila trilineata Philippi, 1836 Strausz, p. 167, pl.
 figs 22, 24 (non Seila trilineata Philippi, 1836).
- 1970 Seila trilineata Philippi Csepreghy-Meznerics,
 p. 21, pl. 3, figs 28, 29 (non Seila trilineata Philippi, 1836).
- 1975 Seila (Seila) trilineata (Philippi, 1836) Bałuk, p.

166, pl. 20, figs 8-11 (*non Seila trilineata* Philippi, 1836).

2001 Seila (Cinctella) turritissima Sacco, 1895 – Marquet, p. 200, pl. 1, fig. 4.

Dimensions and material – Maximum height 4.8 mm (incomplete). Locality 6: JvdV/2, RGM 784 045/1; locality 17: JvdV/1, RGM 776 857/1 (ex JvdV collection).

Discussion - Marshall (1978), Rolán & Fernandes (1990) and Marquet (2001) showed this genus, in both the Recent and fossil faunas, to be more varied than previously thought. As with other Cerithiopsidae, the protoconch is essential to differentiate many of the species, but is not of higher systematic value (Marguet, 2001). The protoconch of the Turkish shell illustrated here (Pl. 63, fig. 7) is incomplete, but clearly has at least 4-5 smooth whorls and three elevated spiral cords per whorl. These are the diagnostic characters of Seila turritissima Sacco, 1895 Marquet, 2001, p. 200). The apical angle in Turkish shells is of 24°, slightly greater than the 20° described by Marquet (2001) for Paratethyan shells. Seila turritissima differs from S. trilineata (Philippi, 1836), with which it has usually been confused, in having more numerous protoconch whorls (5 vs. 2.25). The small differences in the teleoconch sculpture discussed by Marquet (2001) can clearly be seen in the shell illustrated (Plate 63, fig. 7b); the spiral cords all develop simultaneously on the first teleoconch whorl in S. turritissima, whereas in S. trilineata the middle cord and in S. trilineata and agavensis Marquet, 2001 the adapical cord develop first.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1855; Marquet, 2001), Hungary (Csepreghy-Meznerics, 1970; Strausz, 1955, 1966), Poland (Bałuk, 1975); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Superfamily Epitonioidea Berry, 1910 (1812) Family Epitoniidae Berry, 1910 (1812) Genus *Epitonium* Röding, 1798

Type species – Turbo scalaris Linnaeus, 1758, by subsequent designation (Suter, 1913). Recent, Mediterranean.

Epitonium cf. *pliosubappenninum* (Sacco, 1891) Plate 20, fig. 7

- ?*1891a Parviscala pliosubappennina Sacco, p. 29, pl. 1, fig. 41.
- ? 2006b Epitonium cf. pliosubappenninum (Sacco, 1891)
 Landau et al., p. 31, pl. 10, figs 4, 5 (with additional synonyms).

Dimensions and material – Maximum height 5.4 mm. Locality 17: NHMW 1874/0058/1124/1, JvdV/2. *Discussion* – This species is characterised by its smooth polished shell, with no traces of spiral sculpture, rather broad shape, strongly convex whorls separated by a deep-ly impressed suture and low, weakly reflected lamellae, the outer portions of which are somewhat irregular, forming one or two spines at the shoulder. These shells are probably the same species as that discussed by Landau *et al.* (2006b) as *Epitonium* cf. *pliosubappenninum* (Sacco, 1891), but the Karaman specimens are only about half the size of the early Pliocene specimens from the Estepona Basin of southern Spain. The small size is a recurrent theme with the Karaman epitoniids. For further discussion see Landau *et al.* (2006b, p. 31).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Epitonium miofrondiculoides (Sacco, 1891) Plate 20, fig. 8

- 1856 Scalaria clathratula Turt. Hörnes, p. 475, pl. 46, fig. 8 [non Epitonium clathratulum clathratulum (Kanmacher, 1798)].
- 1891a *Hirtoscala frondicula* var. *spinosa* (Bon.) Sacco, p. 26, pl. 1, fig. 38.
- *1891a Hirtoscala miofrondiculoides Sacco, p. 27, pl. 1, fig. 38 [nov. nom. pro Scalaria clathratula in Hörnes, 1856, pl. 46, fig. 8; non Epitonium clathratulum clathratulum (Kanmacher, 1798)].
- 1912 Spiniscala spinosa (Bonelli) Cossmann, p. 169, pl. 5, fig. 2.
- 1932/33 Scala (Spiniscala) frondicula Wood. var. spinosa Bonelli – Meznerics, p. 337, pl. 14, fig. 5a, b.
 - 1938 Scala spinosa Bonelli Friedberg, p. 83, text-fig.20.
 - 1954 Scala (Clathrus) frondicula spinosa Bon. Strausz, p. 19, 56, 99, pl. 1, fig. 9.
 - 1962 Scala (Clathrus) frondicula spinosa Bonelli Strausz, p. 18, pl. 1, figs 34, 35, pl. 13, fig. 17.
 - 1966 Scala (Clathrus) frondicula spinosa Bonelli, 1826
 Strausz, p. 175, pl. 1, figs 34, 35, pl. 13, fig. 17.
 - 1975 Scala (Clathrus) spinosa Bonelli, 1826 Bałuk, p.
 171, pl. 20, figs 17, 18.
 - 1985 *Scala (Spiniscala) frondicula spinosa* (Bonelli) Atanacković, p. 115, pl. 27, figs 15, 16.
 - 2002 *Epitonium spinosum* (Bonelli, 1826) Harzhauser, p. 93.
 - 2003 Epitonium miofrondiculoides (Sacco, 1891) Mandic & Harzhauser, p. 97, pl. 1, figs 2, 3.

Dimensions and material – Maximum height 7.3 mm. Locality 17: NHMW 1874/0058/1125/1, JvdV/1, RGM 783 966/2.

Discussion – This is the same species as that illustrated as *Scalaria spinosa* "Bonelli, 1826" from the middle Miocene Paratethys (Friedberg, 1938; Cossmann, 1912; Strausz, 1954, 1962, 1966) and late Miocene Proto-Mediterranean of Italy (Sacco, 1891). However, Bonelli's work, variously given the date of 1825, 1826 or 1827, was never published. Therefore the first available name for this species is *Epitonium miofrondiculoides* (Sacco, 1891).

Chirli (2009) synonymised these Paratethyan shells with Epitonium frondiculum (Wood, 1842), a species originally described from the Pliocene North Sea Basin. However, the Pliocene species is far larger than the Paratethyan shells, with big recurved lamellae, and is not conspecific (Marquet, 1998, fig. 92). Moreover, the shells illustrated by Chirli (2009, pl. 11, figs 13-18) from the Italian Pliocene as E. frondiculum are not conspecific with the North Sea Basin shells either. The Italian specimens are squatter, with a much wider apical angle and fewer axial lamellae, and are very similar, if not the same, as the shells from the early Pliocene of Estepona, Spain, illustrated as Epitonium cf. pliosubappenninicum (Sacco, 1891) by Landau et al. (2006b, pl. 10, figs 4, 5). The present specimens from Karaman clearly belong in E. miofrondiculoides Sacco, 1891, characterised by its smooth polished shell, with no traces of spiral sculpture, rather slender shape, convex whorls separated by a deeply impressed suture and low, reflected lamellae, bearing a small spine just below the suture.

Distribution – **Early Miocene**: Paratethys (Burdigalian): Austria (Harzhauser, 2002). **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856; Meznerics, 1932/33; Mandic & Harzhauser, 2003), Hungary (Strausz, 1954, 1962, 1966), Poland (Friedberg, 1938; Bałuk, 1975), Romania (Cossmann, 1912), Bosnia (Atanacković, 1985); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco 1891a).

Epitonium cf. pulchellum (Bivona, 1832)

Plate 20, fig. 9

?*1832 Scalaria pulchella Bivona, p. 168, pl. 2, fig. 1.
? 2006b Epitonium pulchellum (Bivona, 1832) – Landau et al., p. 33, pl. 11, fig. 3 (with additional synonyms).
? 2009 Epitonium pulchellum (Bivona Ant., 1832) – Chirli, p. 34, pl. 13, figs 7-17.

Dimensions and material – Maximum height 3.8 mm. Locality 6: JvdV/1: locality 17: NHMW 1874/0058/1126/1, JvdV/1.

Discussion – These specimens from the Turkish deposits are similar to the Pliocene to Recent Mediterranean species *Epitonium pulchellum* (Bivona, 1832), with a rapidly broadening profile, non-shouldered convex whorls, very close-set prosocline lamellae, an inflated last whorl and, under magnification, fine spiral sculpture is present (Landau *et al.*, 2006b, p. 34). However, they are much smaller, the whorls are less convex than in *E. pulchellum* and the axial lamellae are even more densely packed than in *E. pulchellum*. We are unsure whether the scant Turkish material represents the adult state and refrain from describing the species until further material is available.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Epitonium trevelyanum (Johnston, 1841) Plate 20, fig. 10

- *1841 *Scalaria trevelyana* Johnston, p. 263.
- 2006b *Epitonium trevelyanum* (Johnston, 1841) Landau *et al.*, p. 36, pl. 12, figs 1, 2 (with additional synonyms).

Dimensions and material – Maximum height 8.7 mm. Localities 2 & 3: JvdV/2; locality 13: NHMW 1847/0058/1691/1; locality 17: NHMW 1874/0058/1127/1, JvdV/2.

Discussion - Although small, this is the largest Epitonium species found in the Karaman assemblages. Epitonium trevelyanum (Johnston, 1841) is characterised by relatively low, strongly reflected lamellae, which are not continuous and form a well-defined auricle at the adapical suture. The number of ribs is relatively constant (about 15) and does not decrease with ontogeny. Very faint spiral sculpture is present between the ribs. All these features are clearly seen in the specimen illustrated. The shell closely resembles the European Pliocene to Recent Mediterranean and Atlantic species E. clathrus (Linnaeus, 1758) (= E. communis Lamarck, 1822) but is more delicate, with a glossier surface, the lamellae are more numerous (14-16 vs. 8-9), but less strongly developed and the auricles at the adapical suture are more prominent. For further discussion see Landau et al. (2006b, p. 36).

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po valley, Italy (de Boury, 1890). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Landau *et al.*, 2006b); central Mediterranean, Italy (Harmer, 1920). Late Pliocene: central Mediterranean, Italy (Harmer, 1920). Pliocene (unspecified): central Mediterranean, Italy (de Boury, 1890). Pleistocene: Atlantic, Norway (Harmer, 1920); The Netherlands (Beets, 1946); central Mediterranean, Italy (Harmer, 1920). Holocene: Atlantic, British Isles (Harmer, 1920). Recent: Mediterranean, north along the west coast of Europe to Norway and the Kattegat (Fretter & Graham, 1982).

Genus Cirsotrema Mörch, 1852

Type species – Scalaria varicosa Lamarck, 1822, by monotypy. Recent, Indo-Pacific.

Cirsotrema pumiceum (Brocchi, 1814) Plate 20, fig. 11

- *1814 *Turbo pumiceus* nob., Brocchi, p. 380, pl. 7, fig. 3.
 1844 *Scalaria cochlea* Sow., Sowerby, G.B. II, p. 103, pl. 35, fig. 142.
- 2006b *Cirsotrema* (*Cirsotrema*) *pumiceum* (Brocchi, 1814) Landau *et al.*, p. 40, pl. 13, fig. 2 (with additional synonyms).
- 2010 *Cirsotrema pumiceum* (Brocchi, 1814) Sosso & dell'Angelo, p. 28, p. 37, unnumbered top row third figure.
- 2011 *Cirsotrema* (*Cirsotrema*) *pumiceum* (Brocchi, 1814) Landau *et al.*, p. 20, pl. 9, fig. 7 (with additional synonyms).

Dimensions and material – Height 22.2 mm. Locality 17: NHMW 1874/0058/1128/1, YI 356/1.

Discussion – Most authors working on modern faunas have used the name *Cirsotrema cochlea* (Sowerby G.B. II, 1844). However, this is undoubtedly conspecific with the fossil species *C. pumiceum* (Brocchi, 1814), which has priority. Some authors have amended the species name to *pumicea* (Strauz, 1966; Poppe & Goto, 1992). However, the Latin word '*pumiceus*' is an adjective (of or resembling pumice ['*pumex*']), and it should be declined to agree in gender with the neuter generic name. Therefore the correct binomen is *Cirsotrema pumiceum*.

Several similar species occur in the Atlantic early Miocene Aquitanian of France. *Cirsotrema subspinosum* (Grateloup, 1845) has a far squatter shell, with a greater apical angle, the sculpture is more frilly, varices weakly developed, the basal cord is bifid and a small spine is formed on the labral varix at the shoulder. *Cirsotrema crassicostatum* (Deshayes, 1853) (= *C. thais* de Boury *in* Cossmann, 1912; see Lozouet *et al.*, 2001a) is similar to *C. subspinosum*, but larger, more elongate with a more acute apical angle, with fewer axial ribs, more convex whorls and a much narrower sutural ramp. The axial ribs are well separated and not fused as in *C. subspinosum* and *C. pumiceum*.

Cirsotrema bourgeoisi de Boury *in* Cossmann, 1912 from the Atlantic middle Miocene of France is very similar to *C. pumiceum*, but has a smaller, more elongate shell, with more elevated whorls, the sutural canal is narrower, the sculpture is more frilly, the axial ribs are slightly less fused and the basal cord is less strongly developed. *Cirsotrema sallomacense* de Boury *in* Cossmann, 1912, also from the Atlantic middle Miocene of France, is quite different from *C. pumiceum*, with a much squatter shell with only five or six strongly scalate whorls, the sutural canal is much broader and the basal cord not strongly developed. For further discussion see Landau *et al.* (2006b, p. 40).

Distribution – **Early Miocene**: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (de Boury, 1890). **Middle Miocene**: Paratethys (Langhian-Serravallian): Hungary (Strausz, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Ear-Iy Pliocene: northeastern Atlantic, Guadalquivir Basin (González Delgado, 1986; Landau *et al.*, 2011); western Mediterranean, Estepona, northern Spain (Martinell, 1979); central Mediterranean, Italy (de Stefani, 1877; Pavia, 1975). Early-late Pliocene: central Mediterranean, Italy (Calcara, 1841; de Gregorio, 1889; de Boury, 1890; Sacco, 1891a; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010). Pliocene (unspecified): central Mediterranean, Italy (Rossi Ronchetti, 1955). Recent: Mediterranean. Lives on sand and detritus bottoms in shallow water, between 8-60 m deep.

Genus Amaea H. Adams & A. Adams, 1853

Type species – *Scalaria magnifica* G.B. Sowerby II, 1844, by subsequent designation (de Boury, 1909). Recent, Pacific.

Subgenus Acrilla H. Adams, 1860

Type species – Scalaria acuminata G.B. Sowerby II, 1844, by original designation designation. Recent, Pacific.

Amaea (Acrilla) kimakowiczi (Boettger, 1896) Plate 20, fig. 12

- *1896 *Scalaria (Acrilla) kimakowiczi* Boettger, p. 53, no. 33.
- 1906 *Scala (Acrilla) kimakowiczi* (Boettger) Boettger, p. 95, no. 344.
- 1912 Acrilla kimakowiczi (Boettger) Cossmann, p. 59, 185, pl. 5, fig. 6.
- 1934 *Scala (Acrilla) kimakowiczi* (Boettger) Zilch, p. 230, pl. 10, fig. 79.
- 1960 Acrilla (Acrilla) kimakowiczi (Boettger) Kojumdgieva & Strachimirov, p. 94, pl. 30, fig. 2a, b.
- 1967 Cirsotrema (Elegantiscala) kimakowiczi (Boettger, 1896) – A.W. Janssen, p. 142, pl. 14, fig. 4.

Dimensions and material – Maximum height 31.7 mm. Localities 7 & 8: NHMW 1847/0058/1693/1; locality 12: JvdV/1; locality 13: NHMW 1874/0058/1129/1, 1874/-0058/1130/4.

Discussion – The genus *Amaea* H. Adams & A. Adams, 1853 is characterised by narrowly to broadly acuminate shells, most of which have a basal cord, cancellate sculpture or thin, low axial lamellae; a thin to moderately thick labrum; and a smooth, conical, multispiral protoconch (Kilburn, 1985). *Acrilla* H. Adams, 1860, considered here to be a subgenus of *Amaea* (Wenz, 1940), is closely similar; most species have more acuminate shells, the axial lamellae are very thin, the interspaces are glossy, with fine spiral striae, the base always has a cord and disc, and the peristome is slightly angular at the basal cord. We are not sure whether these differences are great enough to warrant separation, but follow most authors

in recognising *Acrilla* as a subgenus of *Amaea* (Kilburn, 1985; Cavallo & Repetto, 1992). *Amaea* (*Acrilla*) *kimako-wiczi* (Boettger, 1896) is typical of the subgenus in having very fine axial lamellae and the spiral striae are only visible under magnification.

It is difficult to give a good comparison of our shell with other Neogene species, as published illustrations are often poor. Many of the species placed in Acrilla by Cossmann (1912) and Cossmann & Peyrot (1922), such as Scalaria subcancellata d'Orbigny, 1852, Scalaria bronni Seguenza, 1876, Acrilla miobronni, Sacco, 1890 and Scalaria (Acrilla) phoenix de Boury, 1912 amongst others, we would place in the genus Scalina Conrad, 1865, which differs in having a more regular reticulate sculpture, in which the axial and spiral elements are of roughly equal strength, and a prominent basal cord, with the sculpture differing above and below the cord. Amaea (Acrilla) herthae (Boettger, 1906), also described from the middle Miocene Paratethys of Romania, differs in having a narrower shell, with more convex whorls and sculpture consisting of more widely spaced axial lamellae and more evident spiral threads. Amaea (Acrilla) multilamella (de Basterot, 1825) from the early Miocene Aquitanian of the Aquitaine Basin, France also has more convex whorls and fewer axial lamellae.

Distribution – Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Germany (A.W. Janssen, 1967). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann, 1912); Paratethys (Langhian-Serravallian): Romania (Boettger, 1896, 1906; Zilch, 1934), Bulgaria (Kojumdgieva & Strachimirov, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Acrilloscala Sacco, 1891

Type species – Turbo geniculatus Brocchi, 1814, by monotypy. Neogene, Italy.

Acrilloscala sp.

Plate 20, fig. 13

- ? 1960 Acrilloscala tenuicosta (Michaud, 1829) Kojumdgieva & Strachimirov, p. 93, pl.
- ? 1985 Scala (Fuscoscala) tenuicosta (Michaud) Atanacković, p. 115, pl. 27, figs 13, 14 [non Michaud, 1829 = Epitonium turtonis (Turton, 1819)].

Dimensions and material – Maximum height 5.9 mm. Locality 17: NHMW 1874/0058/1131/1, JvdV/1.

Discussion – These shells from Turkey are problematic. The basal disc is very clearly defined, with the axial lamellae extending over the disc, placing it in the genus *Acrilloscala* Sacco, 1891 (Bouchet & Warén, 1986, p. 524). The Miocene species *Acrilloscala terebralis* (Michelin, 1831), which occurs in both the middle Miocene French Atlantic (Cossmann, 1912; Ivolas & Peyrot, 1900; Cossmann & Pevrot, 1922; Glibert, 1949) and Paratethys (Bałuk, 1975) is more slender than the Turkish shells, with fewer axial ribs. The Pliocene Mediterranean and adjacent Atlantic species Acrilloscala geniculata (Brocchi, 1814) differs from A. terebralis in having more numerous, but weaker axial lamellae and varices and in having a deeper suture. The Pliocene species differs from the Turkish shell in being more slender and having finer lamellae. The Recent species Acrilloscala lamyi (de Boury, 1909) from Atlantic southwestern Europe to Mauritania and the Mediterranean has even more numerous axial lamellae and stronger spiral microsculpture (Bouchet & Warén, 1986, figs 1221 and 1223). All these species are closely related and seem to form an evolutionary lineage (Landau et al., 2006b) in which there is an increase in the number of axial lamellae with time. The Recent Acrilloscala lamyi (de Boury, 1909) differs from the two fossil species in having even more numerous lamellae and stronger microscuplture.

The Turkish Miocene shells are not identical to any of the above species, but do seem very similar to the Paratethyan shells recorded by Kojumdgieva & Strachimirov (1960, pl. 30, fig. 1a, b) and Atanacković (1985, pl. 27, figs 13, 14) as *Acrilloscala tenuicosta* (Michaud, 1829) [= *Epitonium turtonis* (Turton, 1819); Landau *et al.*, 2006b]. This is a much larger species, in which the basal disc is not well defined in most specimens. It is unclear which species these Turkish shells represent and it must be stressed that the very small size of the shells suggests that they are not fully grown.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Acirsa Mörch, 1857

Type species – Scalaria eschrichti Holböll *in* Möller, 1842, by subsequent designation (Bouchet & Warén, 1986). Recent, northwestern Atlantic.

Acirsa lanceolata (Brocchi, 1814) Plate 20, fig. 14

- *1814 Turbo lanceolatus Brocchi, p. 375, pl. 7, fig. 7.
- 1856 Scalaria lanceolata Brocc. Hörnes, p. 481, pl. 46, fig. 14.
- 1889 Scalaria lanceolata Brocc. de Gregorio, p. 8, pl. 1, fig. 22.
- 1956 Acirsa (Hemiacirsa) lanceolata Brocchi var. Csepreghy-Meznerics, p. 389, pl. 3, figs 36, 37.
- Acirsa (Hemiacirsa) lanceolata (Brocchi, 1814) –
 A.W. Janssen, p. 139, pl. 12, figs 4-6.
- Acirsa (Hemiacirsa) lanceolata (Brocchi, 1814) Robba, p. 520, pl. 20, fig. 7.
- 1989 *Hemiacirsa lanceolata* (Brocchi, 1814) Moths, p. 111, pl. 10, fig. 49.
- 2006b *Acirsa lanceolata* (Brocchi, 1814) Landau *et al.*, p. 46, pl. 14, fig. 6 (with additional synonyms)
- 2009 Acirsa lanceolata (Brocchi, 1814) Chirli, p. 42,

pl. 16, figs 13-18.

- 2010 Acirsa lanceolata (Brocchi, 1814) Sosso & dell'Angelo, p. 28, p. 37, unnumbered, 2nd row third figure.
- 2010 Acirsa (Hemiacirsa) lanceolata (Brocchi, 1814) Moths et al., p. 48, pl. 14, fig. 15.
- 2011 Acirsa lanceolata (Brocchi, 1814) Landau et al., p. 21, pl. 9, fig. 11.

Dimensions and material – Maximum height 15.3 mm. Locality 13: NHMW 1874/0058/1132/1, 1874/0058/1133/9, JvdV/2, YI 258/4.

Discussion – This species is easily recognised by its very slender elongate appearance, almost straight-sided whorls and broad axial ribs, which become flatter, broader and weaker abapically. For further discussion see Landau *et al.* (2006b, p. 47).

Distribution - Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands, Belgium (Glibert, 1952; A.W. Janssen, 1984a), Germany (Kautsky, 1925; A.W. Janssen, 1967; Wienrich, 2001; Moths, 1989; Moths et al., 2010). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria, (Hörnes, 1856), Hungary (Csepreghy-Meznerics, 1956); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (Landau et al., 2006b); central Mediterranean, Italy (de Boury, 1890; Chirli, 2009). Early-late Pliocene: central Mediterranean, Italy (de Boury, 1890; Sacco, 1891; Robba, 1968; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010). Early Pleistocene: central Mediterranean, Italy (de Boury, 1890; Cerulli-Irelli, 1914).

Superfamily Eulimoidea H. Adams & A. Adams, 1853 Family Aclididae Sars, 1878 Genus *Aclis* Lovén, 1846

Type species – Alvania supranitida S.V. Wood, 1842 [= *Aclis minor* (Brown, 1827)], by monotypy. Recent: Europe.

Aclis ascaris (Turton, 1819)

Plate 63, fig. 8

- *1819 Turbo Ascaris Turton, p. 217.
- 1848 Alvania ascaris Turt. Wood, p. 99 (partim, pl. 12, fig. 11b only).
- ?1965 Aclis minor (Brown) van Regteren Altena et al.,
 p. 21, pl. 8, fig. 77 [non A. minor (Brown, 1827].
- Aclis ascaris (Turton, 1819) Fretter & Graham,
 p. 400, figs 284, 285.
- 1988 *Aclis ascaris* (Brown, 1819) Graham, p. 505, fig, 213.
- 1997b Aclis ascaris (Turton, 1819) Marquet, p. 84, pl.

4, fig. 2.

- Aclis ascaris (Turton, 1819) Marquet, p. 113, fig.
 87.
- 1999 *Aclis ascaris* (Turton, 1819) Giannuzzi-Savelli *et al.*, p. 58, figs 102-105.
- 2009 Aclis minor (Brown, 1827) Chirli, p. 75, pl. 31, figs 6-10 [non A. minor (Brown, 1827)].
- 2010 Aclis ascaris (Turton, 1819) Sosso & dell' Angelo, p. 29, unnumbered figure p. 37 third row middle.

Dimensions and material – Maximum height 1.3 mm. Localities 7 & 8: RGM 783 962/1; locality 17: RGM 784 063/1, 783 938/1 + 2 fragments.

Discussion - The tall multispiral protoconch, well preserved in the Turkish specimen, is similar to that illustrated in Recent shells by Giannuzzi-Savelli et al. (1999, fig. 104). Two similar species of Aclis with spiral cords are known, A. minor (Brown, 1827) and A. ascaris (Turton, 1819). Most specimens of Aclis ascaris are smaller than A. minor (3 mm vs. 7 mm), with a broader, flattened sutural ramp as opposed to evenly convex whorls in A. *minor*, and the umbilicus is reduced to a narrow slit in A. ascaris. Although our material is incomplete, the whorls are convex, and the sutural ramp is poorly developed, as in A. ascaris. The Recent European species Aclis trilineata Watson, 1897 (= Pherusa carinata Chaster, 1896, non Aclis carinata Smith, 1871 = Aclis verduini van Aartsen, Menkhorst & Gittenberger, 1984) from the Alboran Sea also has spiral sculpture, but is immediately distinguished by its paucispiral protoconch.

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: North Sea Basin (Wood, 1848). Early-late Pliocene: central Mediterranean (Sosso & dell'Angelo, 2010). Late Pliocene: North Sea Basin (Marquet, 1997b, 1998). Recent: Scandinavia to the Mediterranean (Graham, 1988; Giannuzzi-Savelli *et al.*, 1999).

Family Eulimidae H. Adams & A. Adams, 1853 Genus *Eulima* Risso, 1826

Type species – Awaiting decision by ICZN, *Strombiformis glabra* da Costa, 1778 considered to be the type species by Bouchet & Warén (1986, p. 318). Recent, Europe.

Eulima cf. jaskiewiczi Bałuk, 1995

Plate 20, fig. 15; Plate 63, fig. 9

?*1995 Eulima jaskiewiczi Bałuk, p. 162, pl. 1, figs 5, 6.

Dimensions and material – Maximum height 15.8 mm. Localities 2 & 3: JvdV/6; locality 6: JvdV/15; localities 7 & 8: NHMW 1874/0058/1135/15, YI 254/8; locality 9: YI 259/1; locality 10: YI 260/15; locality 13: NHMW 1847/0058/1690/4, JvdV/15, RGM/ 794 568/2, YI 255/9; locality 17: NHMW 1874/0058/1134/1, 1874/0058/1135/20, RGM 783 936/2 + 10 fragments, YI 256/50+.

Discussion - Landau et al. (2006b, p. 60) distinguished the early Pliocene species Eulima boucheti Landau, La Perna & Marquet, 2006 from the Recent species E. glabra (da Costa, 1778) by the protoconch of the fossil species having a more horizontal suture and a more depressed first whorl than Recent specimens. The Turkish Eulima species seems to be different again, with a protoconch of just over three whorls (dp = $170 \ \mu m$; hp = 210 μ m; Pl. 63, fig. 9), much smaller than that of the Pliocene species. The Turkish shells are very slender and the teleoconch whorls are almost completely flat-sided, whereas they are slightly convex in E. boucheti. Another peculiarity of the Turkish shells is that the growth scars cannot be seen clearly in the most pristine specimens even under high light magnification, but what traces are taken as growth scars suggests they are orthocline and irregularly placed. Bałuk (1995) recognised the middle Miocene Paratethyan shells as different from the Recent species E. glabra and named them Eulima jaskiewiczi (Bałuk, 1995). This was based on their slimmer shells (width/ height ratio 0.19-0.21 vs. 0.24-0.25) and a different last whorl height vs. total shell height (0.43-0.44 for E. jaskiewiczi vs. 0.47-0.53 for E. glabra). The Turkish shells have a width/height ration of about 0.20 and a last whorl height vs. total shell height of 0.4, and therefore are more closely similar to the Paratethyan than to the Recent shells.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Campylorhaphion Bouchet & Warén, 1986

Type species – Eulima famelicum Bouchet & Warén, 1986, by original designation. Recent, Eastern Atlantic.

Campylorhaphion famelicum (Watson, 1883) Plate 20, fig. 16

- *1883 Eulima famelica, Watson, p. 121.
- 1999 *Campylorhaphion famelicum* (Watson, 1883) Di Geronimo & La Perna, p. 48, figs 24-28, 33.
- 2006a *Campylorhaphion famelicum* (Watson, 1883) Landau *et al.*, p. 66, pl. 20, figs 1-3, pl. 22, fig. 8.

Dimensions and material-Maximum height 14.6 mm. Locality 13: NHMW 1874/0058/1379/1, 1874/0058/1380/2, YI 451/4.

Discussion – This species is characterised by its solid curved shell and its growth scars placed on the left side of the shell. The position of the scars on the left of the shell is seen in both *Melanella* Bowdich, 1822 and *Campylorhaphion* Bouchet & Warén, 1986, but the protoconch in the latter is cylindrical with the same apical angle as the teleoconch, whereas in *Melanella* the larval shell has a greater apical angle than the teleoconch. Unfortunately, the protoconch is missing in all our Turkish material and assignment cannot be made with absolute certainty, but the teleoconch is similar to the specimens from the early Pliocene of Estepona figured by Landau *et al.* (2006b).

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: western Mediterranean, Estepona. Pleistocene: central Mediterranean, Sicily (Di Geronimo & La Perna, 1999). Recent: Azores, 1372 m depth (Bouchet & Warén, 1986).

Genus Vitreolina Monterosato, 1884

Type species – Eulima incurva Bucquoy, Dautzenberg & Dollfus, 1883, by subsequent designation (Bucquoy *et al.*, 1898). Recent, Mediterranean.

Vitreolina sp.

Plate 63, fig. 10

Dimensions and material – Maximum height 5.0 mm. Locality 13: NHMW 1874/0058/1381/1, 1874/0058/1382/1, RGM 784 099/1, YI 261/1.

Discussion – The genus *Vitreolina* Monterosato, 1884 is here used to include small curved eulimids, but they do not necessarily comprise a monophyletic group (Bouchet & Warén, 1986). The shells from Turkey have the incremental scars very slightly behind each other, winding anticlockwise from the aperture to the apex. The protoconch forms a relatively pointed apex. It consists of at least three whorls, although the protoconch/teleoconch boundary is not distinguishable (Pl. 63, fig. 10).

The shells from the middle Miocene Paratethys of Romania named *Eulima (Vitreolina) colon* by Boettger (1907) possibly represent the same species, but without a more detailed revision of the group this cannot be verified. The Turkish shells are also similar to the Recent species *Vitreolina knudseni* Bouchet & Warén, 1986 from the Azores, but in this species the scars are aligned along the vertical shell axis in a curved line.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Melanella Bowdich, 1822

Type species – Melanella dufresnei Bowdich, 1822, by monotypy. Recent, Indo-Pacific.

Melanella sp.

Plate 17, figs 2, 3; Plate 63, fig. 11

Dimensions and material – Maximum height 5.0 mm. Locality 13: RGM 776 939 (ex JvdV collection).

Discussion - The genus is extremely poorly represented

in the Turkish assemblages, with a single specimen available to us from the Akpinar deposits. The Turkish shell is very straight, with straight-sided whorls. The last whorl is weakly angular at the periphery, similar to that of *M. alba* (da Costa, 1778), but the whorls are smooth and do not have the very fine reticulate sculpture typical of this species (Landau *et al*, 2006b, pl. 19, fig. 1c). Bałuk (1995, pl. 2, fig. 3) illustrated a similar shell under the name *M. polita* (Linnaeus, 1758). The group of shells illustrated by Bałuk under this name represent several species, none of which is likely to be conspecific with the Recent species *M. polita*. As with the other Miocene eulimids, a revision of this family is required.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Clade Neogastropoda Superfamily Muricoidea Rafinesque, 1815 Family Muricidae Rafinesque, 1815 Subfamily Muricinae Rafinesque, 1815

Note – Descriptions of Muricidae follow Merle (1999, 2001) in the notation of spiral cords.

Genus Bolinus Pusch, 1837

Type species – Murex brandaris Linnaeus, 1758, by original designation. Recent, Atlantic and Mediterranean Sea.

Bolinus brandaris torularius (Lamarck, 1822) Plate 21, fig. 1

- *1822 Murex torularius Lamarck, p. 576
- 1958 *Murex (Murex) torularius* Lamarck Erünal-Erentöz, p. 53, pl. 8, figs 1, 2.
- 2004 Murex (Bolinus) subtorularius Hörnes & Auinger 1879 [sic] – İslamoğlu, p. 154, pl. 3, fig. 3 [non Bolinus subtorularius (Hörnes & Auinger 1885)].
- 2007 *Bolinus brandaris torularius* (Lamarck, 1822) Landau *et al.*, p. 5, pl. 1, figs 3-6 (with additional synonyms).
- 2011 *Bolinus brandaris torularius* (Lamarck, 1822) Landau *et al.*, p. 22, pl. 10, figs 2-4 (with additional synonyms).
- 2011 Bolinus brandaris torularius (Lamarck, 1822) Merle et al., p. 302, pl. 29, figs 5-8.

Dimensions and material – Maximum height 82.8 mm. Localities 2 & 3: JvdV/10, RGM 783 916/2, YI 175/2 + 1 juvenile; locality 6: NHMW 1847/0058/1492/2, JvdV/9, RGM 783 849/3; localities 7 & 8: JvdV/6; locality 9: Jvd/3; locality 12: JvdV/3, RGM 783 948/2; locality 13: JvdV/19, RGM 783 660/6, YI 176/64; locality 17: NHMW 1847/0058/0716/1, 1847/0058/0717-1847/0058/0729/13, 1847/0058/0780-1847/0058/0782/3, 1847/0058/1619-1847/ 0058/1621/3, JvdV/50+, RGM 783 761-764/50+, MTA 2013/032/30, YI 177/50 + 14 juveniles. *Discussion* – Caretto (1967) showed that fossil shells differ from the Recent *Bolinus brandaris brandaris* (Linnaeus, 1758) in having a lower spire, a deeper suture, an aperture extending further adaperturally and two rows of spines on the siphonal fasciole as opposed to only one in *B. brandaris brandaris*. The fossil shells also tend to be more robust, with stronger, larger spines than in the modern form. We consider all the Miocene and Pliocene specimens to belong to a single chronosubspecies, *Bolinus brandaris torularius* (Lamarck, 1822), which was replaced in the Pleistocene by the living taxon *B. b. brandaris*. The transition from one subspecies to another may not have been that clear-cut, as *B. b. brandaris* occurs in the late Redonian (late Pliocene) of France (Didier Merle personal communication 2006).

The specimens from Karaman are fairly typical of *Bolinus brandaris torularius* (Lamarck, 1822), with robust shells, two rows of spines on the siphonal canal as opposed to only one in the Recent *Bolinus brandaris brandaris* (Linnaeus, 1758), and strong recurved spines at the shoulder of the last whorl. This species has not been found in the Paratethys, where it is replaced by *Bolinus subtorularius* (Hoernes & Auinger, 1885), which differs in having a stockier shell, with a higher spire, a less pronounced sutural canal and stronger ribs bearing less developed spines. For further discussion see Landau *et al.* (2007).

Distribution - Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1924); Proto-Mediterranean Sea (Langhian): Kasaba Basin, Turkey (İslamoğlu, 2004), (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (Brébion, 1964), (Tortonian): Cacela, Portugal (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Montanaro, 1935). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González-Delgado, 1989; Landau et al., 2011); western Mediterranean, Estepona, Spain (Landau et al., 2007), northeastern Spain (Almera & Bofill, 1893; Martinell, 1979), Roussillon Basin, France (Fontannes, 1879; Cataliotti-Valdina, 1975; Chirli & Richard, 2008); central Mediterranean, Italy (Chirli, 2000), Tunisia (Stchepinsky, 1938; Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001; Landau et al., 2007); central Mediterranean (Sacco, 1904; Ruggieri et al., 1959; Palla, 1967; Caretto, 1963, 1967; Annoscia, 1970; Malatesta, 1974; Caprotti, 1976; Cavallo & Repetto, 1992; Andreoli & Marsigli, 1992a; Damarco, 1993; Merle et al., 2011); eastern Mediterranean, Turkey (Karakus & Taner, 1994). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1911; Malatesta, 1960).

Bolinus submuticus (Grateloup, 1845)

Plate 21, figs 2, 3

*1845 *Murex rectispina* var. *submutica* Grateloup, pl. 31, fig. 4.
- 1845 Murex Borsonii mihi, Michelotti, p. 233, pl. 11, fig. 1.
- 1853 *Murex Partschi* Hörnes, Hörnes, p. 258, pl. 26, fig.
 5.
- 1873 Murex Sismondae Bell., Bellardi, p. 47, pl. 4, fig.4.
- 1903 Murex (Haustellum) submuticus Desh. Cossmann, p. 16, pl. 1, fig. 9.
- 1904 Murex (Haustellum) Partschi Hörn. Sacco, p. 18, pl. 4, fig. 24.
- 1904 Murex (Haustellum) Partschi var. subspinosa Sacc., Sacco, p. 18, pl. 4, figs 25, 26.
- 1904 Murex (Haustellum) Sismondae var. varicosissima Sacc., Sacco, p. 18, pl. 4, figs 27, 28.
- 1924 Murex (Haustellum) Partschi var. submuticus Grateloup – Cossmann & Peyrot, no. 726, pl. 17, fig. 35.
- 1924 *Murex (Haustellum) haudmuticus* Cossmann & Peyrot, no. 728, pl. 17, figs 28-30, 36, pl. 18, fig. 4.
- 1956 Murex (Haustellum) partschi M. Hörnes 1856 Csepreghy-Meznerics, p. 433, pl. 5, figs 7-10.
- 1960 *Murex (Haustellum) partschi* Hoernes 1856 Kojumdgieva & Strachimirov, p. 144, pl. 39, fig. 3.
- 1966 Murex (Haustellum) partschi Hörnes, 1856 Strausz, p. 260, pl. 54, figs 9, 10.
- 1978 Murex (Bolinus) partschi M. Hörnes, 1853 Stojaspal, p. 336, pl. 4, fig. 2.
- 1981 *Murex sismondae* Bellardi, 1872 Ferrero Mortara *et al.*, p. 31, pl. 1, fig. 9.
- 1994 *Murex (Haustellum) haudmuticus* Cossmann & Peyrot, 1924 Marcomini, p. 19, figs 30, 31.
- 1995 Murex (Bolinus) partschi Hörnes, 1856 Bałuk, p.
 211, pl. 24, figs 5-7.
- 2011 *Bolinus submuticus* (Grateloup, 1846) Merle *et al.*, p. 300, pl. 28, figs 6-10.
- non 2009 Murex (Bolinus) partschi Hörnes, 1856 Mikuž, p. 26, pl. 8, figs 101, 102 [= Ocinebrina polonica (Bałuk, 1995)].

Dimensions and material – Maximum height 50.9 mm. Locality 6: JvdV/3; localities 7 & 8: NHMW 1847/-0058/0520/1, locality 12: JvdV/11, RGM 783 947/2; locality 13: NHMW 1847/0058/0518/1, 1847/0058/0519/8, JvdV/35, RGM 783 659/17, YI 186/15.

Discussion – Bolinus submuticus (Grateloup, 1845) is a very distinctive species, which is widespread in the European Miocene Atlantic, Proto-Mediterranean Sea and Paratethys. In the Miocene North Sea Basin assemblages it is replaced by a closely similar species; Bolinus beyrichi (von Koenen, 1889) [= M. inornatus Beyrich, 1854, non Récluz, 1851; for further synonymy see Merle et al. (2011)], which differs in having more rounded whorls, without the short spines present at the shoulder in B. submuticus. Bolinus verefusoides (Cossmann & Peyrot, 1924) from the Atlantic middle Miocene Langhian of the Aquitaine Basin, France has rounded whorls without spines, similar to B. beyrichi, but is much higher-spired. Bolinus submuticus is uncommon in the Karaman as-

semblages, where it occurs only in the clayey deposits. In the Paratethys area, this species has been identified by most authors as *Bolinus partschi* (Hörnes, 1853), which is a junior synonym.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1924; Marcomini, 1994; Merle *et al.*, 2011); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1873; Sacco, 1904; Merle *et al.*, 2011). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1924; Merle *et al.*, 2011); Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1853), Poland (Bałuk, 1995), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Csepreghy-Meznerics, 1956; Strausz, 1966), Romania (Merle *et al.*, 2011); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus *Hexaplex* Perry, 1811 Subgenus *Trunculariopsis* Cossmann, 1921

Type species – Murex trunculus Linnaeus, 1758, by original designation, Recent, Mediterranean.

Hexaplex (Trunculariopsis) austriacus (Tournouër, 1875)

Plate 21, fig. 4

- 1837 Murex pomum L. Pusch, p. 136, pl. 11, fig. 24 [non Phyllonotus pomum (Gmelin, 1791)].
- 1853 Murex pomiformis m. Eichwald, p. 191 [non Mörch, 1852 (= M. pomum Gmelin, 1791)].
- 1853 Murex Sedgewicki Micht. Hörnes, p. 220, pl. 23, figs 1-5 [non Hexaplex (Trunculariopsis) sedgewicki Michelotti, 1841)].
- *1875a Murex Austriacus Tournouër, p. 158.
- 1885 Murex ambernus De Greg., de Gregorio, p. 271 [nom. nov. pro Murex Sedgewicki in Hörnes, 1853, pl. 23, fig. 1 only].
- 1912 Murex austriacus Tourn. Friedberg, p. 169, pl. 10, fig. 10.
- 1958 *Murex (Hexaplex) austriacus* Tournouër Erünal-Erentöz, p. 55, pl. 8, figs 5-7.
- Murex (Muricanthus) pomiformis Eichwald 1853 – Kojumdgieva & Strachimirov, p. 146, pl. 40, fig.
 1.
- Murex (Muricanthus) turonensis pontileviensis Tournouër, 1875 – Strausz, p. 264, pl. 32, figs 1, 4, pl. 33, fig. 2, pl. 56, figs 9-11, pl. 79, fig. 1 [non Murex turoniensis var. pontileviensis Tournouër, 1875 = Hexaplex (Trunculariopsis) turonensis (Dujardin, 1837)].
- 1966 Murex (Muricanthus) rudis sedgewicki Michelotti, 1841 – Strausz, p. 265, pl. 56, fig. 12 [non Hexaplex (Trunculariopsis) rudis (Borson, 1821)].
- 1972 *Murex (Muricanthus) pomiformis* Eichwald, 1853 – Nicorici, p. 140, pl. 16, figs 3, 4.
- 1978 Hexaplex austriacus Tournouer, 1875 Stojaspal,

p. 336, pl. 4, fig. 4.

- 1985 *Murex (Muricanthus) sedgewicki* (Michelotti, 1841) Atanacković, p. 138, pl. 31, figs 7, 8.
- 1995 *Hexaplex (Muricanthus) pomiformis* (Eichwald 1853) Bałuk, p. 214, pl. 21, figs 1-6.
- 2002 Murex (Bolinus) subtorularius Hoernes & Auinger, 1885 – Harzhauser, p. 94, pl. 6, figs 4, 5. [non Bolinus subtorularius (Hoernes & Auinger, 1885)].
- 2002 *Hexaplex (Phyllonotus) pomiformis* (Eichwald 1853) Harzhauser, p. 94, pl. 6, figs 1-3.
- 2011 *Hexaplex (Trunculariopsis) austriacus* (Tournouër, 1875) – Merle *et al.*, p. 318, pl. 37, fig. 7.
- non 1994 Hexaplex (Muricanthus) turonensis pontileviensis Tournouër, 1875 – Nikolov, p. 48, pl. 1, figs 3, 4. [= might represent Hexaplex (Trunculariopsis) bourgeoisi (Tournouër, 1875)].

Dimensions and material – Maximum height 123.0 mm. Localities 2 & 3: NHMW 1847/0058/0521/2, JvdV/18, RGM 783 915/3, YI 188/4 + 1 juvenile; locality 6: NHMW 1847/0058/1495/3, JvdV/1, RGM 783 850/2; localities 7 & 8: NHMW 1847/0058/0522/7, JvdV/9, RGM 783 877/1; locality 12: JvdV/4, RGM 783 949/3; locality 13: NHMW 1847/0058/0521, 1847/0058/0805/8, JvdV/2, RGM 783 654-655/24, YI 469/3 + 1 juvenile; locality 17: NHMW 1847/0058/0783-1847/0058/0804/22, 1847/0058/1622-1847/0058/1624/3, JvdV/50+, RGM 783 755, 783 765-783 768/50+, MTA 2013/033/28, YI 187/50 + 1 juvenile.

Discussion – The name Murex hörnesi (which following ICZN Code (1999) Art. 32 (c) i, is changed to hoernesi) was introduced by d'Ancona (1871, p. 30) for Murex sedgewicki Hörnes (1856, pl. 23, figs 2, 3) non Michelotti 1841. However, this is a junior homonym of Murex hörnesi Speyer, 1863, a species from the Oligocene of Germany. Whilst d'Ancona (1871, p. 30) said his species encompassed the specimen illustrated by Hörnes (1856), he described and illustrated a specimen from the Italian Pliocene 'colline Senesi'. Bałuk (1995, p. 214) argued that the correct name for the Paratethyan shell illustrated by Hörnes as M. sedgewicki should be Murex pomiformis Eichwald, 1853. However, this is also a junior homonym of Murex pomiformis 'Martini' Mörch, 1852 (= M. pomum Gmelin, 1791). The earliest available name for the Paratethyan form is Murex austriacus Tournouër, 1875.

Hexaplex (Trunculariopsis) austriacus (Tournouër, 1875) is characterised by its rather rounded last adult whorl, with P1-P6 subequal in strength and s1-s6 almost as strongly developed, and in having a relatively small aperture. Hexaplex (Trunculariopsis) turonensis (Dujardin, 1837) from the Atlantic middle Miocene Langhian of the Loire Basin, France differs by having P1 much more strongly developed at the shoulder, the primary ribs weakening abapically, and in having a wider aperture.

Distribution – **Early Miocene**: Paratethys (Burdigalian): Austria, (Harzhauser, 2002). **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1853; Merle *et al.*, 2011), Poland (Friedberg, 1912; Bałuk, 1995), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1966), Romania (Merle *et al.*, 2011), Bosnia (Atanackovič, 1985); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Hexaplex (Trunculariopsis) rudis (Borson, 1821) Plate 21, figs 5-9

- *1821 Murex rudis nob., Borson, p. 308, pl. 1, fig. 6.
- 1885 Murex terigus De Greg., de Gregorio, p. 264 [nom. nov. pro Murex rudis in d'Ancona, 1871, pl. 6, fig. 7 only].
- 1904 *Murex (Phyllonotus) rudis* var. *plicatula* Sacc., Sacco, p. 22.
- 2007 *Hexaplex (Trunculariopsis) rudis* (Borson, 1821) – Landau *et al.*, p. 12, pl. 2, fig. 7 (with additional synonyms).
- 2011 *Hexaplex (Trunculariopsis) rudis* (Borson, 1821) – Merle *et al.*, p. 320, pl. 38, figs 6-12.

Dimensions and material – Maximum height 43.3 mm. Localities 2 & 3: YI 196/1 juvenile; locality 6: 1 (JvdV collection); locality 17: NHMW 1847/0058/0524-1847/0058/0528/5, 1847/0058/0529/32, JvdV/50+, RGM 783 769/5, MTA 2013/034/4, YI 192/48 + 4 juveniles; locality 18: JvdV/1.

Discussion – Hexaplex (Trunculariopsis) rudis (Borson, 1821) is easily distinguished from the Recent species *Hexaplex (Trunculariopsis) trunculus* (Linnaeus, 1758) and the fossil species *Hexaplex (Trunculariopsis) austriacus* (Tournouër, 1875) by its smaller, more solid, fusiform shell. It is more similar to the Pliocene Mediterranean *Hexaplex (Trunculariopsis) tapparonii* (Bellardi, 1873), which has a less solid, more fusiform shell, a higher spire, more angulate whorls, with short spines produced at the shoulder, a more flattened, distinct infrasutural platform and has a longer siphonal canal. In the Karaman assemblages *H. (T.) rudis* is found in the sandy deposits.

The occurrence of this species in the Badenian of the Paratethys is unclear. The shells from the Badenian of Austria, described by Hörnes (1856) as *Murex rudis* Borson, are stout and have a short siphonal canal They possibly belong rather to *Hexaplex (Trunculariopsis) syrticus* (Mayer, 1871), which is represented by typical specimens also in the Badenian of Hungary (Strausz, 1966).

Distribution – Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France (Glibert, 1952a; Merle *et al.*, 2011); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, Italy (Bellardi, 1882; Montanaro, 1935; Venzo & Pelosio, 1963; Pavia, 1976; Merle *et al.*, 2011), Crete (Merle *et al.*, 2011). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Landau *et al.*, 2007); central Mediterranean, Italy (Chirli, 2000). Late Pliocene: central Mediterranean (Ruggieri *et al.*, 1959; Palla, 1967; Malatesta, 1974; Caprotti, 1976; Chirli, 1988, 2000; Cavallo & Repetto, 1992; Andreoli & Marsigli, 1992a; Merle *et al.*, 2011). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1911).

Hexaplex (Trunculariopsis) turonensis (Dujardin,

1837) Plate 21, fig. 10

- *1837 *Murex turonensis* Duj., Dujardin, p. 295, pl. 19, fig. 27.
- 1875 Murex (Chicoreus? Phyllonotus?) Turonensis Dujardin Var. Pontileviensis Tournouër, p. 159, pl. 5, fig. 6.
- Murex (Muricantha) turonensis Dujardin Cossmann & Peyrot, no. 741, p. 454, pl. 13, figs 42, 43, pl., 18, fig. 11.
- Murex (Favartia) turonensis Dujardin Var. pontileviensis Tournouer [sic] – Peyrot, no. 287, p. 182, pl. 3, fig. 20.
- 1952a Murex (Muricantha) turonensis pontileviensis Tournouër, 1875 – Glibert, p. 285, pl. 4, fig. 8.
- 2011 Hexaplex (Trunculariopsis) turonensis (Dujardin, 1837) Merle et al., p. 318, pl. 37, figs 8-12.

Dimensions and material – Maximum height 123.0 mm. Localities 2 & 3: JvdV/4, RGM 783 917/1; locality 6: JvdV/1; locality 13: JvdV/2, YI 190/2 + 12 juveniles; locality 17: NHMW 1847/0058/0806-1847/0058/0816/11, 1847/0058/1615-1847/0058/1618/4, JvdV/32, RGM 783 770/8, MTA 2013/035/6, YI 189/21 + 1 juvenile.

Discussion - Merle et al. (2011) considered Murex turonensis pontileviensis Tournouër, 1875 to be a syonym of Hexaplex (Trunculariopsis) turonensis (Dujardin, 1837), and we follow them here. The illustrated shell from Turkey is reminiscent of strongly sculptured specimens of the early Miocene species Hexaplex (Trunculariopsis) subasperrimus (d'Orbigny, 1852) from the eastern Atlantic and a phylogenetic relationship between both species would not be surprising. A constant difference is the more convex base, the less angulated shoulder and the less bulgy varices of H. (T.) subasperrimus. Moreover, it lacks spines on the last spire whorls and develops only very indistinct shoulder knobs, whilst H. (T.) turonensis bears strong, somewhat tubular spines. In addition, H(T)turonensis differs from H. (T.) subasperrimus in lacking small columellar tubercles.

The spire fragment from the Miocene of Winterswijk-Miste in the Netherlands, identified as *Trunculariopsis* cf. *turonensis* by A.W. Janssen (1984a), differs in its densely spaced axial ribs, the prominent secondary spirals and the overall slender outline from typical *H*. (*T*.) *turonensis* and possibly represents another species.

Distribution – Middle Miocene: northeastern Atlantic

(Langhian and Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1924; Merle *et al.*, 2011); (Langhian): Loire Basin (Glibert, 1952a; Merle *et al.*, 2011); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Chicoreus de Montfort, 1810

Type species – Murex ramosus, Linnaeus, 1758, by original designation (ICZN Opinion 911, 1970).

Subgenus Triplex Perry, 1810

Type species – Murex foliatus Perry, 1811 (rejected ICZN *= T. rosaria* Perry, 1810; see Petit, 2003, p. 47), by mono-typy.

*Chicoreus (Triplex) aquitanicus (*Grateloup, 1833) Plate 21, fig. 11

- *1833b Murex aquitanicus Grat., Grateloup, p. 94.
- 1845 *Murex Aquitanicus* Grat., Grateloup, pl. 31, fig. 12a, b.
- 1841a Murex triqueter Born. Michelotti, p. 11, pl. 2, figs 9, 10.
- 1847 *Murex Bonellii* mihi, Michelotti, p. 237, pl. 11, fig.2.
- 1847 Murex despectus mihi, Michelotti, p. 238, pl. 11, fig. 5.
- 1853 Murex Aquitanicus Grat. Hörnes, p. 219, pl. 22, figs 1-3.
- 1873 Murex Aquitanicus Grat. Bellardi, p. 78.
- 1885 Murex (b. Chicoreus) Aquitanicus Grat. Hoernes & Auinger, p. 207, pl. 25, fig. 3.
- 1885 Murex trunculus var. calismus De Greg., de Gregorio, p. 267 [nom. nov. pro Murex Aquitanicus in Hörnes, 1853, pl. 22, fig. 1 only].
- 1885 Murex trunculus var. mitopicus De Greg., de Gregorio, p. 267 [nom. nov. pro Murex Aquitanicus in Hörnes, 1853, pl. 22, fig. 3 only].
- 1885 Murex trunculus var. astrogus De Greg., de Gregorio, p. 267 [nom. nov. pro Murex Aquitanicus in Hörnes, 1853, pl. 22, fig. 2 only].
- 1904 *Murex (Chicoreus ?) aquitanicus* Grat. Sacco, p. 21, pl. 6, figs 1, 2.
- 1912 Murex aquitanicus Grat. var. Friedberg, p. 168, pl. 10, fig. 9.
- Murex (Favartia) aquitaniensis Grateloup (emend.) – Cossmann & Peyrot, no. 746, pl. 18, fig. 14 (unjustified emendation).
- 1944 *Chicoreus (Chicoreus) aquitanicus* (Grateloup) van Voorthuysen, p. 60, pl. 5, figs 17-22.
- 1952a Murex (Chicoreus) aquitanicus Grateloup, 1833 Glibert, p. 90, pl. 7, fig. 5.
- 1956 Murex (Chicoreus) aquitaniensis Grat. Csepreghy-Meznerics, p. 399, pl. 6, figs 5, 6.
- 1958 *Murex* (*Chicoreus*) *aquitanicus* Grateloup Erünal-Erentöz, p. 56, pl. 8, fig. 8.
- 1960 Murex (Chicoreus) aquitanicus Grateloup, 1833 -

Kojumdgieva & Strachimirov, p., 145, pl. 39, figs 5, 6.

- 1966 *Murex (Chicoreus) aquitanicus* Grateloup, 1847 Strausz, p. 262, pl. 31, figs 4, 5.
- 1968 Murex aquitanicus Grateloup, 1840 Zelinskaya et al., p. 185, pl. 44, figs 3, 4.
- 1978 *Chicoreus* (*Chicoreus*) *aquitanicus* (Grateloup, 1833) Stojaspal, p. 336, pl. 4, fig. 3.
- 1984a Chicoreus (Chicoreus) aquitanicus (Grateloup, 1833) A.W. Janssen, p. 213, pl. 9, fig. 10, pl. 59, figs 3, 4.
- 1998 *Chicoreus (Chicoreus) aquitaniensis* (Grateloup) [*sic*] – Schultz, p. 64, pl. 25, fig. 1.
- 2011 *Chicoreus (Triplex) aquitanicus* (Grateloup, 1833) – Merle *et al.*, p. 350, pl. 53, figs 1-7.

Dimensions and material – Maximum height 116.4 mm. Locality 12: JvdV/1; locality 13: NHMW 1847/0058/0817-1847/0058/0821/5, JvdV/19, RGM 783 661/5, YI 191/6; locality 17: YI 355/1.

Discussion - Chicoreus (Triplex) aquitanicus (Grateloup, 1833) is very similar to Chicoreus (Triplex) foliosus (Bellardi, 1873) found in the Atlantic and Mediterranean Miocene to Pliocene, but differs from *C. foliosus* in having a taller spire and a more steeply sloping sutural ramp. There are also small differences in the sculpture; P2 is more strongly developed in *C. (T.) aquitanicus* than in *C. (T.) foliosus*. In the Karaman assemblages *C. (T.) aquitanicus* is found in the clayey deposits.

Distribution - Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1924); Paratethys (Burdigalian): Austria (own data MH); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1873; Sacco, 1904; Merle et al., 2011). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (van Voorthuysen, 1944; Janssen, 1984a). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1924; Merle et al., 2011), (Langhian): Loire Basin, France (Glibert, 1952a; Merle et al., 2011); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Hoernes & Auinger, 1885; Schultz, 1998; Merle et al., 2011), Hungary (Strausz, 1966; Csepreghy-Meznerics, 1956), Romania (Hoernes & Auinger, 1885), Poland (Friedberg, 1912), Ukraine (Zelinskaya et al., 1968), Bulgaria (Kojumdgieva & Strachimirov, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Michelotti, 1847).

Genus Pterynotus Swainson, 1833

Type species – Murex pinnatus Swainson, 1822, by subsequent designation. Recent, Indo-West Pacific.

Note – The placement of *Pterynotus* Swainson, 1833 in the subfamily Muricinae is doubtful and provisional, as molecular data presented by Barco *et al.* (2010) showed

the subfamily to be polyphyletic. See Merle *et al.* (2011) for further discussion.

Pterynotus granuliferus (Grateloup, 1833) Plate 21, figs 12, 13

- *1833b Murex granuliferus Nob., Grateloup, p. 96.
- 1845 Murex granuliferus Gr. Grateloup, pl. 30, fig. 17.
- 1853 *Murex granuliferus* Grat. Hörnes, p. 254, pl. 25, fig. 19.
- 1873 Murex granuliferus Grat. Bellardi, p. 79, pl. 6, fig. 4.
- 1904 *Murex (Chicoreus?) granuliferus var. exgranulosa* Sacc., Sacco, p. 21.
- 1924 Murex (Inermicosta) granulifer Grateloup (emend.) – Cossmann & Peyrot, no. 737, pl. 18, fig. 10.
- Murex (Chicoreus) granuliferus Grateloup 1840 Kojumdgieva & Strachimirov, p. 145, pl. 39, fig.
 7.
- 2011 *Pterynotus (s.s.) granuliferus* (Grateloup, 1833) Merle *et al.*, p. 416, pl. 86, figs 1-3.

Dimensions and material – Maximum height 46.2 mm. Localities 2 & 3: YI 194/1; locality 13: NHMW 1847/0058/0532/0533/2, 1847/0058/1683/1, JvdV/2, RGM 783 656/1; locality 17: NHMW 1847/-0058/0530-1847/0058/0531/2, 11847/0058/1639/1.

Discussion – Pterynotus granuliferus (Grateloup, 1833) has a very distinctive shell. Cossmann & Peyrot (1924, p. 112) considered the French, Italian and German specimens to represent distinct species. The shells from Turkey are indeed slightly more angular at the peripheral carina than those illustrated by Merle *et al.* (2011, pl. 86, figs 1-3) from the early Miocene of France, but the development of the varices and other characters is similar. In our opinion they all represent a single species. Throughout its distribution *P. granuliferus* is extremely rare.

Distribution – Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1924; Merle *et al.*, 2011). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1924; Merle *et al.*, 2011); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856); Bulgaria (Kojumdgieva & Strachimirov, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1873).

Genus Dermomurex Monterosato, 1890

Type species – Murex scalarinus Bivona, 1832 (= *M. scalaroides* Blainville, 1826) by monotypy. Recent, Mediterranean.

Note – As for *Pterynotus*, the placement of *Dermomurex* Monterosato, 1890 in the subfamily Muricinae is doubtful and provisional, as molecular data presented by Barco *et al.* (2010) showed the subfamily to be polyphyletic. See Merle *et al.* (2011) for further discussion.

Subgenus Trialatella Berry, 1964

Type species – Trialatella cumminghamae Berry, 1964, by original designation. Recent, eastern Pacific.

Dermomurex (*Trialatella*) *kilikiensis* nov. sp. Figure 22; Plate 22, figs 1, 2; Plate 64, fig. 1

Dimensions and material – Holotype NHMW

1847/0058/0534, height 17.0 mm; paratype 1 NHMW 1847/0058/0535, height 15.8 mm; paratype 3 RGM 794 569, height 12.9 mm; paratype 4 RGM 794 570, height 17.3 mm; paratype 5 RGM 794 571, height 15.2 mm; furthermore two specimens in YI 437, height 19.0 mm, and YI 474, height 19.1 mm; all from the type locality. Paratype 2 NHMW 1847/0058/0536, height 21.8 mm, from locality 7 & 8.

Additional material – Maximum height 20.6 mm. Localities 2 & 3: JvdV/4, YI 179/17; locality 6: JvdV/2; localities 7 & 8: NHMW 1847/0058/0538/13, JvdV/1; locality 12: JvdV/1; locality 13: NHMW 1847/0058/0537/50+, JvdV/10, RGM 783 662/6, MTA 2013/036/7, YI 178/50+; locality 17: NHMW 1847/0058/0539/1, JvdV/2, YI 202/1.

Derivatio nominis – Referring to the historical province of Kilikia, which corresponds roughly geographically to modern Mersin and Adana provinces.

Locus typicus – Pinarlar Yaylası, Akpınar, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Dermomurex* (*Trialatella*) species, with a solid, broadly biconic teleoconch, a tall protoconch composed of 2.5 convex whorls, varices elevated and continuous, intervarical ribs well-developed, forming strong shoulder nodes on the last whorl, spiral sculpture with only P1-P4 developed, crossed by secondary spiral sculpture, D1-D5 weak (for terminology see Fig. 22).

Description – Shell small, very solid, broadly biconic, trivaricate. Protoconch tall, consisting of 2.5 convex whorls, with a medium-sized nucleus. Junction with teleoconch sharply defined by an elevated comma-shaped scar. Teleoconch consisting of 5.5 angular whorls, with periphery placed just below mid-whorl. Suture impressed, undulating. Axial sculpture of six narrow prosocline ribs, three varicose, intervarical ribs strongly developed until last whorl, producing strong single intervarical node at shoulder of last whorl. Varices elevated, recurved, each joined at suture with varix of preceeding whorl, forming weakly conjoined ridge that steps backwards as it ascends

spire. Spiral sculpture: P1-P4 weakening abapically, crossed by numerous, narrow, close-set spiral cordlets. Last adult whorl 65% of total height, sutural ramp broad, angled at shoulder, convex below, evenly constricted at base. Aperture ovate, outer lip erect, weakly crenulate, D1-D5 weakly developed on base, strengthening slightly abapically. Inner lip smooth, thin, adpressed. Siphonal canal relatively long, open, slightly recurved.



Figure 22. Dermomurex (Trialatella) kilikiensis nov. sp., paratype 2 NHMW 1847/0058/0536, localities 7 & 8, Akboğazi, Lale River, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene; height 21.8 mm. P1 = shoulder cord, P2-P4 = primary cords of the convex part of the whorl, IP = infrasutural primary cord, D1-D5 = abapical denticles (see Merle *et al.*, 2011, p. 12, 18).

Discussion - Dermomurex (Trialatella) differs from Dermomurex (Dermomurex) in having only three varices on the last whorl as opposed to six and the spiral sculpture on the last whorl is weaker. Dermomurex (Trialatella) kilikiensis nov. sp. is closely similar to the late Miocene and Pliocene Mediterranean species Dermomurex (Trialatella) jani (Doderlein, 1863), but differs in the character of its protoconch, which is tall and consists of 2.5 whorls, with a medium-sized nucleus, as opposed to the bulbous paucispiral protoconch of D. (T.) jani, which has only 1.5 whorls with a large nucleus (Landau et al., 2007). The teleoconch in D. (T.) kilikiensis is more solid and squatter than that of D. (T.) jani, the intervarical ribs are more strongly developed on the spire whorls and the intervarical node on the last adult whorl is more prominent.

The Recent West African species *Dermomurex* (*Triala-tella*) sepositus Houart, 1993 has quite a different shell shape, with the shoulder placed very high and rounded and the intervarical nodes on the last adult whorl very weak or lacking (Houart, 1996, figs 39, 40).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Homalocantha Mörch, 1852

Type species – Murex scorpio Linnaeus, 1758, by monotypy. Recent, Indo-Pacific.

Note – As for *Pterynotus* and *Dermomurex* above, the placement of *Homalocantha* Mörch, 1852 in the subfamily Muricinae is doubtful and provisional, as molecular data presented by Barco *et al.* (2010) showed the subfamily to be polyphyletic. See Merle *et al.* (2011) for further discussion.

Homalocantha heptagonata (Bronn, 1831)

Plate 22, fig. 3

- *1831 Murex heptagonatus Bronn, p. 35.
- 1978 Homalocantha heptagonata (Bronn, 1831) Stojaspal, p. 339, pl. 5, fig. 7.
- 1998 Aspella (Favartia) heptagonata (Bronn) Schultz, p. 66, pl. 26, fig. 7.
- 2003 Homalocantha heptagonata (Bronn, 1831) Lagarde, p. 51, figs 5, 6.
- 2007 *Homalocantha heptagonata* (Bronn, 1831) Landau *et al.*, p. 24, text-fig. 5 (with additional synonyms).

Dimensions and material – Maximum height 55.5 mm. Locality 17: RGM 794 553/1 (ex JvdV collection).

Discussion – Homalocantha heptagonata (Bronn, 1831) and related species have a long geological history in the European Neogene. The group first appeared in the Atlantic early Miocene Aquitaine Basin of France with Homalocantha pauli (Tournouër in Benoist, 1880). This species differs from H. heptagonata in having a more trigonal shell, with stronger secondary spiral sculpture, less rounded varices and a shorter siphonal canal. Cossmann & Peyrot (1924) considered it to be a subspecies of H. heptagonata. We note that Cossmann & Peyrot's (1924, pl. 12, figs 44-45) illustrations are not this species, but Favartia excisa (Grateloup, 1833). Malatesta (1974, p. 285) considered both H. pauli and Murex clavus Michelotti, 1841 to be subspecies of H. heptagonata forming an evolutionary lineage, the middle to late Miocene M. clavus allegedly having a longer siphonal canal. These three taxa undoubtedly form an evolutionary lineage and probably could be assigned to a single species, however, we have not included the French early Miocene specimens in the synonymy of *H. heptagonata* as Lozouet et al. (2001a) gave H. pauli full specific status.

Homalocantha heptagonata is extremely rare in the Karaman assemblages, as it is represented by a single large, but incomplete specimen in the JvdV collection. For further discussion see Landau *et al.* (2007, p. 25).

Distribution – **Middle Miocene**: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Lagarde, 2003); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Hoernes & Auinger, 1885; Schultz, 1998), Bulgaria (Kojumdgieva & Strachimirov, 1960; Nikolov, 1994), Hungary (Strausz, 1966), Poland (Bałuk, 1995); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Early Pliocene**: western Mediterranean, Estepona Basin (Landau *et al.*, 2007); central Mediterranean, Italy (Chirli, 2000). **Early-late Pliocene**: central Mediterranean (Sacco, 1904; Ruggieri *et al.*, 1959; Malatesta, 1974; Andreoli & Marsigli, 1992a; Damarco, 1993).

Subfamily Ocenebrinae Cossmann, 1903 Genus *Ocinebrina* Jousseaume, 1880

Type species – Fusus corallinus Scacchi, 1836 (= *Murex aciculatus* Lamarck, 1822), by original designation. Recent, Mediterranean.

Ocinebrina bicaudata (Borson, 1821) Plate 22, fig. 4

- *1821 *Murex bicaudatus* nob., Borson, p. 307, pl. 1, fig. 5.
- 1840 Murex filosus Gené Bellardi & Michelotti, p. 128, pl. 3, figs 1, 2.
- 1841a Murex filosus Gené Michelotti, p. 25, pl. 1, figs 12, 13.
- 1873 Murex bicaudatus Bors. Bellardi, p. 112, pl. 7, fig. 14.
- 1935 *Ocenebra (Ocenebrina) bicaudata* (Bors.) Montanaro, p. 44, pl. 3, fig. 14.
- non 1924 Ocenebra (Ocenebrina) bicaudata (Borson) Cossmann & Peyrot, p. 511, no. 784, pl. 15, figs 34, 35.
- non 1994 Ocinebrina bicaudata (Borson, 1821) Muñiz-Solis & Guerra-Merchán, p. 32, figs 6J-K [= Ocinebrina imbricata (Brocchi, 1814)].

Dimensions and material – Maximum height 19.6 mm. Locality 17: NHMW 1847/0058/0540/1.

Discussion – *Ocinebrina bicaudata* (Borson, 1821) is similar to the Pliocene Mediterranean and adjacent Atlantic species *Ocinebrina imbricata* (Brocchi, 1814), but differs in being smaller, in having less convex whorls, the last whorl is less constricted at the base, and the siphonal canal is shorter. The single shell from Seyithasan is somewhat worn, but clearly represents *O. bicaudata*. This species was also mentioned by Cossmann & Peyrot (1924) from the middle Miocene of the Aquitaine Basin in France. Their illustrated specimen, however, differs from the Italian and Turkish specimens strongly in its short spire, globose last adult whorl and in the strong differentiation of primary and secondary spirals. Moreover, it lacks the typical broad axial swellings of *O. bicaudata*. Therefore, in our opinion it is not conspecific.

Distribution – **Early Miocene**: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1873). **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (NHMW collection); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1873; Montanaro, 1935).

Ocinebrina dertonensis (Bellardi, 1873)

Plate 22, fig. 5

- *1873 Murex dertonensis May., Bellardi, p. 107, pl. 7, fig. 12.
- 1885 *Murex (Ocenebra) Dertonensis* May. Hoernes & Auinger, p. 218, pl. 26, fig. 15.
- ?1912 Ocenebra sublavata Bast. Friedberg, p. 177 (partim, pl. 11, figs 8, 9 only) (non fig. 10).
- 1935 Ocenebra dertonensis (May.) Montanaro, p. 36, pl. 3, figs 1, 2.
- 1935 Ocenebra dertonensis f. crassa Dod. Montanaro, p. 36, pl. 3, fig. 3.
- 1966 Ocinebrina sublavata dertonensis Mayer (in Bellardi) – Strausz, p. 273, pl. 33, figs 5-8.
- Hadriania coelata (Dujardin, 1837) Bałuk, p. 223, pl. 28, figs 4-7, pl. 29, fig. 6 [non Ocinebrina coelata (Dujardin, 1837)].
- 2011 Ocinebrina dertonensis (Mayer in Bellardi 1872 [sic]) – Caprotti, p. 63, pl. 6, figs O-P.
- 2012 Ocinebrina dertonensis (Mayer in Bellardi 1872 [sic]) d'Amico et al., p. 168, pl. 3, fig. 30-32.
- ?non 1935 Ocenebra dertonensis f. mutinensis Montanaro, p. 37, pl. 3, fig. 4.

Dimensions and material – Maximum height 35.0 mm. Localities 2 & 3: JvdV/1; locality 17: NHMW 1847/0058/0541/1, NHMW 1847/0058/0542/29, JvdV/10, RGM 783 774/4, YI 195/4.

Discussion – The classification of the European Miocene species referred to Ocenebra Gray, 1847 and Ocinebrina Jousseaume, 1880 is extremely confusing and requires revision. The difficulty of assigning species to each of these genera was discussed by Houart (2001, p. 59). Landau *et al.* (2007) placed *Murex dertonensis* Bellardi, 1873 in the genus *Heteropurpura* Jousseaume, 1880, which some authors consider to be a synonym of Ocinebrina. However, the type species *Murex polymorphus* Brocchi, 1814, from the Mediterranean Pliocene has more strongly carinate whorls, *M. dertonensis* does not have numerous 'split' denticles, and it does not have spines. On the basis of its small size, the lack of true varices and the axial sculpture consisting of rounded ribs we place *M. dertonensis* in the genus *Ocinebrina*.

In the Paratethyan literature this species has been confused by many auhors with the early Miocene French Atlantic species *Ocenebra sublavata* (de Basterot, 1825) (for figures see Lozouet *et al.*, 2001a, pl. 23, figs 1-5), which differs in having the character of the genus *Ocenebra* discussed above. Other authors have confused it with *Hadriania coelata* (Dujardin, 1837) from the middle Miocene Langhian Atlantic of France (for figures see Glibert, 1952a, pl. 7, fig. 3), which differs in having the character of the genus *Hadriania* Bucquoy & Dautzenberg, 1882, in having a large rounded aperture and a long, straight, sealed siphonal canal. Furthermore, many Sarmatian shells, treated as *Ocenebra sublavata* (de Basterot, 1825) in Paratethyan literature, actually represent *Ocinebrina striata* (Eichwald, 1853) (*non* Röding, 1798), which is a poorly defined, polymorphic species from Sarmatian deposits. Its occurrence in older strata and its relation to other Paratethyan species need revision. Nevertheless, *Ocinebrina dertonensis* seems to be present also in the Badenian (middle Miocene) Paratethys. To avoid further confusion, however, we have reduced the references in the synonymy to a few selected cases.

Montanaro (1935) described *Ocenebra dertonensis* f. *mutinensis* based on a single shell from the late Miocene Tortonian of Montegibbio, Italy. Whilst the shell shape is similar, it has none of the strong spiral sculpture typical of *O. dertonensis*. As the author rightly pointed out, *O. dertonensis* has an extremely variable shell, and this unusually smooth form may just represent extreme variation. However, the differences are striking enough for us to provisionally exclude it from the synonymy.

When describing this species, Bellardi (1873) also referred to material in the collection of Mayer in Basel. Therefore, *Murex dertonensis* Mayer is merely based on a collection label, and authorship must be credited to Bellardi (1873), who was the first to publish a valid description.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Hungary (Strausz, 1966), Poland (Bałuk, 1995), Romania (Hoernes & Auinger, 1885); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1873; Montanaro, 1935; Caprotti, 2011; d'Amico *et al.*, 2012).

Ocinebrina kojumdgievae (Bałuk, 1995) Plate 22, fig. 6

- 1853 Murex Lassaignei Bast. Hörnes, p. 232, pl. 24, fig. 8 [non Ocinebrina lassaignei (de Basterot, 1825)].
- Murex (g Phyllonotus) Lassaignei Bast. Hoernes & Auinger, p. 213 [non Ocinebrina lassaignei (de Basterot, 1825)].
- 1960 Tritonalia (Tritonalia) lassaignei Basterot 1825 Kojumdgieva & Strachimirov, p. 149, pl. 40, fig. 8 [non Ocinebrina lassaignei (de Basterot, 1825)].
- *1995 Purpura (Tritonalia) kojumdgievae Bałuk, p. 228, pl. 30, fig. 8 [nom. nov. pro Murex Lassaignei Bast. in Hörnes, 1853, non Ocinebrina lassaignei (de Basterot, 1825)].

Dimensions and material – Maximum height 33.3 mm. Locality 17: NHMW 1847/0058/0543/1, 1847/0058/1600/1 (small adult). Discussion - Cossmann & Peyrot (1924) pointed out that the shells from the middle Miocene Paratethys identified as Ocinebrina lassaignei (de Basterot, 1825) were not conspecific with this French Atlantic early Miocene species. Bałuk (1995) renamed the Paratethyan shells Purpura (Tritonalia) kojumdgievae, without any discussion regarding the difference between the two. Generic placement is again problematic. Lozouet et al. (2001a) placed Murex lassaignei in the genus Ocenebra Leach in Gray, 1847. They described the protoconch as multispiral (Lozouet et al., 2001a, fig. 16b), which would support this generic placement (see Houart, 2001, p. 60). However, as pointed out by Vermeij & Vokes (1996) and Houart (2001), the two genera differ in their axial sculpture. Most species of Ocinebrina lack true varices, their axial sculpture consisting of rounded ribs. Both Ocinebrina lassaignei and Ocinebrina kojumdgievae (Bałuk, 1995) lack true varices. Ocinebrina kojumdgievae differs from O. lassaignei in being slightly larger, and in having nine as opposed to eight axial ribs. The ribs in O. lassaignei are almost contiguous down the entire teleoconch, with poorly delimited tubercles developed at the periphery on the last whorl. In O. kojumdgievae the axial ribs are subobsolete, except at the whorl periphery where they develop strong rounded tubercles. The primary spiral cords are more strongly developed in O. kojumdgievae. The aperture is slightly wider in O. kojumdgievae, the apertural denticles slightly more strongly developed, and the terminal varix more widely expanded, especially abapically. Cossmann & Peyrot (1924) also considered the specimens assigned by Sacco (1904, pl. 5, fig. 5) to Ocenebra Lassaignei Bast. from the Proto-Mediterranean Burdigalian of the Colli Torinesi in Italy to be a distinct species, which they named Ocenebra saccoi. Unfortunately, the specimen is small and illustrated only from its dorsal aspect. It seems more closely related to O. kojumdgievae than to O. lassaignei, with a tuberculate periphery and stronger spiral sculpture. We have insufficient material to decide whether the two are conspecific, but if they were, Bałuk's (1995) name would become a junior subjective synonym of Ocinebrina saccoi (Cossmann & Peyrot, 1924). This group of Ocinebrina species is represented in the early Pliocene Mediterranean by Ocinebrina ariesiensis (Fontannes, 1879), which differs in having fewer axial ribs than any of the Miocene species discussed above, and in having the ribs developed at the shoulder into low rounded tubercles, and having the spiral sculpture subobsolete.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Austria, (Hoernes & Auinger, 1885), Romania (Hoernes & Auinger, 1885), Hungary (Strausz, 1954, 1966), Poland (Bałuk, 1995), Bulgaria (Kojumdgieva & Strachimirov, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Ocinebrina perparva nov. sp. Plate 22, figs 7-9; Plate 64, fig. 2

Type material - Holotype NHMW 1847/0058/0881,

height 12.2 mm, width 5.5 mm; paratype 1 NHMW 1847/0058/0882, height 11.2 mm, width 5.7 mm; paratype 2 NHMW 1847/0058/0883, height 12.3 mm, width 5.9 mm; paratype 3 NHMW 1847/0058/0903, height 7.8 mm (juvenile); paratype 4 NHMW 1847/0058/0904, height 10.1 mm, width 5.2 mm.

Dimensions and material – Maximum height 10.4 mm. locality 11: JvdV/1; locality 17: NHMW 1847/0058/0884/4, RGM 783 971/1 juvenile.

Etymology – From Latin *perparvus*, adj, very little, very trifling.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – An *Ocinebrina* species with a small, slender shell, paucispiral protoconch, axial sculpture weakening abapically, spiral sculpture of narrow elevated cords, the cords almost of equal strength on the last whorl, a narrow ovate aperture, the outer lip denticulate within, and a long, open siphonal canal.

Description - Shell small, slender, fusiform, weakly shouldered, with scabrous surface. Protoconch of 1.5 smooth, convex whorls, with a large nucleus. Junction with teleoconch sharply delimited. Teleoconch of six weakly convex whorls, with periphery at abapical suture. Suture weakly impressed, linear. Axial sculpture of weakly opisthocline ribs, about 14 on first teleoconch whorl, widening, flattening and becoming less numerous abapically, ten on penultimate whorl. Spiral sculpture of narrow scabrous cords, two adapical cords slightly stronger, close-set, forming subsutural band, whorl slightly concave below band to shoulder; cords on early whorls of alternating strength, secondary cords strengthening abapically, almost of equal strength on last adult whorl. Last whorl slender, 75% of total height, slightly concave below subsutural band, rounded at shoulder, base weakly constricted, with 8-9 axial ribs, subobsolete towards outer lip. Aperture ovate, 50% of height, anal canal poorly developed, siphonal canal open, long, slightly posteriorly recurved. Outer lip evenly curved, with crenulated edge, denticulate within, 7-8 denticles of which abapical 1-2 more strongly developed than remainder. Columella straight, smooth, siphonal fasciole flattened, bearing spiral cords, bordering pseudumbilicus.

Discussion – The European Neogene *Ocinebrina* species are in need of revision, which is beyond the scope of this work. However, *Ocinebrina perparva* nov. sp. is distinct enough from its European congeners to warrant description. The species is characterised by its small slender shell and all specimens available have an open siphonal canal. The Turkish shells have been compared to the various forms in the NHMW collections (MH)

under the names '*credneri*' Hoernes & Auinger, 1885, '*sublavata*' de Basterot, 1825, '*caelata*' Dujardin, 1837 and '*grundensis*' Hoernes & Auinger, 1885. These all require revision, which will be dealt with in a forthcoming paper, but they are all larger, stockier and more strongly shouldered than the Turkish shell. Moreover, none of the Miocene Paratethyan species has comparably regular spiral sculpture on the last whorl. The same differences can be applied to *O. perparva* when compared with the Atlantic early and middle Miocene French species described by Cossmann & Peyrot (1924).

In the Recent European faunas, some specimens of *Ocinebrina aciculata* (Lamarck, 1822) have a similarly slender shape and it has a paucispiral protoconch (see Houart, 2001), but it is immediately distinguished by its sealed siphonal canal.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Ocinebrina polonica (Bałuk, 1995)

Plate 22, figs 10, 11; Plate 64, fig. 3

- 1912 Fusus an virgineus Grat Friedberg, p. 160 (partim, pl. 9, fig. 10 only).
- *1995 Hadriania polonica Bałuk, p. 225, pl. 29, figs 2-5.
 2009 Hadriania coelata (Dujardin, 1837) Mikuž, p. 27 (partim, pl. 8, fig. 110 only) [non fig. 111
 = Ocinebrina dertonensis (Mayer in Bellardi, 1873)].

Dimensions and material – Maximum height 22.1 mm. Localities 2 & 3: JvdV/50+, RGM 783 936/1), MTA 2013/037/2, YI 181/44; localities 7 & 8: NHMW 1847/0058/0544-1847/0058/0545/1, 1847/0058/0546/50+, JvdV/16, RGM 784 004/1, RGM 783 909/7; locality 9: RGM 783 842/1; locality 10: YI 182/8; locality 13: NHMW 1847/0058/0547/3, RGM 783 682/1, YI 183/6; locality 17: YI 187/1.

Discussion – As discussed above, the specific assignment of the European Miocene Ocinebrina species is far from simple. We distinguish a second group of shells, which differ from Ocinebrina dertonensis (Mayer in Bellardi, 1873) in being smaller, in having a more scalate spire, with the shoulder placed higher on the spire whorls, and in having a longer, narrower siphonal canal, which is twisted rather than straight as in O. dertonensis. These shells do not have a small umbilical chink, which is formed adapically on the broad siphonal canal of many specimens of O. dertonensis. The same species was illustrated and described as a new taxon by Bałuk (1995), Hadriania polonica. Most species of Hadriania Bucquoy & Dautzenberg, 1882 have a large circular aperture and a long, straight, sealed siphonal canal, neither of which are characters of Bałuk's species, and we therefore prefer to place it in the genus Ocinebrina Jousseaume, 1880. Ocinebrina polonica (Bałuk, 1995) may well be more widespread in the Neogene European assemblages, but confused with or recorded as another species. Bałuk (1995) illustrated a multispiral protoconch for his species, similar to that seen in the Turkish specimens.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Friedberg, 1912; Bałuk, 1995), Slovenia (Mikuž, 2009); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Ocinebrina sp.

Plate 22, fig. 12

Dimensions and material – Maximum height 25.2 mm. Localities 2 & 3: NHMW 1847/0058/1441/1; locality 17: YI 193/1 + 1 incomplete specimen.

Discussion - A single shell is present in the Vienna collections and a second complete specimen in the YI collection representing a very solid, relatively slender Ocinebrina species, with six broad axial ribs on the spire whorls, of which three become varicose on the last whorl, giving the shell a triangular profile. The spiral sculpture is composed of regular, narrow, close-set primary and secondary cords. Although the shell is somewhat worn, as usual for the genus, the surface has a scabrose appearance. The aperture in ovate and narrow, the outer lip is strongly thickened by the terminal varix and coarsely denticulate within and the siphonal canal is open. Ocinebrina galiciana (Hilber, 1882) from the middle Miocene Paratethys of Poland has a similar triangular shell, but seems to be stockier, with a shorter spire and a lowerplaced shoulder. We await further specimens before formally describing this species.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Pteropurpura Jousseaume, 1880

Type species – Murex macropterus Deshayes, 1839, by original designation. Recent, eastern Pacific.

Pteropurpura delbosiana (Grateloup, 1845) Plate 22, figs 13, 14; Plate 23, fig. 1

- *1845 *Murex Delbosianus* Grat., Grateloup, pl. 30, figs 7, 10.
- 1924 *Murex (Alipurpura) Delbosianus* Grateloup Cossmann & Peyrot, no. 736, pl. 18, figs 8, 9.
- 1958 *Murex (Alipurpura) delbosianus* Grateloup Erünal-Erentöz, p. 56, pl. 9, figs 1-5.
- 1966 Murex (Pterynotus) latilabris Bellardi & Michelotti, 1840 – Strausz, p. 261, pl. 55, figs 5-10 [non Purpurellus latilabris (Bellardi & Michelotti, 1840)].
- non 1856 Murex Delbosianus Grat. Hörnes, p. 675, pl. 51, fig. 7 [= Pteropurpura friedbergi (Cossmann & Peyrot, 1924)].

- non 1885 Murex Delbosianus Grat. Hoernes & Auinger, p. 199, pl. 24, figs 9-11 [= Pteropurpura friedbergi (Cossmann & Peyrot, 1924)].
- non 1912 Murex Delbosianus Grat. Friedberg, p. 163, pl.
 9, figs 11, 12 [= Pteropurpura friedbergi (Cossmann & Peyrot, 1924)].

Dimensions and material – Maximum height 67.8 mm. Localities 2 & 3: NHMW 1847/0058/0554/2, RGM 783 918/3, YI 170/4 + 3 juveniles; locality 6: NHMW 1847/0058/0553/8, JvdV/11, RGM 783 886/1; locality 9: JvdV/6, RGM 783 837/18; locality 12: JvdV/50+, RGM 783 950/9; locality 13: NHMW 1847/0058/0554/8, NHMW 1847/0058/0550/3, NHMW 1847/0058/0551, 1847/0058/0552/50+, JvdV/50+, RGM 783 663-783 666/50+, MTA 2013/091/12, YI 169/50+, + 5 juveniles; locality 17: YI 171/1.

Discussion – We agree entirely with Cossmann & Peyrot (1924) and Bałuk (1995) that the shells from the Paratethys figured by Hörnes (1856), Hoernes & Auinger (1885) and Friedberg (1912) as Murex delbosianus Grateloup were not that species, but Murex (Tubicauda) friedbergi Cossmann & Peyrot, 1924. However, both species have a sealed siphonal canal, a diagnostic character of ocenebrine muricids, and therefore we follow Vokes (1971) in placing them in Pteropurpura Jousseaume, 1880. Pteropurpura friedbergi is unusual in having long, exaggerated shoulder spines, showing some similarity to Pteropurpura (Calcitrapessa) leeana (Dall, 1890), a Recent species from California, and could also be placed in the subgenus Calcitrapessa Berry, 1959. The spines on the siphonal canal present on *M. friedbergi* are not seen in any other Pteropurpura species. Apart from the spines on the siphonal canal, P. (C.) friedbergi differs from P. (P.) delbosiana in being smaller and lighter-shelled. Both species have two spiral cords on the last whorl more strongly developed than the others, forming spines at the labral varix, but in *P. friedbergi* the spines develop from P1 and P4, with P2 and P3 very weakly developed, whilst in *P. delbosiana* it is P1 and P3 which develop into spines and P4 is weak. Also the labral varix in P. friedbergi is rounded and hardly developed, whereas it is strong, foliose and alate in P. delbosiana.

Pteropurpura delbosiana does, however, seem to occur in the Paratethys. The specimens illustrated by Strausz (1966) from Hungary as *Murex (Pterynotus) latilabris* Bellardi & Michelotti, 1840 are rather worn, juvenile specimens of *P. delbosiana*. This record should not be confused with *M. latilabris* in Hörnes (1856, pl. 25, fig. 11) from the Miocene Paratethys (holotype figured by Landau *et al.*, 2007, pl. 5, fig. 6), renamed *M. ampistus* by de Gregorio, (1885, p. 276), which was considered to be a species of *Jaton* Pusch, 1837 by Landau *et al.* (2007), whereas the true *M. latilabris* from the Miocene of Italy is a species of *Purpurellus* Jousseaume, 1880.

In the Karaman assemblages *P. delbosiana* is very abundant in the clayey assemblages such as Pinar Yarlaysi, whereas in the sandy deposits such as Seyithasan it is rare. Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1924). Middle Miocene: Paratethys (Langhian-Serravallian): Poland (Hoernes & Auinger, 1885), Romania (Hoernes & Auinger, 1879), Hungary (Strausz, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Vitularia Swainson, 1840

Type species – Murex miliaris Gmelin, 1791, by mono-typy. Recent, Indo-West Pacific.

Note –The placement of this genus in the Ocenebrinae Cossmann, 1903 is provisional, as molecular data presented by Barco *et al.* (2010) showed the subfamily to be polyphyletic.

Vitularia linguabovis (de Basterot, 1825)

Plate 23, figs 2, 3

- *1825 *Murex Lingua-Bovis* Nob., de Basterot, p. 59, pl. 3, fig. 10.
- 1845 Murex Vitilinus Lam. Grateloup, pl. 31, fig. 17.
- 1845 *Murex Vitulinus* var. *Edentula* Grateloup, pl. 31, fig. 18.
- 1852 *Murex subvitulinus* d'Orb., d'Orbigny, p. 73, no. 1342.
- 1852 Murex lingua-bovis Bast. d'Orbigny, p. 75, no. 1373.
- 1853 Murex lingua-bovis Bast. Deshayes, p. 66, pl. 111, fig. 7.
- 1853 Murex lingua-bovis Bast. Hörnes, p. 230, pl. 24, figs 1-3.
- 1867 Murex lingua-bovis Bast. Periera da Costa, p. 158, pl. 18, fig. 6.
- 1885 Murex (Vitularia) lingua-bovis Bast. Hoernes & Auinger, p. 213, pl. 25, figs 4-7.
- 1903 Ocenebra (Vitularia) linguabovis (Bast.) Cossmann, p. 40, pl. 2, fig. 25.
- 1904 Vitularia linguabovis (Bast.) Sacco, p. 74, pl. 17, figs 17-19.
- 1924 Vitularia lingua-bovis (Basterot) Cossmann & Peyrot, no. 788, pl. 14, figs 33, 34.
- 1924 Vitularia vindobonula Cossmann & Peyrot, p. 228, pl. 14, figs 30, 31.
- 1924 Vitularia salbriacensis Cossmann & Peyrot, no. 789, pl. 14, figs 30, 31.
- 1954b Ocenebra (Vitularia) lingua bovis var. vindobonula Cossm. et Peyr. – Friedberg, p. 600, fig. 84.
- 1957 Vitularia linguabovis (Basterot) Zbyszewski, p. 174, pl. 15, figs 151, 158, 160.
- 1960 Tritonalia (Vitularia) lingua-bovis var. vindobonula Cossmann & Peyrot, 1923 – Kojumdgieva & Strachimirov, p. 150, pl. 40, fig. 11.
- 1966 *Vitularia linguabovis vindobonula* Cossmann & Peyrot, 1923 Strausz, p. 278, fig. 126.
- 1978 Vitularia vidobonula Cossmann–Payrot [sic], 1924 – Stojaspal, p. 339, pl. 5, fig. 8.

- 1995 Vitularia linguabovis (Basterot, 1825) Bałuk, p. 229, pl. 30, fig. 9.
- 1998 Vitularia (Vitularia) vidobonula Cossmann & Peyrot Schultz, p. 66, pl. 26, fig. 6.
- 2001a *Vitularia linguabovis* (Basterot, 1825) Lozouet *et al.*, p. 58, pl. 24, fig. 5.

Dimensions and material – Maximum height 90.5 mm. Localities 2 & 3: YI 201/1; locality 13: JvdV/1, YI 199/4; locality 17: NHMW 1847/0058/0555-1847/0058/0572/17, 1847/0058/1635-1847/0058/1638/4, JvdV/23, RGM 783 771/4, MTA 2013/038/3, YI 200/10.

Discussion – Vitularia linguabovis (de Basterot, 1825) is a very distinctive species distributed widely in the European Miocene, at the time present along the northeastern Atlantic frontage of France to Portugal, central and eastern Proto-Mediterranean Sea and Paratethys. It belongs to a genus today represented by only two species: *V. salebrosa* (King, 1832) present along the eastern Pacific from Mexico to Ecuador (Vokes, 1989), and the widespread Indo-Pacific species *V. miliaris* (Gmelin, 1791).

Cossmann & Peyrot (1924) considered only the French Atlantic early Miocene Burdigalian specimens to represent V. linguabovis. The Vienna Basin specimens figured by Hörnes (1853, pl. 24, figs 1-3) were said to differ from V. linguabovis in having a squatter spire and a longer siphonal canal, and they erected the name Vitularia vindobonula for the Paratethyan form. The early Miocene Tethyan form from the Colli Torinesi of Italy figured by Sacco (1904, pl. 17, figs 17-19) was considered to be different again by these authors, differing from the French Burdigalian form in having a more rhomboidal shape, an even shorter spire than V. vindobonula, by having more numerous axial lamellae and coarser labral teeth, a form they named Vitularia saccoi Cossmann & Peyrot, 1924. The French middle Miocene Langhian specimens from the Aquitaine Basin were considered to be different yet again, and were named Vitularia salbriacensis Cossmann & Peyrot, 1924, said to differ from V. linguabovis in having again a shorter spire, more prominent tubercles at the shoulder, denser pustules on the shell surface and a smaller aperture. Bałuk (1995) discussed the great variability in shell shape in V. linguabovis, and showed the width/height ratio of the various Paratethyan and Atlantic Miocene populations to overlap. The width/height ratio of our Karaman population is 0.60-0.72, similar to the ranges given by Bałuk (1995). Lozouet et al. (2001a) synonymised all the French Miocene forms in the synonymy of V. linguabovis, without further comment. We follow the position taken by these authors and consider all these forms to represent a single variable species.

Vokes (1977) discussed the relationship between the old and new world *Vitularia* species, and drew attention to their differences. Old world species are characterised by strong pustular surface sculpture, absent or only weakly developed in the new world species, and a strongly developed labral tooth, a primitive structure only weakly present in the new world species in the fossil species *V. dominicana* Vokes, 1977 from the early Pliocene Gurabo Formation of the Dominican Republic. The fossil record of *Vitularia* is slightly older in the northeastern Atlantic, where it is present in the Aquitanian of France (Lozouet *et al.*, 2001a), whereas the first occurrence in the Caribbean is in the late Burdigalian Cantaure Formation of Venezuela (BL unpublished data, NHMW 2012/0197/0008; ex BL collection).

Vitularia seems not to have survived the Miocene in Europe or the eastern Atlantic, as it did not return to the Mediterranean following the Messinian salinity crisis and does not occur along the coast of West Africa today.

Distribution - Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1924; Lozouet et al., 2001a), (Burdigalian): Tagus Basin, Portugal (Zbyszewski, 1957); Paratethys (Burdigalian): Austria (Harzhauser, 2004); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1904). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (JvdV collection). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Pevrot, 1924); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1853; Hoernes & Auinger, 1885; Schultz, 1998), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1966), Poland (Bałuk, 1995); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian) Crete (Didier Merle personal observation).

Subfamily Rapaninae Gray, 1853 Genus *Stramonita* Schumacher, 1817

Type species – Buccinum haemastoma Linné, 1767, by subsequent designation (Gray, 1847). Recent, Europe.

Stramonita haemostomoides (Hoernes & Auinger,

1882) Plate 23, fig. 4

- 1852 Purpura haemastoma Lam. Hörnes, p. 167, pl.
 13, fig. 18 [non Stramonita haemastoma (Linné, 1767)].
- *1882 *Purpura (Stramonita) haemostomoides* Hoernes & Auinger, p. 151.
- non 1928 Purpura haemostomoides Hoernes & Auinger Friedberg, p. 593, pl. 38, fig. 6 [= Janssenia echinulata (Pusch, 1837)].
- non 1960 Thais (Stramonita) haemastomoides (Hoernes & Auinger, 1882) Kojumdgieva & Strachimirov, p. 153, pl. 41, fig. 1 [= Janssenia echinulata (Pusch, 1837)].
- non 1960 Thais (Stramonita) haemastomoides Hoernes & Auinger, 1882 – Strausz, p. 282, fig. 129a, pl. 35, figs 13-15, pl. 36, figs 1-5, pl. 64, fig. 1 [= Janssenia echinulata (Pusch, 1837)].
- non 1981 Thais (Stramonita) haemastomoides Hoernes &

Auinger – Krach, p. 68, pl. 17, fig. 9, pl. 18, figs 1-4, 6 [= *Janssenia echinulata* (Pusch, 1837)].

Dimensions and material – Maximum height 54.3 mm. Locality 12: JvdV/5, RGM 783 622/1; locality 13: NHMW 1847/0058/0572/1, 1847/0058/0573/1.

Discussion – Bałuk (1995) synonymised Purpura (Stramonita) haemostomoides Hoernes & Auinger, 1882 with Ricinula echinulata Pusch, 1837. This is incorrect, as R. echinulata is an ergalataxine taxon differing from Stramonita haemostomoides in having columellar folds, which are not present in Stramonita species. These folds are particularly clearly seen in the shell figured by Bałuk (1995, pl. 27, fig. 5). Ricinula echinulata belongs to a group of species here described under the genus Janssenia nov. gen.

Stramonita haemostomoides differs from the Pleistocene to Recent eastern Atlantic and Mediterranean Stramonita haemastoma (Linné, 1767) in having a more slender, taller-spired shell, in having a more evenly convex last whorl rather than shouldered as in most specimens of *S. haemastoma* and in having four rows of small, sharp, pointed tubercles on the last whorl instead of the large rounded tubercles seen in *S. haemastoma*.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1853; Hoernes & Auinger, 1882); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subfamily Ergalataxinae Kuroda, Habe & Oyama, 1971 Genus Orania Pallary, 1900

Type species – Murex spadae Libassi, 1859 (= *Murex fusulus* Brocchi, 1814), by original designation. Pliocene to Recent, Mediterranean, northeastern Atlantic.

Orania cheilotoma (Hoernes & Auinger, 1890) Plate 23, figs 5, 6

- 1837 Fusus variabilis Jan. Pusch, p. 141, pl. 12, fig. 4 (non F. variabilis Lamarck, 1803).
- 1853 Murex intercisus Micht. Hörnes, p. 241, pl. 25, fig. 2 (non M. intercisus Michelotti, 1841).
- 1853 Murex flexicauda Bronn Hörnes, p. 241, pl. 25, fig. 8 (non M. flexicauda Bronn, 1831).
- *1890 *Pollia cheilotoma* Partsch Hoernes & Auinger, p. 234, pl. 30, figs 1, 2.
- 1890 Pollia Barrandei M. Hoernes Hoernes & Auinger, p. 235, pl. 30, fig. 3.
- 1912 Pollia cheilotoma Partsch Friedberg, p. 185, pl. 11, figs 20, 21.
- 1960 Cantharus (Pollia) cheilotoma (Partsch in Hoernes und Auinger 1890) Kojumdgieva & Strachimirov, p. 173, pl. 43, fig. 18.
- 1966 *Cantharus (Pollia) cheilotomus* Partsch (*in* Hörnes) (1848) 1856 – Strausz, p. 308, pl. 35, figs 2, 3.

- 1968 Cantharus cheilotomus (Partsch in R. Hoernes und Auinger 1879 [sic]) Zelinskaya et al., p. 191, pl. 45, figs 18, 19.
- 1972 Cantharus (Pollia) cheilotomus Partsch Csepreghy-Meznerics, p. 28, pl. 11, figs 14-16.
- 1984a *Cantharus (Pollia) cheilotomus* (Hoernes, 1848) [*sic*] – A.W. Janssen, p. 231, pl. 62, figs 6, 7.
- 1995 Coralliophila (Orania) cheilotoma (Hoernes & Auinger, 1890) Bałuk, p. 232, pl. 37, figs 5, 6.

Dimensions and material – Maximum height 15.7 mm. Localities 2 & 3: JvdV/1, RGM 794 085/1 (ex JvdV collection); localities 7 & 8: NHMW 1847/0058/0574/1.

Discussion -As discussed by Landau et al. (2007), the subfamily Ergalataxinae Kuroda, Habe & Oyama, 1971 comprises a small number of primarily Indo-Pacific taxa, which had been placed in a number of families over the years. In the European Neogene litearature they have usually been described within the genus Pollia Gray in G.B. Sowerby I, 1834, a buccinid. However, the characters that unite the subfamily are a muricine radula, but with a strongly recurved rachidian plate much like that of the Muricopsinae; an operculum half-way between typical Muricinae and purpuroid; and a shell with no varices (in some species irregular or limited to the apertural varix) (Vokes, 1996; Houart, 1996). Based on a cladistic analysis combining anatomical characters and shell morphology, Vermeij & Carlson (2000) suggested the Ergalataxinae were a polyphyletic group. However, more recent studies by Claremont et al. (2008) and Barco et al. (2010) distinguished two monophyletic clades, the Rapaninae and Ergalataxinae.

Two species attributed to *Orania* by Bałuk (1995) have been reported in the middle Miocene Paratethys: *Pollia cheilotoma* Hoernes & Auinger, 1890 (= *P. barrandei* Hoernes & Auinger, 1890; see Bałuk, 1995, p. 232) and *P. exacuta* Bellardi, 1873. The latter was considered to be a synonym of *O. fusulus* (Brocchi, 1814) by Landau *et al.* (2007). The Turkish material shows that *O. cheilotoma* is indeed a distinct species, characterised by shells that are smaller and squatter than those of *O. fusulus*, and although they show the same basic sculpture composed of four major cords, the secondary sculpture is much stronger in *O. cheilotoma* than in *O. fusulus*

Other European Neogene congeners are *Orania subspinosa* (Bellardi, 1873) from the Pliocene of Italy, which has a much smaller shell, with more angular whorls and strongly developed labral denticles (see Landau *et al.*, 2007, pl. 13, fig. 11) and *Orania fischeri* (Benoist, 1874) from the early Miocene Aquitanian of the Aquitaine Basin, France, which has a small fusiform shell with elevated, rounded ribs, regular fine spiral sculpture in which the primary and secondary cords are of almost equal strength, and strong denticulation within the outer lip.

Distribution – **Early-middle Miocene**: North Sea Basin (late Burdigalian-Langhian): Netherlands (A.W. Janssen, 1984a). **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1853; Hoernes & Auinger,

1890), Czech Republic (Hörnes, 1853), Hungary (Strausz, 1966), Poland (Friedberg, 1912; Bałuk, 1995); Romania (Hörnes, 1853), Bulgaria (Kojumdgieva & Strachimirov, 1960), Ukraine (Zelinskaya *et al.*, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Janssenia nov. gen.

Type species – Ricinula calcarata Grateloup, 1834. Fossil, Neogene, France.

Other included species – Cymia pluriplicata Cossmann & Peyrot, 1924, *Ricinula echinulata* Pusch, 1837, *Purpura tuberculata* Bellardi, 1882, *Cymia helenica* Harzhauser & Kowalke, 2001.

Diagnosis – Shell medium-sized, very solid, fusiform, spire of medium height, last whorl fusiform to moderately inflated, weakly constricted at base; spiral sculpture of four tuberculous spiral cords, entire surface covered with close-set fine spiral cordlets and threads of irregular strength; axial sculpture subobsolete, in some species broad, weak, rounded ribs present on last whorl; aperture medium-sized, ovate, not flared; outer lip smooth-edged, with four or five strongly developed denticles within; anal notch marked by a narrow adapical notch; inner lip bearing two rounded folds in abapical portion; siphonal canal relatively short, open, weakly recurved; siphonal fasciole prominent, rounded.

Etymology – After Arie W. Janssen (Naturalis Biodiversity Centre, Leiden), in recognition of his contributions to Neogene European molluscan palaeontology and his tireless help producing this work.

Discussion – As discussed by Landau *et al.* (2007, p. 53), with the new restricted interpretation of the genus *Thais* (Vermeij, 2001) the generic placement of several European Neogene species traditionally placed in that genus needs to be re-evaluated. These European fossil taxa differ from *Thais* in having a more fusiform shell, a higher spire, a smaller aperture, which is strongly denticulate within, a less developed anal notch, and the last adult whorl is less excavated ventrally in the parietal area. They cannot be placed in any existing rapanine genus as revised by Kool (1993). In his revision of *Oppomorus* and *Habromorula*, Houart (2004) stressed that one of the best ways to distinguish rapanine from ergalataxine taxa was to examine the radula. Unfortunately, in fossil specimens this is not possible.

Landau *et al.* (2007) recognised two groups of European Miocene-Pliocene ergalataxine muricids. The genus *Ca-thymorula* was erected by them for members of the second group, characterised by subobsolete spiral sculpture consisting of very low cords, and by a smooth inner lip. This group is represented in the Karaman assemblages by *Cathymorula tessellata* (Meneghini *in* Pecchioli, 1864), and will be discussed further under that species. The first of the groups defined by Landau *et al.* (2007,

p. 53) is characterised by having sculpture of tuberculate spiral cords, and by having folds on the abapical portion of the inner lip. Species included in this group are Ricinula calcarata Grateloup, 1834, Cymia pluriplicata Cossmann & Peyrot, 1924 (see Lozouet et al., 2001a, p. 59), Ricinula echinulata Pusch, 1837 (see Bałuk, 1995, pl. 27; this paper), Cymia helenica Harzhauser & Kowalke, 2001 and Purpura tuberculata Bellardi, 1882 (see Ferrero Mortara et al., 1981, pl. 33, fig. 2). These species were referred to the genus Cymia Mörch, 1860 by Cossmann & Peyrot (1924), which is a Neogene to Recent tropical American genus. All the European shells in this group differ from typical Cymia in having the shoulder on the last whorl less pronounced, located higher towards the suture, not centrally placed as in the Recent species, and in having the apertural lip thickened with a few, prominent, knob-like, denticles rather than having a thin lip, finely denticulate to lirate within. Finally the European members of this group have two or more folds on the columella whereas American Cymia species have a single heavy central fold. As discussed by Landau et al. (2007), these European Neogene species do not fit within the genus Cymia and are here placed in the genus Janssenia nov. gen.

Thais (Stramonita) spinulosa Kojumdgieva & Strachimirov, 1960 was introduced as a new name for *Purpura inconstans* Hoernes & Auinger, 1882 *non* Michelotti, 1847 (*Ricinula calcarata* Grateloup, 1834). This species, found in the Paratethyan middle Miocene of Romania and Bulgaria, has a shell shape characteristic for *Janssenia*, and may belong within this new genus, but lacks the folds on the columella, and is therefore excluded provisionally.

Janssenia echinulata (Pusch, 1837)

Plate 23, figs 7, 8

- *1837 *Ricinula echinulata* m., Pusch, p. 140, pl. 11, fig. 27.
- 1852 Purpura elata Blainv. Hörnes, p. 168, pl. 13, fig.
 19 (non Purpura elata Blainville, 1832).
- 1882 Purpura (Stramonita) haemastoma Linn. Hoernes & Auinger, p. 151, pl. 16, fig. 18 [non Stramonita haemastoma (Linné, 1767)].
- 1928 Purpura haemastomoides Hoernes & Auinger Friedberg, p. 593, pl. 38, fig. 6 [non Stramonita haemastomoides (Hoernes & Auinger, 1882)].
- 1954 Thais (Stramonita) haemastomoides Hoern. & Auing. – Csepreghy-Meznerics, p. 36, pl. 4, figs
 9-19 [non Stramonita haemastomoides (Hoernes & Auinger, 1882)].
- 1960 Thais (Stramonita) haemastomoides (Hoernes & Auinger, 1882) Kojumdgieva & Strachimirov, p. 153, pl. 41, fig. 1 [non Stramonita haemastomoides (Hoernes & Auinger, 1882)].
- 1960 Thais (Stramonita) haemastomoides Hoernes & Auinger, 1882 Strausz, p. 282, fig. 129a, pl. 35, figs 13-15, pl. 36, figs 1-5, pl. 64, fig. 1 [non Stramonita haemastomoides (Hoernes & Auinger, 1882)].

- 1981 Thais (Stramonita) haemastomoides Hoernes & Auinger – Krach, p. 68, pl. 17, fig. 9, pl. 18, figs 1-4, 6 [non Stramonita haemastomoides (Hoernes & Auinger, 1882)].
- 1995 *Thais (Stramonita) echinulata* (Pusch, 1837) Bałuk, p. 222, pl. 27, figs 5, 6.
- 2009 Thais (Stramonita) echinulata (Pusch, 1837) Mikuž, p. 26, pl. 8, figs 108, 109.

Dimensions and material – Maximum height 34.5 mm. Localities 2 & 3: NHMW 1847/0058/1440/1; locality 17: NHMW 1847/0058/0575/3, JvdV/1, RGM 794 086/1 (ex JvdV collection), RGM 794 087/1 (ex JvdV collection).

Discussion – Janssenia echinulata (Pusch, 1837) is characterised by the description of the genus given above. The tubercles on the last whorl tend to be sharp and the folds on the columellar are weaker than in any of its congeners. Although not visible in the drawing, Pusch (1837) mentions the columellar folds in his Latin and German descriptions of this species.

Janssenia calcarata (Grateloup, 1834) from the early Miocene Aquitaine Basin of France differs in having a squatter, even more robust shell than J. echinulata, the tubercles in most specimens are more rounded (although the sculpture of the shell figured by Cossmann & Peyrot, 1924, pl. 14, fig. 50 var. épineuse, is very similar to that of J. echinulata), and the fold on the abapical part of the columella is more strongly developed than in J. echinulata. Janssenia pluriplicata (Cossmann & Peyrot, 1924), also from the early Miocene Aquitaine France, differs in having the spiral sculpture and tubercles very poorly developed and subobsolete on the last whorl. The columellar fold is also more strongly developed than in J. echinulata. Janssenia tuberculata (Bellardi, 1882) from the early Miocene of Italy is the species with the most strongly developed tubercles, which are heavy, elevated and rounded at the shoulder of the last whorl. The columellar fold is visible in the syntype illustrated by Ferrero Mortara et al. (1981, pl. 33, fig. 2), but not particularly strongly developed. Finally, J. helenica (Harzhauser & Kowalke, 2001) from the early Miocene of Greece differs in having a more fusiform, slender shell, the spiral sculpture is composed of rounded cords of anternate strength, more clearly defined than in any of its congeners, but without tubercles or spines. The columellar fold is very strongly developed in this species.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Hoernes & Auinger, 1882), Hungary (Csepreghy-Meznerics, 1954; Strausz, 1966), Poland (Friedberg, 1928; Bałuk, 1995); Bulgaria (Kojumdgieva & Strachimirov, 1960), Slovenia (Mikuž, 2009); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Cathymorula Landau, Houart & Silva, 2007

Type species – Cathymorula cathyae Landau, Houart & Silva, 2007, by original designation. Miocene-Pliocene, Europe.

Cathymorula exilis (Hörnes, 1852) Plate 23, fig. 9

- *1852 *Purpura exilis* Partsch, Hörnes, p. 169, pl. 13, figs 20-23.
- 1870 Purpura exilis Partsch Roemer, p. 380, pl. 47, fig. 7.
- 1912 Purpura exilis Partsch Friedberg, p. 134, pl. 7, fig. 9.
- 1954 *Thais (Stramonita) exilis* Partsch Csepreghy-Meznerics, p. 37, pl. 4, figs 12, 13.
- 1960 Thais (Stramonita) exilis (Partsch in Hoernes 1856) Kojumdgieva & Strachimirov, p. 153, pl. 41, fig. 2.
- 1966 *Thais (Stramonita) exilis* (Partsch in Hoernes), 1856 – Strausz, p. 283, pl. 64, figs 2, 5.
- 1981 Thasis exilis (Partsch in Hoernes) Krach, p. 69 (partim, pl. 17, figs 8, 10-11, pl. 18, fig. 5, pl. 22, fig. 13 only) (non pl. 18, figs 7-8).
- 1995 *Thais (Stramonita) exilis* (Partsch in Hörnes, 1856) Bałuk, p. 222, pl. 27, figs 5, 6.
- 2002 *Thais (Stramonita) exilis* (Partsch in Hörnes, 1856) Harzhauser, p. 94, pl. 6, fig. 6.
- 2006 Thais (Stramonita) exilis Partsch in Hörnes, 1856 – Bałuk, p. 208, pl. 12, figs 3-6.

Dimensions and material – Maximum height 24.8 mm. Locality 13: RGM 794 552/1 (ex JvdV collection); locality 17: RGM 783 772/1.

Discussion - Cathymorula exilis (Hörnes, 1852) is characterised by its fusiform, globular shape, in having four subobsolete spiral cords on the last whorl that weaken abapically, the adapical two cords bearing well-defined, small, rounded tubercles, again the tubercles weakening abapically, and relatively small denticles within the outer lip. Cathymorula stazzanensis (Bellardi, 1882) from the Miocene of Italy and late Miocene Tortonian of the Cacela Basin, Portugal, and C. cathyae from the early Pliocene of southern Spain can immediately be separated by the presence of axial folds. Cathymorula subumbilicata (Bellardi, 1882) and C. gastraldii (Bellardi, 1882) from the late Miocene of Italy both have a shouldered last whorl. Several other species belonging to this genus from the Miocene of Italy were described by Bellardi (1882). However, as discussed by Landau et al. (2007) they are all rare in the Italian assemblages and many of the syntypes illustrated by Ferrero Mortara *et al.* (1981) are abraded and poorly preserved. It is unclear how many species they represent (for further discussion; see Landau et al., 2007).

Among the Polish specimens identified as *Thasis exilis* by Krach (1981) the specimen illustrated on plate 18 as figs 7 and 8 is clearly not conspecific with *Cathymorula exilis* based on its large size, high and gradate spire and blunt spiral cords.

Distribution – **Early Miocene**: Paratethys (Burdigalian): Austria (Hörnes, 1852; Harzhauser, 2002). **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria

(Hörnes, 1852), Czech Republic (Hörnes, 1852), Hungary (Hörnes, 1852; Csepreghy-Meznerics, 1954; Strausz, 1966), Serbia (Hoernes & Auinger, 1882), Poland (Friedberg, 1912; Bałuk, 1995, 2006); Romania (Hoernes & Auinger, 1882), Bulgaria (Kojumdgieva & Strachimirov, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Cathymorula sismondai (Doderlein, 1862)

Plate 23, figs 10, 11

- 1841a Purpura intermedia mihi, Michelotti, p. 22 (non Purpura intermedia Kiener, 1835).
- *1862 Purpura Sismondai Mich., Doderlein, p. 23.
- 1864 *Purpura tessellata* Mngh. Pecchioli, p. 14, pl. 5, figs 10, 11.
- 1882 Purpura Sismondae Micht. Bellardi, p. 181, pl. 11, fig. 15 (unnecessary emendation).
- 1992 Acanthina sismondai (Michelotti, 1840, ex. Doderlein, ms [sic]) – Cavallo & Repetto, p. 96, no. 214.
- 1999 Acanthina sismondai (Michelotti, 1840, ex. Doderlein, ms [sic]) Forli et al., p. 115, pl. 4, figs 8, 9.
- 2000 Acanthina sismondai (Michelotti in Doderlein, 1864) Chirli, p. 51, pl. 20, figs 5, 6.

Dimensions and material – Maximum height 33.3 mm. Locality 17: NHMW 1847/0058/0576/1, RGM 794 550/1 (ex JvdV collection).

Discussion - Michelotti (1841a) described this species and proposed the name Purpura intermedia, which was preoccupied by Kiener (1835). According to Bellardi (1882), Michelotti recognised his mistake and proposed the replacement name Sismondai in an unpublished communication with Doderlein. Doderlein's (1862) usage of Purpura Sismondai is available (ICZN, 1999, Article 12.1). The first to offer a description of the species was Bellardi (1882) who emended the name to Purpura sismondae (unnecessary emendation). Pecchioli (1864) described the same species as Purpura tessellata Mngh., which is accepted as a junior synyonym of Purpura sismondai by all later authors (e.g. Bellardi, 1882; Chirli, 2000). Pecchioli (1864) referred to 'signor professore Meneghini', who had provided a specimen of this shell and notes, which made him feel obliged to accept his name 'tessellata'. Again, the author making the name available was Pecchioli, and the name must be attributed to him.

The second group of European Miocene-Pliocene ergalataxine muricids, which was placed in *Cathymorula* by Landau *et al.* (2007), includes: *Purpura subumbilicata, gastraldii, arata, stazzanensis, megastoma* all of Bellardi, 1882 (see Ferrero Mortara *et al.*, 1981, pls 32-33) and *Cathymorula cathyae* Landau, Houart & Silva, 2007. The true number of species amongst this group is hard to ascertain, as they are all represented by very small numbers of specimens and much of the type material is in a poor state of preservation. *Purpura sismondae* Bellardi, 1882 (= tessellata) and Purpura bicarinata Bellardi, 1882 (a junior homonym of Purpura bicarinata Blainville, 1832, renamed Cathymorula saccoi Landau, Houart & Silva, 2007) are intermediate between the two groups, with tuberculate sculpture and a smooth columellar lip. Although Bellardi (1882, p. 181) described Purpura sismondae as having a smooth apertural lip, the specimen he figured is subadult. The specimen illustrated by Pecchioli (1864, p. 14, pl. 5, figs 10, 11) as Purpura tessellata Meneghini in Pecchioli, 1864 (= P. sismondai) has four stout denticles within the outer lip. Purpura exilis Partsch in Hörnes, 1856 (see Bałuk, 1995, pl. 27) has extremely weak columellar folds, which are completely absent from some specimens. Species within this group we consider to belong within the genus Cathymorula.

The specimens from the Karaman Basin are relatively broader than those illustrated from the Italian Pliocene, with stronger tubercles. However, we must note that all the Italian figured specimens are worn and in a poor state of preservation. Nevertheless, the sculptural elements are identical to those seen in the shell figured by Chirli (2000, pl. 20, fig. 5), with four rows of rounded tubercles, incised spiral threads between the rows of tubercles, and a prominent siphonal fasciole bordering a shallow umbilical chink. In the Karaman shells the denticles inside the outer lip are subobsolete and elongated.

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1882). Early Pliocene: Central Mediterranean, Italy (Bellardi, 1882; Cavallo & Repetto, 1992; Forli *et al.*, 1999; Chirli, 2000).

Genus Daphnellopsis Schepman, 1913

Type species – Clavatula fimbriata Hinds, 1843 (*Daph-nellopsis lamellosa* Schepman, 1913), by original designation, Recent, western Pacific.

Daphnellopsis tournoueri Lozouet, Ledon & Lesport, 1993

Plate 24, fig. 1

- 1874 Triton alatus Millet Tournoüer, p. 288, pl. 9, fig.
 8 [non Lindapterys alata (Millet, 1854)].
- 1952a Eupleura alata Millet, 1866 [sic] Glibert, p. 309, pl. 7, fig. 7 [non Lindapterys alata (Millet, 1854)].
- *1993 Daphnellopsis tournoueri Lozouet et al., p. 46, text-fig. 3, pl. 2, figs 12-15.

Dimensions and material – Height 18.1 mm. Locality 17: NHMW 1847/0058/1599/2 (adult), 1847/0058/0577, 1847/0058/0578/2 both subadult, RGM 794 060/1 (ex JvdV collection).

Discussion – Only one well-preserved large adult specimen is available from the Karaman assemblages. It is somewhat different from the type material (Lozouet *et*

al., 1993, pl. 2, figs 12-15) in having a larger shell, and in having more numerous axial ribs. The original description mentions 15 axial ribs on the penultimate whorl, of which four are varices, whereas in the Turkish shell there are 22 axial ribs on the penultimate whorl of which only two are developed into varices. The denser axial sculpture results in finer cancellate sculpture, whereas in the French specimens the cancellate sculpture is more elongated horizontally. In the French specimens the protoconch is paucispiral, composed of 1.5 whorls (Lozouet *et al.*, 1993, fig. 3). Unfortunately the protoconch is not preserved on the Turkish specimens. More specimens of this exceedingly rare shell are required to ascertain whether these differences are of specific value.

Distribution – **Middle Miocene**: northeastern Atlantic (Langhian): Loire Basin, France (Tournouër, 1874; Glibert, 1952a; Lozouet *et al.*, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subfamily Muricopsinae Radwin & d'Atillio, 1971 Genus *Muricopsis* Bucquoy & Dautzenberg, 1882 Subgenus *Muricopsis s.str*.

Type species – Murex blainvillei Payreaudeau, 1826 (= *Murex cristatus* Brocchi, 1814), by original designation. Recent, Mediterranean.

Muricopsis (Muricopsis) cristata (Brocchi, 1814) Plate 24, fig. 2

- *1814 *Murex cristatus* nob., Brocchi, 1814, p. 394, pl. 7, fig. 15.
- 1978 Muricopsis (Muricopsis) cristata (Brocchi, 1814)– Stojaspal, p. 337, pl. 5, fig. 1.
- 1998 Muricopsis cristata (Brocchi) Schultz, p. 66, pl. 26, fig. 8.
- 2007 Muricopsis (Muricopsis) cristata (Brocchi, 1814)
 Landau et al., p. 42, pl. 11, figs 10, 11 (with additional synonyms).

Dimensions and material-Maximum height 23.4 mm. Locality 17: NHMW 1847/0058/0579/1, 1847/0058/0580/2; locality 17a: NHMW 1847/0058/1583/1.

Discussion – Muricopsis cristata (Brocchi, 1814) is a highly polymorphic species, with many synonyms in the fossil and Recent literature (see Houart, 2001, p. 92). It seems to be exceedingly rare in the Turkish assemblages. The four specimens from Seyithasan are of the smooth *inermis* Philippi, 1836 morphotype (*non Murex inermis* Dujardin, 1837 = *Muricopsis dujardini* Peyrot, 1938). The spinose *M. cristata* morphotype *cristata* has not so far been found in the Turkish deposits.

Muricopsis crassicosta (Benoist, 1873) from the Atlantic late Oligocene, Chattian and early Miocene, Aquitanian of France differs from *M. cristata* in having a protoconch consisting of three whorls, whereas that of *M. cristata* is paucispiral, consisting of only 1.5 whorls, and in developing pointed spines between the fifth and seventh whorls that are not present in *M. crassicosta* (Merle, 1999). For further discussion see Landau *et al.* (2007, p. 43). Merle (1999) considered the middle Miocene Atlantic Loire Basin specimens identified by Glibert (1952a, p. 299, pl. 6, fig. 11) as *Muricidea cristata inermis* Philippi, 1836 to be a distinct species, *Muricopsis dujardini* Peyrot, 1938, distinguished from *M. cristata* by the late appearance of the spiral sculpture (Didier Merle, pers. comm. 2006).

Distribution - Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Hoernes & Auinger, 1885; Schultz, 1998), Czeck Republic (Hörnes, 1856; Hoernes & Auinger, 1885), Hungary (Kókay, 1966; Strausz, 1966), Poland (Friedberg, 1912; Krach, 1981; Bałuk, 1995), Romania (Hörnes, 1856; Hoernes & Auinger, 1885); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, Italy (Montanaro, 1935; Venzo & Pelosio, 1963). Early Pliocene: western Mediterranean, Estepona Basin (Landau et al., 2007); central Mediterranean, Italy (Chirli, 2000), Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin (RM collection); central Mediterranean (Sacco, 1904; Ruggieri & Greco, 1965; Palla, 1967; Malatesta, 1974; Caprotti, 1976; Chirli, 1988; Cavallo & Repetto, 1992; Andreoli & Marsigli, 1992a). Pleistocene: western Mediterranean, Balearic Islands (Cuerda Barceló, 1987); central Mediterranean, Italy (Cerulli-Irelli, 1911; Bevilaqua, 1928; Malatesta, 1960). Recent: northeastern Atlantic, southern Portugal and the Canaries, Mediterranean, intertidal to 120 m, on rocks and dead coral (Houart, 2001).

Genus Murexsul Iredale, 1915

Type species – Murex octogonus Quoy & Gaimard, 1833, by original designation. Pleistocene and Recent, New Zealand.

Murexsul sandbergeri (Hörnes, 1856) Plate 24, figs 3, 4

- *1856 *Murex Sandbergeri* Hörn., Hörnes, p. 674, pl. 51, fig. 5.
- 1885 *Murex (Ocenebra) Sandbergeri* M. Hoern. Hoernes & Auinger, p. 222.
- 1958 Hadriania sandbergeri (Hörn.) Sieber, p. 146.
- 1995 *Hexaplex (Muricanthus) sandbergeri* (Hörnes, 1856) Bałuk, p. 215, pl. 24, figs 3, 4.
- non 2009 Hexaplex (Muricanthus) sandbergeri (Hörnes, 1856) Mikuž, p. 26, pl. 8, fig. 107.

Dimensions and material – Maximum height 35.8 mm. Localities 2 & 3: JvdV/1; locality 12: JvdV/1; locality 13: NHMW 1847/0058/0581/1, JvdV/2, RGM 794 551/1 (ex JvdV collection); locality 17: NHMW 1847/0058/0582/1. Discussion – The generic placement of this species has been problematic. Vokes (1971) placed it in Ocinebrina Jousseaume, 1880, however, this is incorrect as the siphonal canal is open in all specimens. For the same reason its placement in Hadriania Bucquoy, Dautzenberg & Dollfus, 1882 by Sieber (1958) must be rejected. Bałuk (1995) placed it in Muricanthus Swainson, 1840, considered to be a subgenus of Hexaplex Perry, 1811 by Merle et al. (2011), which is clearly quite wrong. It is probably best placed within the genus Murexsul Iredale, 1915, which differs from Muricopsis Bucquoy & Dautzenberg, 1882 in having a more rounded, broader, last teleoconch whorl, and more numerous, stronger and more rounded spiral cords; the columellar lip is always smooth (Houart 2001), and the labral denticles are less strongly developed than in the genus Muricopsis (Vokes, 1994; Merle & Houart, 2003). We provisionally place this species in the genus Murexsul, although the neozelandic species are much more spinose. Both Muricopsis and Murexsul have a long geological history; Murexsul appeared in the late Eocene and Muricopsis appeared in the early Oligocene (Vokes, 1994; Merle & Houart, 2003).

The illustrated syntype of Murex sandbergeri in Hörnes (1856) is exceptionally large, the shoulders are less distinctly angulated than in the Turkish specimens and the siphonal canal is extremely wide. Thus, at first glance it might be doubtful that the Turkish shells are conspecific. Further syntypes in the collection of NHMW and the specimens from the Badenian of Poland described by Bałuk (1995), however, agree well with the Turkish specimens. Murex sp. ind. an nova sp. in Krach (1981, p. 67, pl. 22, fig. 9) from the Badenian of Poland possibly also represents a strongly sculptured specimen of Murexsul sandbergeri. Murexsul sandbergeri (Hörnes, 1856) seems to be rare wherever it is found and is very distinctive. The shell illustrated by Mikuž (2009, pl. 8, fig. 107) does not represent this species, but is a true Ocinebrina species with a sealed siphonal canal.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Hoernes & Auinger, 1885), Poland (Bałuk, 1995), Romania (Hoernes & Auinger, 1885); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Favartia Jousseaume, 1880

Type species – Murex breviculus Sowerby, 1834, by original designation. Recent, Indo-West Pacific.

Favartia suboblonga (d'Orbigny, 1852)

Plate 24, fig. 5

- *1852 *Murex suboblongus* d'Orbigny, p. 73, no. 1334 (*nom. nov. pro Murex oblongus* Grateloup, 1833, *non* Brocchi, 1814).
- 2007 *Favartia suboblonga* (d'Orbigny, 1852) Landau *et al.*, p. 46, text-fig. 12, pl. 12, figs 5-8 (with additional synonyms).

Dimensions and material – Maximum height 18.3 mm. Localities 2 & 3: JvdV/1; locality 13: NHMW 1847/-0058/0583/1, 1847/0058/0584/5, JvdV/2, YI 197/1; locality 17: NHMW 1847/0058/1602/2, JvdV/1.

Discussion – Landau et al. (2007, p. 47) discussed the taxonomic confusion surrounding the European Pliocene Favartia species, and concluded that all the late Miocene and Pliocene European shells identified by authors as F. excisa (Grateloup, 1833) and F. incisa (Broderip, 1833) were F. suboblonga (d'Orbigny, 1852). Murex incisus Broderip, 1833 is a Recent tropical American Pacific species. The main difference between F. excisa and F. suboblonga is the frequent absence of the secondary spiral cords s2 and s3 in F. excisa (see Merle, 1999, p. 304, ci = s). The relative frequency of the presence of secondary cords in the two species is as follows: for F. suboblonga, s1 (0%), s2 (99%), s3 (33%), s4 (0%), s5 (86%, s6 (88%); for F. excisa, s1 (0%), s2 (1%), s3 (1%), s4 (1%), s5 (1%), s6 (11%). Therefore more than 80% of specimens of F. suboblonga have s2-s5 developed, whereas fewer than 1% of F. excisa do (Merle, 1999). In France, Favartia excisa occurs in the Atlantic late Oligocene, Chattian to late early Miocene, Burdigalian. Favartia suboblonga coexisted with F. excisa in the Atlantic early Miocene, Aquitanian, and persisted into the middle Miocene, Langhian (Merle, 1999). Favartia suboblonga differs from Favartia absona (de Cristofori & Jan, 1832) in having a higher spire, broader, rounded, rather than spinose varices, and in having the siphonal canal much shorter and strongly dorsally recurved, whereas that in F. absona is almost straight. For further discussion see Landau et al. (2007, p. 47).

Distribution – Middle Miocene: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin (Cossmann & Peyrot, 1924), (Langhian): Loire Basin, France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1853), Poland (Bałuk, 1995), Romania (Boettger, 1902; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Montanaro, 1935). Early Pliocene: western Mediterranean, Estepona Basin (Landau *et al.*, 2007); central Mediterranean, Italy (Chirli, 2000). Early-late Pliocene: central Mediterranean (Sacco, 1904; Cavallo & Repetto, 1992; Andreoli & Marsigli, 1992a).

Genus Subpterynotus Olsson & Harbison, 1953

Type species – Murex textilis Gabb, 1873, by original designation. Miocene, Caribbean.

Note – The oldest members of the genus *Subpterynotus* Olsson & Harbison, 1953 are from Europe, where it is represented by *S. graniferus* (Michelotti, 1841) from the middle Miocene Proto-Mediterranean Sea and Paratethys. *Subpterynotus subgranifer* (Cossmann & Peyrot, 1924) from the Atlantic Aquitanian and Burdigalian of France is a synonym (see below).

The genus Subpterynotus Olsson & Harbison, 1953 is

another example of a thermophile genus. It disappeared from European faunas during the Miocene and did not manage to return to the Atlantic European frontage or repopulate the Mediterranean during the Pliocene. Today it occurs in the Atlantic further south, along the coasts of Western Sahara, represented by *Subpterynotus exquisitus* (Sowerby, 1904) (Houart, 1996).

Subpterynotus graniferus (Michelotti, 1841)

Plate 24, figs 6, 7

- *1841a *Murex graniferus* mihi, Michelotti, p. 11, pl. 5, fig. 6.
- 1847 *Murex graniferus* mihi Michelotti, p. 236, pl. 11, fig. 8.
- 1853 *Murex graniferus* Micht. Hörnes, p. 254, pl. 26, fig. 1.
- 1873 Murex graniferus Michtti Bellardi, p. 65, pl. 5, fig. 1.
- 1924 *Murex (Tubicauda) subgranifer* Cossmann & Peyrot, no.725, pl. 17, fig. 34, pl. 18, fig. 2.
- 1958 *Murex (Tubicauda) subgranifer* Cossmann & Peyrot Erünal-Erentöz, p. 54, pl. 8, figs 3, 4.

Dimensions and material-Maximum height 69.8 mm. Localities 2 & 3: JvdV/2; locality 6: JvdV/2, YI 172/1; localities 7 & 8: NHMW 1847/0058/0589/11, JvdV/7, RGM 783 887/2; locality 10: YI 185/1; locality 12: JvdV/1 collection); locality 13: NHMW 1847/0058/0590/3, JvdV/8, YI 174/12; locality 17: NHMW 1847/0058/0585/1, 1847/0058/0586/1, NHMW 1847/0058/0587-1847/0058/0588/50+, JvdV/50+, RGM 783 773/23, MTA 2013/039/9, YI 173/50+. Exact locality unknown: AÜ LE-K-221/1.

Discussion – Vokes (1968, 1989) considered Subpterynotus graniferus (Michelotti, 1841) from the Tethyan and Paratethyan Miocene to differ from *S. subgranifer* Cossmann & Peyrot, 1924 in having a wide varical extension on the siphonal canal, lacking in *P. subgranifer*, which had a more typical *Murexiella*-like straight canal with spines along its length. However, as can be seen from the specimens illustrated here (Pl. 24, figs 6, 7), the two forms represent extremes in the development of the siphonal canal, with the primary spiral cords on the canal: ADP, MP and ABP strongly developed, elevated and forming long spines in some specimens, whereas in others they are weaker and fused into a varical wing extension of the siphonal canal.

Vokes (1968, 1989) also questioned whether the New World *Subpterynotus* species, which she considered to consist of a single species, *Subpterynotus textilis* (Gabb, 1873), were congeneric with the Old World species *S. graniferus*. However, it is possible that there are up to three species present in Caribbean and Floridian Neogene fossil assemblages, differing in the degree of development of their varices and details of their sculpture, and we consider them all to form a monophyletic genus. *Subpterynotus graniferus* never shows the flared, recurved varices seen in Floridian specimens and, as

noted by Vokes (1994), *S. graniferus* has a larger aperture for the same shell size than *S. textilis*.

Subpterynotus graniferus is relatively common in the sandy facies in the Karaman assemblages, but rare in the clayey facies.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France, (Cossmann & Peyrot, 1924); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Michelotti, 1841a; Bellardi, 1873). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1853), Czech Republic (Hörnes, 1853; Hoernes & Auinger, 1885), Romania (Hörnes, 1853; Hoernes & Auinger, 1885); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1873).

Subfamily Typhinae Cossmann, 1903 Genus *Typhinellus* Jousseaume, 1880

Type species – Murex sowerbyii Broderip, 1833 (= *Murex labiatus* de Cristofori & Jan, 1832), by original designation. Pliocene to Recent, Mediterranean, eastern and western Atlantic.

Typhinellus labiatus (de Cristofori & Jan, 1832) Plate 24, figs 8, 9; Plate 64, fig. 13

- *1832 *Murex labiatus* nob., de Cristofori & Jan, p. 11.
 1896 *Typhis (Typhinellus) tetrapterus* Bronn Meli, p. 76, pl. 2, fig. 2.
- 1998 *Typhis (Typhinellus) tetrapterus* (Bronn) Schultz, p. 66, pl. 26, fig. 4.
- 2007 *Typhinellus labiatus* (Cristofori & Jan, 1832) Landau *et al.*, p. 57, text-fig. 16 (2), pl. 15, fig. 2 (with additional synonyms).
- 2011 *Typhinellus labiatus* (Cristofori & Jan, 1832) Houart *et al.*, p. 92, figs 1-4.

Dimensions and material – Maximum height 22.4 mm. Localities 2 & 3: JvdV/1; localities 7 & 8: NHMW 1847/0058/0594/1; locality 11: JvdV/2; locality 13: NHMW 1847/0058/0591/1, 1847/0058/0592/1, 1847/0058/0593/27, JvdV/3, YI 180/5; locality 17: NHMW 1847/0058/0595/6, JvdV/2, RGM 784 003/1, YI 184/1.

Discussion – As discussed by Landau *et al.* (2007, p. 58), this well-known and distinctive species is usually attributed an amphiatlantic distribution (Gertman, 1969; Vokes, 1989), although Houart (2001) doubted the conspecificity of the Caribbean population. We have examined a single shell from the late Miocene Gurabo Formation of the Dominican Republic (NHMW coll.), which is small, and indistinguishable from European fossil specimens. The western Atlantic records are therefore added to the distribution, pending further review. For further discussion see Houart *et al.* (2011, p. 92).

Distribution - Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1853; Hoernes & Auinger, 1885; Schultz, 1998), Hungary (Strausz, 1966), Poland (Bałuk, 1995), Romania (Csepreghy-Meznerics, 1956); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Western Atlantic Caribbean (Springvale Formation): Trinidad (Jung, 1969); (Cercado Formation): Dominican Republic (Vokes, 1989); northeastern Atlantic (Messinian): Loire Basin, France (Glibert, 1952a). Early Pliocene: western Atlantic Caribbean (Gurabo Formation), Dominican Republic (Vokes, 1989); western Mediterranean, Estepona Basin, Spain (Landau et al, 2007); central Mediterranean, Italy (Chirli, 2000), Tunisia (Fekih, 1975). Early-late Pliocene: central Mediterranean (Sacco, 1904; Ruggieri et al., 1959; Caprotti, 1976; Cavallo & Repetto, 1992; Andreoli & Marsigli, 1992a). Late Pliocene: western Atlantic Caribbean, Agueguexquite Formation, Mexico (Vokes, 1989). Early Pleistocene: Moin Formation, Costa Rica (Robinson, 1991); central Mediterranean, Italy (Cerulli-Irelli, 1911). Recent: eastern Atlantic coasts of Spain and Morocco to Somalia, Gulf of Oman, Mediterranean (Houart, 2001), Caribbean, Florida Keys (Gertman, 1969), West Africa, Gulf of Guinea, São Tomé and Principe (Houart, 2011).

Subfamily Coralliophilinae Chenu, 1859 Genus *Coralliophila* H. Adams & A. Adams, 1853

Type species – Fusus neritoideus Lamarck, 1816, by subsequent designation (Cossmann, 1903). Recent, Indo-Pacific.

Coralliophila scarrosa (Bellardi, 1873)

Plate 24, figs 10, 11

- *1873 *Murex scarrosus* Bell., Bellardi, p. 125, pl. 8, fig. 15.
- 1873 Murex concrispatus Bell., Bellardi, p. 125, pl. 8, fig. 16.

Dimensions and material-Maximum height 14.6 mm. Locality 13: NHMW 1847/0058/0596/1, 1847/0058/0597/1; locality 17: NHMW 1847/0058/0596/1, YI 198/1.

Discussion – Vokes (1971) synonymised *Murex scarrosus* Bellardi, 1873 and *Murex concrispatus* Bellardi, 1873, as first reviser choosing the former name, and placed the species in the genus *Latimurex* Coen, 1922, which is now considered to be a synonym of *Coralliophila* H. Adams & A. Adams, 1853. We have not been able to find any illustrations of the species subsequent to the original description. The specimens from Karaman ascribed here to *Coralliophila scarrosa* represent a species that is somewhat variable in shell shape. The specimen from Seyithasan (Pl. 24, fig. 10) is relatively slender, not unlike the shell illustrated by Bellardi (1873, pl. 8, fig. 16) as *M. concrispatus*. The shell from Pinarlar Yaylasi (Pl. 24, fig. 9) is more globose, more similar to Bellardi's illustration of *M. scarrosus* (Bellardi, 1873, pl. 8, fig. 15), but with a less scalate spire. The sculpture consists of seven broad rounded axial ribs, numerous narrow spiral cords, weakly alternating in strength, and a finely scabrous surface. The protoconch is well preserved in both specimens and is paucispiral, consisting of 1.5 whorls with a large nucleus.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1873).

Coralliophila sp.

Plate 24, fig. 12.

Dimensions and material – Maximum height 24.8 mm. Locality 17: NHMW 1847/0058/0599, 1847/0058/1601/2.

Discussion – A single shell from the Seyithasan deposits represents a medium-sized, solid *Coralliophila* species, characterised by a rather tall, almost flat-sided conical spire, a very short siphonal canal and a very broad but shallow umbilicus. The very short siphonal canal immediately separates this species from *Coralliophila scarrosa* (Bellardi, 1873) discussed above and the French Atlantic early Miocene species *Coralliophila burdigalensis* (Tournouër, 1874), which both have a rather biconic shape. The same biconic shape separates it from the middle Miocene Paratethyan species *Coralliophila gracilispira* Boettger, 1906 and *C. biconica* Boettger, 1906, both from Romania. This specimen probably represents another unnamed species, but we await more material before being certain of its distinguishing characters.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Babyloniidae Kuroda, Habe & Oyama, 1971 Genus *Babylonia* Schlüter, 1838 *sensu lato*

Type species – Buccinum spiratum Linnaeus, 1758 by monotypy, Recent, Indo-West Pacific Region.

Note – The genus *Peridipsaccus* Rovereto, 1900 was erected for *Babylonia* species with the umbilicus sealed by callus. Although Rovereto (1900) was clearly dealing with the Oligocene and Miocene species from Europe, in an unfortunate decision he selected the extant species *Eburnea molliana* Sowerby, 1859 [= *Babylonia valentiana* (Swainson, 1822)] as type species. Cossmann (1901) improved the definition of this subgenus-level taxon but still referred mainly to European fossils species. In their recent monograph of *Babylonia*, van Regteren Altena & Gittenberger (1981) synonymised *Peridipsaccus* with *Babylonia*, stating: 'as the umbilicus may be open or closed, with all intermediate stages in even the same subspecies (*e.g. B. spirata spirata*), *Peridipsaccus* is considered a junior

synonym of *Babylonia*'. As *Babylonia valentiana* is even considered as synonym of *B. spirata* by some authors (*e.g.* Bosch *et al.*, 1995) or only as geographic subspecies of *B. spirata* (Gittenberger & Goud, 2003), it is a synonym (or nearly so) of the type species of *Babylonia*. Therefore, we agree that *Peridipsaccus* Rovereto, 1900 is an inappropriate generic name.

The Chattian species *Babylonia umbilicosiformis* (Telegdi-Roth, 1914) from Hungary and the Rupelian species *Babylonia apenninica* (Bellardi, 1882) from Italy are both umbilicate and cannot be separated from *Babylonia s. str*. Nevertheless, the conspicuous umbilical callus of the Oligocene Italian species *B. caronis* (Brongniart, 1823) and of the Miocene species *B. eburnoides* (Mathéron, 1842) possibly points to a lineage, supporting Rovereto's original intention to separate these species. We are not aware of any available generic name for this group and prefer to use the genus *Babylonia* in a wide sense for the moment.

Babylonia eburnoides (Mathéron, 1842)

Plate 25, fig. 1; Pl. 79, fig. 9

- 1820 Buccinum Mutabile Linn.? Borson, p. 219, pl. 1, fig. 12 (non Nassarius mutabilis Linnaeus, 1758).
- *1842 Buccinum eburnoides Math., Mathéron, p. 252, pl. 40, figs 14-16.
- 1845 *Ebur: spirata* Lam Grateloup, pl. 46, fig. 6 (*non Eburna spirata* Lamarck, 1845).
- 1845 Ebur. Brugadina Grat., Grateloup, pl. 46, fig. 11.
- 1852 Buccinum Caronis Brong. Hörnes, p. 139, pl.
 12, figs 1-3 [non Babylonella caronis (Brongniart, 1823)].
- Buccinum Caronis Brong. Pereira da Costa, p. 87, pl. 13, figs 14-18 [non Babylonella caronis (Brongniart, 1823)].
- 1882 Buccinum (Eburna) Brugadinum Grat. Hoernes & Auinger, p. 116, pl. 15, figs 24-26.
- 1882 Eburna derivata Bellardi, p. 11.
- 1901 Latrunculus (Peridipsaccus) caronis var. derivata Bell. – Cossmann, p. 190, pl. 8, fig. 21.
- 1904 Peridipsaccus eburnoides (Math.) Sacco, p. 61, pl. 15, figs 4, 5.
- 1904 Peridipsaccus eburnoides var. angustata Sacc., Sacco, p. 61, pl. 15, fig. 6.
- 1904 Peridipsaccus derivatus (Bell.) Sacco, p. 61, pl. 15, figs 7-9.
- 1904 Peridipsaccus derivatus var. clausospirata Sacc., Sacco, p. 62, pl. 15, fig. 10.
- 1904 *Peridipsaccus derivatus* var. *angusticanaliculata* Sacc., Sacco, p. 62, pl. 15, fig. 11.
- 1912 Eburna (Peridipsaccus) eburnoides Math. Schaffer, p. 145, pl. 50, figs 22-25.
- 1925 Latrunculus (Peridipsaccus) Brugadinus Grat. Kautsky, p. 114, pl. 8, fig. 17.
- 1928 Latrunculus (Peridipsaccus) eburnoides (Mathérou [sic]) Peyrot, p. 252, no. 986, pl. 4, figs 69-71.
- 1928 Latrunculus (Peridipsaccus) Brugadinus (Grateloup) – Peyrot, p. 254, no. 987, pl. 1, figs 63, 64.
- 1929 Latrunculus (Peridipsaccus) eburnoides (Matheron)

- Rutsch, p. 24, pl. 1, figs 12, 13.

- 1939 *Latrunculus (Peridipsaccus) brugadinus* (Grat.) Montanaro, p. 113, pl. 8, figs 1-8.
- 1944 Babylonia (Peridipsaccus) brugadina (Grateloup) – van Voorthuysen, p. 86, pl. 7, figs 1-7.
- 1950 Babylonia (Peridipsaccus) brugadina Grateloup Csepreghy Meznerics, p. 49, pl. 3, fig. 2.
- 1952b Babylonia (Peridipsaccus) brugadina Grateloup, 1840 – Glibert, p. 102, pl. 8, fig. 3.
- 1962 Babylonia (Peridipsaccus) brugadina Grateloup Strausz, p. 100, pl. 40, figs 5, 6, text-fig. 113.
- 1966 Babylonia (Peridipsaccus) brugadina (Grateloup, 1847) – Strausz, p. 301, pl. 40, figs 5, 6, text-fig. 136.
- 1971 Babylonia (Peridipsaccus) eburnoides (Matheron) – Steininger, p. 400, pl. 10, fig. 12.
- 1984a *Babylonella brugadina* (Grateloup, 1840) A.W. Janssen, p. 231, pl. 62, figs 7, 8.
- 1998 Babylonia (Peridipsaccus) brugadina (Grateloup) – Schultz, p. 68, pl. 27, fig. 1.
- 2001 *Babylonella brugadina* (Grateloup, 1840) Wienrich, p. 483, pl. 78, fig. 8, pl. 96, figs 3, 4.
- 2002 *Babylonia (Peridipsaccus) eburnoides* (Matheron, 1842) Harzhauser, p. 100, pl. 7, figs 6-8.
- 2009 *Babylonia (Peridipsaccus) eburnoides* (Matheron, 1842) Mikuž, p. 24, pl. 7, fig. 90.
- 2010 *Babylonella brugadina* (Grateloup, 1840) Moths *et al.*, p. 58, pl. 17, fig. 10, pl. 40, fig. 2.
- 2011 Babylonella (Peridipsaccus) derivata (Bellardi, 1882) Caprotti, p. 56, figs 3A-D.

Dimensions and material – Maximum height 54.4 mm. Locality 17: NHMW 1847/0058/0836/1, NHMW 1847/-0058/1670/1, 1847/0058/0837/20, JvdV/6, RGM 783 779/1, YI 284/6 + 1 incomplete.

Discussion – We agree with Glibert (1963b, p. 69) in considering the early and late Miocene forms to be a single species. As rightly pointed out by Glibert, this species is very common in the late Miocene Tortonian of Montegibbio, Italy, where the shells are highly variable in shape and taller and squatter forms coexist. *Babylonia eburnoides* (Mathéron, 1842) is the valid name, as Grateloup's atlas was not published until 1845 despite the frontispiece of the book stating 1840 as the year of publication (Martins & Hugard, 1846). The Oligocene species *Babylonia caronis* (Brongniart, 1823) we distinguish by being smaller, with a squatter spire, less inflated whorls and a narrower aperture.

The genus *Babylonia* Schlüter, 1838 seems to have Tethian roots, as it first appeared in the Eocene of Italy and disappeared from the Proto-Mediterranean at the end of the Miocene. Today it is restricted to the Pacific (Gittenberger & Goud, 2003). Recent species all have a similar colour pattern of reddish-brown rows of axially elongated blotches and dots. A similar pattern can be seen in some of the Turkish specimens under UV light (Pl. 79, fig. 9).

Distribution – **Early Miocene**: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Peyrot, 1928);

Paratethys (Burdigalian): Austria (Schaffer, 1912; Harzhauser, 2002). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Netherlands (van Voorthuysen, 1944; A.W. Janssen, 1984a), Germany (Kautsky, 1925; Wienrich, 2001; Moths et al., 2010). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Peyrot, 1928); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1882; Schultz, 1998), Czech Republic (Hoernes & Auinger, 1882), Romania (Hoernes & Auinger, 1882), Hungary (Strausz, 1962, 1966), Slovenia (Mikuž, 2009); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1882; Sacco, 1904; Montanaro, 1939; Caprotti, 2011).

Superfamily Buccinoidea Rafinesque, 1815 Family Buccinidae Rafinesque, 1815 Subfamily Buccininae Rafinesque, 1815 Tribe Buccinini Rafinesque, 1815 Genus *Euthria* Gray, 1850

Type species – Murex corneum Linnaeus, 1758, by original designation. Recent Mediterranean.

Note – The genus *Buccinulum* Deshayes, 1830 has often been used in the literature for this group of European species, or *Euthria* placed as a subgenus of it. However, *Buccinulum* is an exclusively antipodean genus (Ponder, 1971), now placed in a separate family Buccinulidae Finlay, 1928 (Harasewych & Kantor, 2004).

Euthria curvirostris (Grateloup, 1845)

Plate 25, figs 2, 3; Plate 64, fig. 5; Plate 79, fig. 10

- 1833 *Fusus virgineus* var. C curvirostrâ Grateloup, p. 38 (*nomen nudum*).
- *1845 *Fusus lignarius* var. B *curvirostris* Grateloup, pl. 24, fig. 3.
- 1852 Fusus sublignarius d'Orbigny, p. 66, no. 1188 (nom. nov. pro Fusus virgineus in Grateloup, 1845, pl. 24, fig. 3; non Lamarck, 1816).
- 1928 Euthria cornea mut. Curvirostris Grateloup Peyrot, p. 10, no. 991, pl. 5, figs 45, 46.
- 1958 *Euthria (Euthria) cornea* mut. *curvirostris* Grateloup – Erünal-Erentöz, p. 59, pl. 9, figs 8-10.

Dimensions and material – Maximum height 47.8 mm. Localities 2 & 3: JvdV/1, RGM 777 871/1 (ex JvdV collection); locality 6: JvdV/1; localities 7 & 8: JvdV/1; locality 9: RGM 783 826/3; locality 12: JvdV/12, RGM 783 616/1; locality 13: NHMW 1847/0058/0838/1, 1847/0058/0839/1, 1847/0058/0840/29, JvdV/50+, RGM 783 667/42, 794 572/2, MTA 2013/040/6, YI 283/50+.

Discussion - The name curvisrostris was made available

by Grateloup (1845) in his atlas, as in 1833 the addition 'curvirostrâ' was only a descriptive addition for his Variété C (in the same way 'labo dentato' was a description of Variété A and 'aperture sulcosâ' for Variété B).

Peyrot (1928) rightly separated the French Atlantic middle Miocene shells similar to the Pliocene-Recent species *Euthria cornea* (Linnaeus, 1758) under the name *Euthria cornea* mut. *Curvirostris* Grateloup. Here we consider these shells to be distinct at the species level, differing from *E. cornea* in having a smaller shell on average, in having more regularly convex whorls resulting in a more smoothly conical spire, the well developed subsutural collar present in *E. cornea* is reduced to a modest and poorly delimited constriction, and in most specimens having a slightly longer and more posteriorly recurved siphonal canal. These differences are clearly illustrated when the Turkish shells are compared with the series of Recent specimens figured by Giannuzzi-Savelli *et al.* (2003, figs 269-277).

Like the Recent *Euthria cornea*, *E. curvirostris* (Grateloup, 1833) is quite variable, especially in size, with many dwarf adult specimens present, and in the thickness of the shell. The shell, however, never becomes as thick as that of the widespread middle-late Miocene species *Euthria intermedia* (Michelotti, 1847), which differs in having not only a more solid but also a stockier shell, with a lower spire, a more globose last whorl and a shorter siphonal canal.

The adult shells from Turkey are very similar to the adult shell from the Atlantic middle Miocene Langhian of the Loire Basin, France, illustrated by Glibert (1952a, pl. 9, fig. 3c) as *Euthria subnodosa* Hoernes & Auinger 1890. Both species have a paucispiral protoconch (1.5 whorls in *E. curvirostris* dp = 1090 μ m, dp1 = 930 μ m, dn = 560 μ m; Pl. 64, fig. 5; 2 whorls in *E. subnodosa*), and reticulate sculpture consisting of prominent axial cords that weaken and become obsolete from the fourth teleoconch whorl. However, Glibert (1952a, p. 323) recorded about 12 axial ribs on the early whorls, whereas there are only 7-8 on the early whorls of the Turkish shells. A colour pattern is seen under UV light, consisiting of blotches of irregular size and disposition (Pl. 79, fig. 10), very similar to that of the Recent European species *Euthria cornea*.

Distribution – **Middle Miocene**: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Peyrot, 1928); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Euthria puschi (Andrzejowski, 1830)

Plate 25, figs 4, 5

- *1830 Lathira Puschi Andrzejowski, p. 95, pl. 4, fig. 2.
- 1837 Fasciolaria polonica m., Pusch, p. 145, pl. 12, fig. 3.
- 1840 *Fasciolaria polonica* Pusch Bellardi & Michelotti, p. 119, pl. 2, fig. 15.
- 1847 Fusus armatus mihi, Michelotti, p. 275, pl. 9, fig. 12.
- 1853 Fusus Puschi Andr. Hörnes, p. 282, pl. 31, fig. 6.

- 1866 Fusus puschi Andrzejowski Fischer, p. 238.
- 1873 *Euthria Puschi* (Andr.) Bellardi, p. 196, pl. 13, fig. 17.
- 1904 *Euthria Puschi* (Andr.) Sacco, p. 35, pl. 10, figs 1, 2.
- 1912 Euthria puschi Andrz. Friedberg, p. 153, pl. 8, fig. 12.
- 1912 Euthria Zejszneri Friedb. Friedberg, p. 154, pl. 8, fig. 13.
- 1956 *Euthria puschi* (Andrz.) Csepreghy-Meznerics, p. 434, pl. 7, figs 6, 7.
- 1957 *Euthria puschi* (Andrzejowski) Pavlovsky, p. 53, pl. 1, fig. 8.
- 1960 Euthria (Euthria) puschi (Andrzejowski 1830) –
 Kojumdgieva & Strachimirov, p. 170, pl. 43, fig. 8.
- 1962 *Euthria puschi* Andrzejovski [*sic*] Strausz, p. 87, pl. 34, figs 6, 7, 10.
- 1966 *Euthria puschi* Andrzejowski, 1830 Strausz, p. 304, pl. 34, figs 6, 7, 10.
- 1968 *Euthria puschi* (Andrzejowski, 1830) Zelinskaya *et al.*, p. 191, pl. 45, figs 14, 15.
- 1971a Euthria puschi (Andrzejowsky [sic]) Eremija, p. 76, pl. 6, fig. 10.
- 1972 *Euthria puschi* Andrz. Csepreghy-Meznerics, p. 28, pl. 11, figs 6, 7.
- 1995 *Euthria puschi* (Andrzejowski, 1830) Bałuk, p. 243, pl. 34, figs 3, 4.
- 1998 Euthria (Euthria) puschi (Andrzejowski) Schultz, p. 68, pl. 27, fig. 3.
- 2002 *Euthria (Euthria) puschi* (Andrzejowski, 1830) Harzhauser, p. 100, pl. 7, fig. 5.
- non 2009 Euthria (Euthria) puschi (Andrzejowski, 1830) Mikuž, p. 24, pl. 7, fig. 89 (= probably Ocinebrina species).

Dimensions and material – Maximum height 50.5 mm. Localities 2 & 3: RGM 794 062/1 (ex JvdV collection); localities 7 & 8: NHMW 1847/0058/0841/1; locality 13: NHMW 1847/0058/0842/1, 1847/0058/0843/1, JvdV/3, RGM 794 554/1 (ex JvdV collection); locality 17: JvdV/1.

Discussion – This very distinctive Miocene species is difficult to confuse with any of its congeners, as it has a very distinctive row of small, sharp nodules around the shoulder angle. One of the specimens from Turkey retains its colour pattern (Pl. 21, fig. 5), consisting of large squarish blotches on the sutural ramp, and another row at the periphery of the last whorl.

Distribution – **Early Miocene**: Paratethys (Burdigalian): Austria (Harzhauser, 2002). **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1853; Schultz, 1998), Poland (Andrzejowski, 1830; Friedberg, 1912; Bałuk, 1995), Hungary (Csepreghy-Meznerics, 1956; Strausz, 1962, 1966), Bulgaria (Kojumdgieva & Strachimirov, 1960), Ukraine (Zelinskaya *et al.*, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Fischer, 1866). Genus Euthriofusus Cossmann, 1901

Type species – Fusus burdigalensis de Basterot, 1825, by original designation. Early Miocene, France.

Note – The genus *Euthriofusus* Cossmann, 1901 has been traditionally placed within the Fasciolariidae. Lozouet *et al.* (2001a) moved it to the Buccinidae. Snyder (2003) also removed the genus from the Fasciolariidae.

Euthriofusus anatolicus (Toula, 1901)

Plate 25, figs 6, 7; Plate 64, fig. 6

- *1901 Fusus anatolicus Toula, p. 257, pl. 8, fig. 7.
- 1958 Fusus anatolicus Toula Erünal-Erentöz, p. 72, pl. 11, figs 11-15.

Dimensions and material – Maximum height 100.1 mm. Holotype RGM 47813, exact locality unknown; localities 2 & 3: JvdV/50+, RGM 783 922/38, YI 291/50+; locality 6: NHMW 1847/0058/1491/15, JvdV/6, RGM 783 871/20; localities 7 & 8: NHMW 1847/0058/0870-1847/0058/0886/17, RGM 783 888/50+; locality 9: JvdV/23, RGM 783 827-828/50+; locality 10: YI 290/6; locality 12: JvdV/50+, RGM 783 612-614/50+; locality 13: NHMW 1847/0058/0844-1847/0058/0854/11, JvdV/50+, RGM 794 560/1 (ex JvdV collection), RGM 783 669, 783684-688/50+, MTA 2013/041/50+, YI 289/50+; locality 15: NHMW 1847/0058/0886/1, 1847/0058/0886/1, isolatity 17: HMW 1847/0058/0855-1847/0058/0869/15, JvdV/50+, RGM 783 780-782/50+, MTA 2013/042/15, YI 286/50+.

Discussion – Euthriofusus anatolicus (Toula, 1901) was based on material collected from the Karaman Basin, and is one of the most common and distinctive fossils in almost all the Karaman localities. It differs from Euthriofusus virgineus (Grateloup, 1833) in being more slender, in having the periphery of the penultimate and last whorl almost always carinate (except in very gerontic specimens, in a few of which the last adult whorl is almost smooth), whereas in most specimens of E. virgineus the last two whorls are rounded, in being less constricted at the base, and in having a smaller aperture. Toula (1901) stressed the double row of spines present at the periphery in his material, which according to Toula were present in all specimens. However, his material consisted of one specimen only. This double row of spines is also clearly seen in the shells illustrated by Erünal-Erentöz (1958, pl. 11, figs 11-15).

An analysis of the smooth vs. spined forms and specimens with single or double rows of spines in the JvdV collection produced the results presented in Table 11. Table 11 demonstrates that less than 1% of the specimens have two rows of spines, or a subobsolete second row of spines at the shoulder, and this feature is far less frequent than suggested by Toula (1901) and Erünal-Erentöz (1958).

Both *Euthriofusus anatolicus* and *E. virgineus* have a paucispiral protoconch. *Euthriofusus* cf. *virgineus* reported by Landau *et al.* (2011) from the Atlantic early Pliocene Guadalquivir Basin of Spain also occurs in the

locality	no. specimens	double row	single row	% double row	% single row
13	695	3	692	0,43%	99,71%
12	103	1	102	0,97%	99,03%
9	27	0	27	0,00%	100,00%
7 & 8	88	0	88	0,00%	100,00%
2 & 3	215	4	211	1,86%	98,14%
17	84	0	84	0,00%	100,00%
	1212	8	1204	0,66%	99,42%
		specimens with spines		(almost) smooth specimens	
17	84	72 (85.7%)		12 (14.3%)	

Table 11. *Euthriofusus anatolicus* (Toula, 1901): table showing % of specimens with double or single row of spines at the shoulder of the last adult whorl.

contemporaneous western Mediterranean deposits of the Estepona Basin. It differs from *E. virgineus* and *E. anatolicus* in being much smaller and thinner-shelled, its spire is less elevated and the last adult whorl is more rounded. The protoconch is well preserved in the Estepona material and is tall and mammillate, consisting of 2.5-3 smooth whorls with a small nucleus quite unlike that of the Karaman shells, which is deviated paucispiral, inflated, consisting of 1.5-2 whorls. The Spanish specimens probably represent an undescribed Pliocene species related of *E. virgineus*.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Toula, 1901; Erünal-Erentöz, 1958).

Genus Metula H. Adams & A. Adams, 1850

Type species – Buccinum clathratum A. Adams & Reeve, 1850 (= *Metula agassizi* Clench & Aguayo, 1941) by subsequent designation (Kobelt, 1876). Recent, Panamic western America.

Note – The European Neogene species have often been placed in the genus *Acamptochetus* Cossmann, 1901, which is now considered a synonym (Bouchet, 2012).

Metula submitraeformis (d'Orbigny, 1852)

Plate 53, fig. 17; Plate 79, fig. 11

- 1845 Fusus mitraeformis Grateloup, pl. 24, figs 36-38, pl. 46, fig. 25 [non Metula mitraeformis (Brocchi, 1814)].
- *1852 Fusus submitraeformis d'Orbigny, p. 66, no. 1183 (nom. nov. pro Fusus mitraeformis in Grateloup, 1845, pl. 24, figs 36-38; non Brocchi, 1814).
- 1853 Fusus mitraeformis Brocc. Hörnes, p. 283, pl. 31, fig. 7 [non Metula mitraeformis (Brocchi, 1814)].

- 1923 Acamptochetus submitraeformis (d'Orbigny) Cossmann & Peyrot, p. 300, no. 837, fig. 1.
- 1984a *Acamptochetus submitraeformis* (d'Orbigny, 1852) – A.W. Janssen, p. 230, pl. 62, fig. 3.

Dimensions and material – Height 38.6 mm. Locality 13: RGM 777 864/1 (ex JvdV collection).

Discussion - The middle Miocene species Metula submitraeformis (d'Orbigny, 1852) differs from the Mediterranean Pliocene species Metula mitraeformis (Brocchi, 1814) in having reticulate sculpture on the early teleoconch whorls. Moreover, the protoconch is perfectly preserved in one middle Miocene Paratethyan shell from Romania (NHMW collection, ex BL collection), and has a tall multispiral protoconch, whereas the Pliocene shells have a paucispiral protoconch (Chirli, 2000; BL personal observation). These differences can also be seen in the incomplete shell from the middle Miocene North Sea Basin Miste deposits, illustrated by A.W. Janssen (1984a, pl. 62, fig. 3), which also has a multispiral protoconch and reticulated early teleoconch whorls. The single shell from the Akpinar assemblage does not have the protoconch preserved, but the early teleoconch whorls are reticulate. The Turkish shell has a colour pattern visible under UV light consisting of two spiral rows of elongated oblong blotches (Pl. 79, fig. 11). One Italian Pliocene specimen of M. mitraeformis has a similar colour pattern enhanced under UV light.

Metula reticulata (Bellardi & Michelotti, 1840) from the early Miocene of Turin, Italy differs in having reticulate sculpture developed on all teleoconch whorls (syntype see Ferrero Mortara *et al.*, 1981, pl. 4, fig. 12). *Metula recta* (Sacco, 1904), also from the Turin hills of Italy, is squatter than the Pliocene *M. mitraeformis* and has more rounded whorls than *M. submitraeformis*. The sculpture is poorly illustrated in Sacco's figure (1904, pl. 10, figs 9-11), but seems finer and more subdued than in its European Neogene congeners. *Distribution* – Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (A.W. Janssen, 1984a). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1923); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1853), Romania (NHMW collection, ex BL collection); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subfamily Pisaniinae Gray, 1857 Genus *Pisania* Bivona, 1832

Type species – Pisania striatula Bivona, 1832 (= *Voluta striata* Gmelin, 1791) by subsequent designation (Iredale, 1914) (ICZN Opinion 740; Melville & Smith, 1987). Recent, Mediterranean Sea.

Pisania striata (Gmelin, 1791)

Plate 25, figs 8, 9; Plate 64, fig. 7

- *1791 Voluta striata Gmelin, p. 3255.
- 1822 Buccinum maculosum Lamarck, p. 269.
- 1866 Buccinum maculosum Sow. (non Linn.) Pereira da Costa, p. 116, pl. 16, fig. 20.
- 1867 Buccinum maculosum Sow. (non Linn.) Pereira da Costa, pl. 22, fig. 8.
- 1868 Buccinum maculosum var. magna Foresti, p. 23, pl. 1, figs 6, 7.
- 1872 *Pisania striatula* Bivona d'Ancona, p. 174, pl. 10, figs 2-4.
- 1901 *Pisania maculosa* (Lamk.) Cossmann, p. 164, pl.
 6, fig. 18.
- 1904 *Pisania maculosa* (Lk.) Sacco, p. 58, pl. 14, fig.
 62.
- 1904 Pisania maculosa var. pliobrevis Sacc., Sacco, p. 58, pl. 14, fig. 63.
- 1904 *Pisania maculosa* var. *pliostriatissima* Sacc., Sacco, p. 58, pl. 14, fig. 64.
- 1904 Pisania maculosa var. plioangustata Sacc., Sacco, p. 58, pl. 14, fig. 65.
- 1963 *Pisania (Pisania)* cfr. *maculosa* (Lk.) Venzo & Pelosio, p. 94, pl. 35, fig. 16.
- 1965 *Pisania (Pisania) maculosa* (Lamk.) Ruggieri & Greco, p. 53, pl. 2, fig. 4.
- 1974 *Pisania (Pisania) maculosa* (Lamarck, 1822) Malatesta, p. 313, pl. 25, fig. 6.
- 1979 *Pisania (P.) maculosa* (Lamarck, 1822) Pavia & Rosa, p. 189, pl. 1, fig. 9.
- 1991 *Pisania striata* (Gmelin, 1791) Poppe & Goto, p. 148, pl. 30, fig. 3.
- 1992 *Pisania striata* (Gmelin, 1791) Cavallo & Repetto, p. 100, fig. 224.
- 2000 *Pisania striata* (Gmelin in L., 1791) Chirli, p. 57, pl. 25, figs 10-14.
- 2003 *Pisania striata* (Gmelin, 1791) Giannuzzi-Savelli *et al.*, p. 160, figs 299-310.
- 2010 *Pisania maculosa magna* Foresti, 1868 Ceregato *et al.*, p. 62, pl. 2, figs 46, 47.

Dimensions and material – Maximum height 25.6 mm. Localities 2 & 3: NHMW 1847/0058/0888/1, locality 6: RGM 794 081/1 (ex JvdV collection).

Discussion – As seen from the series of Recent Mediterranean specimens illustrated by Gianuzzi-Savelli *et al.* (2003, figs 299-310), *Pisania striata* (Gmelin, 1791) is an extremely variable species, with inflated and slender, short and tall-spired forms existing. These forms were also present in the Italian Pliocene, leading Sacco (1904) to describe numerous varieties. The protoconch is preserved in one of the Turkish specimens and is multispiral. The early teleoconch whorls are strongly sculptured (Pl. 64, fig. 7), similar to some of the specimens illustrated by Gianuzzi-Savelli *et al.* (2003, figs 303, 308). As far as we are aware this is the oldest record of *P. striata*, although the early Miocene species *Pisania crassa* Bellardi, 1872 from the Burdigalian of the Turin Hills might be an even older representative of this lineage.

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866, 1867); Proto-Mediterranean Sea (Messinian): Po Basin, Italy (Venzo & Pelosio, 1963). Early Pliocene: western Mediterranean, Estepona Basin, Spain (NHMW collection); central Mediterranean, Italy (Pavia & Rosa, 1979; Cavallo & Repetto, 1992; Chirli, 2000). Early-late Pliocene: central Mediterranean, Italy (Foresti, 1868; d'Ancona, 1872; Bellardi, 1873; Sacco, 1904; Malatesta, 1974; Ceregato *et al.*, 2010). Early-late Pleistocene: central Mediterranean, Italy (Ruggieri & Greco, 1965). Recent: Mediterranean (Poppe & Goto, 1991).

Genus Anna Risso, 1826

Type species – Anna massena Risso, 1826 (*nomen dubium fide* Gofas & Fraussen, 2012), by monotypy. France, Pliocene.

Note – the western Atlantic pisaniine buccinids ascribed to *Anna* Risso, 1826 by Watters (2009) belong in the genus *Ameranna* Landau & Vermeij, 2012. They differ from the eastern Atlantic *Anna* species by generally having fewer axial ribs on the last whorl (seven to thirteen as compared with ten to more than twenty) and by having lirae instead of denticles on the inner side of the outer lip. Although these differences (especially the axial rib number) seem slight, the geographic separation and the lirate instead of denticulate outer lip distinguish the western Atlantic species from the many fossil and living species of *Anna* (Landau & Vermeij, 2012).

Anna exsculpta (Dujardin, 1837)

Plate 21, figs 10, 11; Plate 64, fig. 8

*1837 *Pupura* [*sic*] *exsculpta* Duj., Dujardin, p. 297, pl. 19, fig. 8.

- 1853 Murex plicatus Brocc. Hörnes, p. 245, pl. 25, figs 9, 10 (non Brocchi, 1814).
- 1873 Pollia exsculpta (Duj.) Bellardi, p. 185, pl. 12, fig. 28.
- 1878 *Pollia exsculpta* Dujardin Locard, p. 20, pl. 18, figs 8, 9.
- 1912 *Pollia exsculpta* Duj. Friedberg, p. 183, pl. 11, figs 17, 18.
- 1952a Cantharus (Pollia) exsculptus Dujardin, 1837 Glibert, p. 328, pl. 8, fig. 12.
- 1960 *Cantharus (Pollia) exsculptus (Dujardin) Ko-jumdgieva & Strachimirov, p. 172, pl. 43, fig. 13.*
- 1960 Cantharus (Pollia) exsculptus var. canaliculatus Kojumdgieva & Strachimirov, p. 172, pl. 43, fig. 14.
- 1962 Cantharus (Pollia) exsculptus Dujardin Strausz,p. 89, pl. 34, fig. 23, pl. 35, fig. 1.
- 1964 Cantharus (Pollia) exsculpta Dujardin, 1837 Brébion, p. 428
- 1966 Cantharus (Pollia) exsculptus Dujardin, (1835)
 1837 Strausz, p. 307, pl. 34, fig. 23, pl. 35, fig. 1.
- 1966 Cantharus (Pollia) exsculptus (Duj.) Kókay, p. 58, pl. 8, fig. 10.
- 1968 Cantharus exsculptus Dujardin, 1837 Zelinskaya et al., p. 191, pl. 45, figs 20, 21.
- 1981 Cantharus (Pollia) exsculptus (Dujardin) Krach, p. 68, pl. 18, figs 9-12.
- 1995 Cantharus exsculptus (Dujardin, 1837) Bałuk, p. 241, pl. 37, figs 1, 2.
- non 1927 Tritonidea exsculpta (Dujardin) Peyrot, p. 235, no. 974 (partim, pl. 4, figs 37-39 only) [= Anna aquitaniensis (Peyrot, 1927)].
- ?non 1963 Cantharus (Pollia) cfr. exsculptus (Duj) Venzo & Pelosio, p. 64, pl. 35, figs 23, 24.

Dimensions and material – Maximum height 21.4 mm. Localities 2 & 3: JvdV/4; localities 7 & 8: NHMW 1847/0058/1694/1, RGM 783 889/1; locality 13: YI 332/1; locality 17: NHMW 1847/0058/0889/1, 1847/0058/0890/12, JvdV/8, RGM 784 005/1, 783 783/1, YI 295/3.

Discussion – Members of this pisaniine group of buccinids have been placed in the genera Cantharus Röding, 1798 or Pollia Gray in Sowerby, 1834 by most previous authors. Vermeij (2006) revised the Cantharus-group and placed this European-West African Miocene to Recent group in the genus Anna Risso, 1826, characterised by its small fusiform shell, which is poorly constricted at the base, by having weak axial sculpture consisting of at least 11 ribs, dense spiral cords, with secondary cords intercalated in many specimens, a distinct parietal tooth, a crenulated outer lip with six or more short denticles within, and no umbilical chink. Anna differs from Pollia, which is an Indo-West Pacific genus, in lacking a labral tooth at the edge of the outer lip and by having short denticles within the outer lip instead of elongate lirae. Cantharus is also Indo-West Pacific and includes species with shouldered whorls, sculpture of strong axial folds, and a much wider aperture, which is deeply lirate within (Vermeij & Bouchet, 1998).

Lozouet et al. (2001a) pointed out that, whilst the teleoconch characteristics of the French Serravalian species Anna exsculpta (Dujardin, 1837) from the Touraine Basin is almost indistinguishable from that of Anna aquitaniensis (Peyrot, 1927) from the Aquitanian/Burdigalian of the Aquitaine Basin of France, they differed in their protoconch type: A. exsculpta has a paucispiral protoconch, whilst A. aquitaniensis has a multispiral protoconch. Unfortunately, Lozouet et al. (2001a) did not give further details of the protoconch of either species, but the shells from Turkey have a protoconch consisting of 2.25 whorls with a medium-sized nucleus (dp = 520 μ m, dp1 = 280 μ m, dn = 165 μ m; Pl. 64, fig. 8), which is probably what Lozouet et al. (2001a) described as a paucispiral protoconch. The shells recorded by Venzo & Pelosio (1963, pl. 35, figs 23-24) as Cantharus (Pollia) cfr. exsculptus from the late Miocene Messinian of Italy are in poor condition and are not clearly conspecific with A. exsculpta.

Distribution – Middle Miocene: northeastern Atlantic (Langhian): Touraine Basin, France (Dujardin, 1837; Peyrot, 1928), (Langhian): Loire Basin, France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1853), Poland (Friedberg, 1912; Bałuk, 1997), Hungary (Strausz, 1962, 1966), Bulgaria (Kojumdgieva & Strachimirov, 1960), Ukraine (Zelinskaya *et al.*, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (Brébion, 1964); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1873).

Genus Monostiolum Dall, 1904

Type species: Triton swifti Tryon, 1881, by original designation. Recent, Western Atlantic.

Monostiolum nov. sp.

Pl. 53, fig. 18.

Dimensions and material – Height 15.5 mm. Locality 17: NHMW 1847/0058/0885/2.

Discussion - We refrain from describing this species formally, as it is represented by only a single shell from the Seyithasan assemblage. The protoconch is poorly preserved, but is possibly multispiral. A superficially similar species from the middle Miocene Paratethyan assemblages was described by Hörnes (1856) as "Triton varians Michti." and as "Pollia varians Michti. sp." by Hoernes & Auinger (1890). This Paratethyan species, which is most probably not conspecific with the early Miocene Italian species described by Michelotti (1847), differs from the Turkish shell in its even more elongate outline with a long, slowly contracting last whorl, in the more numerous, narrow, well-defined axial ribs, the prominent apertural varix, the straight columella, and the shorter siphonal canal. The Miocene Paratethyan "Turbinella (Latirus) fusiformis Hoernes & Auinger, 1890" has a comparable outline but is distinguished from the Turkish species clearly by its columellar folds and the much stronger denticles inside the inner lip.

The generic assignment of this small shell is also problematic. The overall morphology of this buccinid is reminiscent of *Monostiolum* Dall, 1904. The occurrence of *Monostiolum* in the middle Miocene Proto-Mediterranean Sea would be surprising, as the genus is restricted to the fossil Neogene and Recent Western Atlantic (Watters & Finlay, 1989). Doubts over the generic assignment arise also from the poorly developed anal canal, which is delimited by a prominent parietal denticle in most *Monostiolum* species. This character, seems to be variable, however, and in species such as *M. auratum* Watters & Finlay, 1989 and *M. rosewateri* Watters & Finlay, 1989 some specimens lack the denticle altogether.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Europhos nov. gen.

Type species – Buccinum polygonum Brocchi, 1814. Fossil, Pliocene, Italy.

Other included species – Voluta cytharella Brongniart, 1823, Phos hoernesi Semper, 1861, Phos decussatus von Koenen, 1872, Phos orditus Bellardi, 1882, Phos connectens Bellardi, 1882.

Diagnosis – Shell medium-sized, fusiform, with welldeveloped sutural ramp in most species. Protoconch multispiral, of about 4.5 whorls, with 2-3 spiral cords from second protoconch whorl, axial riblets on at least part of last protoconch whorl. Teleoconch sculpture of prominent axial ribs and narrow spiral threads. Terminal varix poorly developed. Aperture lirate within outer lip. Columella with 1-2 abapical folds, weak parietal fold in some species.

Etymology – Name reflecting the geographical region in which this group of species related to *Phos* were found during the Neogene. According to Gary Rosenberg (for *Antillophos*; Malacolog), three different Greek words may be transliterated as *Phos*, one each masculine, feminine and neuter. It appears that the gender was established as masculine by Montfort who listed *Phos senticosus* as type species.

Note – Buccinum polygonum Brocchi, 1814, *Voluta cytharella* Brongniart, 1823, *Phos hoernesi* Semper, 1861, *Phos decussatus* von Koenen, 1872, *Phos orditus* Bellardi, 1882 and *Phos connectens* Bellardi, 1882 have consistently been placed in the genus *Phos* de Montfort, 1810. However, *Phos* is an exclusively Indo-West Pacific genus, characterised by shells with a smooth multispiral protoconch (Fraussen & Poppe, 2005, p. 77).

We have examined the protoconchs of four of the species listed above. In these European species the protoconch is multispiral with 2-3 spiral cords from the second protoconch whorl and axial riblets on at least part of the last protoconch whorl. In the case of *Buccinum polygonum* the protoconch also has sculpture of micropustules, clearly seen where the surface is not eroded (Figure 23/1). This type of protoconch has also been illustrated for the North Sea Basin Miocene species *P. decussatus* numerous times (Anderson, 1964, fig. 185; A.W. Janssen, 1984a, pl. 9, fig. 14; Moths *et al.*, 2010, pl. 16, fig. 2).

These protoconch characters are similar to those of the tropical American Neogene to Recent genus *Antillophos* Woodring, 1928 (Woodring, 1928, p. 259; Fraussen & Poppe, 2005, p. 81). Watters (2009, p. 233) in his generic revision of *Antillophos* described the protoconch as composed of 1.5 whorls, whereas all the species descriptions state that the protoconch has about 2.5 whorls (Watters, 2009, p. 233, 237, 239, 242, 243, 244). It is unclear how Watters measured the number of protoconch whorls, but all Caribbean *Antillophos* species in the NHMW collection have protoconchs of at least three whorls.

In teleoconch characters *Europhos* is also similar to *Antillophos*, both having reticulate sculpture and the strong abapical columellar fold/folds, characteristic of *Phos*, are also present in the European species. However, species of *Europhos* have a wide, well-defined sutural ramp, which is spinose at the shoulder angle in many species, whereas the whorls in *Antillophos* species are more regularly convex. Furthermore, the axial ribs in *Europhos* are always strongly dominant, whereas in *Antillophos* the sculpture is more evenly reticulate in most species.

We suggest that *Europhos* possibly originated in tropical America, as the earliest member of the genus, *Europhos cytharella* (Brongniart, 1823) from the Burdigalian Proto-Mediterranean of the Colli Torinesi, Italy (Brongniart, 1823; Bellardi, 1882), has the least well-developed sutural ramp, and therefore is most similar to Caribbean of *Antillophos* species. The first Caribbean records for *Antillophos* are also from the early Miocene, from the late Burdigalian Cantaure Formation of Venezuela (Jung, 1965)

The French Oligocene species *Buccinum costellatum* Grateloup, 1845, which has sometimes been placed in *Phos*, has a smooth paucispiral protoconch consisting of two whorls, its teleoconch whorls are not shouldered as in *Europhos*, the axial sculpture is finer and the spiral threads weaker than in any species of *Europhos*, and the columella is smooth. *Buccinum costellatum* was placed in the genus *Pseudoneptunea* Kobelt, 1882 by Harzhauser (2004b).

Species of *Phos* and *Antillophos* have been placed in the subfamily Photinae Gray, 1857 by most authors, but this was synonymised with Pisaniinae Gray, 1857 by Bouchet & Rocroi (2005).

Europhos polygonus (Brocchi, 1814)

Plate 25, fig. 12

- *1814 Buccinum polygonum Brocchi, p. 344, pl. 5, fig. 10.
- 1847 Nassa polygona Brocchi Michelotti, p. 207, pl. 13, fig. 2.
- 1879 *Phos polygonum* Brocchi Fontannes, p. 55, pl. 5, fig. 1.



Figure 23. Europhos polygonus (Brocchi, 1814), NHMW 2012/0197/0011, El Lobillo, Estepona Basin, Spain, Zanclean, early Pliocene; SEM showing protoconch sculpture.

- 1882 Phos polygonus (Brocch.) Bellardi, p. 8, pl. 1, fig. 5.
- 1901 Phos polygonum (Brocchi) Cossmann, p. 158, pl. 5, figs 20, 21.
- 1904 Phos polygonum var. acutespirata Sacc., Sacco, p. 58, pl. 14, figs 57-59.
- 1904 *Phos polygonum* var. *percostata* Sacc., Sacco, p. 58, pl. 14, figs 60, 61.
- ?1927 Phos polygonum (Brocchi) Peyrot, p. 228, no. 970, pl. 4, figs 31-34.
- 1939 *Phos polygonum* (Br.) Montanaro, p. 182, pl. 7, figs 16, 17.
- 1955 *Phos polygonum* (Brocchi 1814) Rossi Ronchetti, p. 202, fig. 107.
- 1958 *Phos (Phos) polygonus* (Brocchi, 1814) Beer-Bistrický, p. 45, pl. 1, fig. 4.
- 1974 Phos (Phos) polygonus (Brocchi, 1814) Malatesta, p. 308, pl. 24, fig. 10.
- 1974 Phos (Phos) polygonus (Brocchi) 1814 Caprotti, p. 27, pl. 2, fig. 3.
- 1976 *Phos (Phos) polygonus* (Brocchi, 1814) Caprotti, p. 11, pl. 15, fig. 16.
- 1978 Buccinum polygonum Brocchi, 1814 Pinna & Spezia, p. 132, pl. 10, fig. 2
- 1982a *Phos polygonum* (Brocchi, 1814) Martinell, p. 66, pl. 1, figs 5, 6.
- 1989 Phos (Phos) polygonus (Brocchi, 1814) González Delgado, p. 279, pl. 2, figs 6-7.
- 1992 *Phos polygonus* (Brocchi, 1814) Cavallo & Repetto, p. 98, fig. 223.
- 1997 Phos cf. polygonus (Brocchi) Ruiz Muñoz, p. 176, pl. 35, figs 11, 12.
- 2000 Phos polygonus (Brocchi, 1814) Chirli, p. 55 (partim, pl. 21, figs 1-7 only).
- 2010 *Phos polygonus* (Brocchi, 1814) Sosso & dell'Angelo, p. 39, p. 57, unnumbered fig. top left.
- 2011 *'Phos' polygonus* (Brocchi, 1814) Landau *et al.*, p. 24, pl. 12, fig. 2.
- non 1852 Buccinum polygonum Brocc. Hörnes, p. 160, pl. 13, figs 14, 15 [= Phos hoernesi (Semper, 1861)].
- non 1866 Buccinum polygonum Brocc. Pereira da Costa,

p. 109, pl. 15, figs 13, 14 [= *Phos connectens* (Bellardi, 1882)].

Dimensions and material – Maximum height 28.2 mm. Locality 13: RGM 794 555/1 (ex JvdV collection); locality 17: NHMW 1847/0058/0885/2.

Discussion – The protoconchs in the Karaman material are not well preserved, but are multispiral with remnants of sculpture characteristic of the European Neogene species of Europhos nov. gen. This is the oldest record for this species, along with the Serravallian occurrences in France (Peyrot, 1927), which need confirmation. It is not known from the coeval assemblages of the Paratethys, where Europhos hoernesi (Semper, 1861) is present (Bałuk, 1995). Europhos hoernesi is very similar to E. polygonus, but differs in having much finer spiral sculpture, in having whorls with a rounded rather than sharply angled shoulder, without the short spines that develop in E. polygonus, and in having a wider last whorl and a wider but shorter siphonal canal. Phos polygonum var. acarinata Peyrot, 1927, from the middle Miocene of France, is possibly a synonym of E. hoernesi, as suggested by Bałuk (1995). Similarly, Europhos orditus (Bellardi, 1882) from the Burdigalian of Italy (re-illustrated in Ferrero Mortara et al., 1981) is possibly close to or conspecific with E. semperi. Europhos decussatus (von Koenen, 1872) from the Miocene North Sea Basin is again similar to E. polygonus, but differs in having more rounded, noncarinate whorls, finer axial sculpture, and weaker spiral sculpture.

The Tortonian species *Europhos connectens* (Bellardi, 1882) differs from *E. polygonus* (Brocchi, 1814) in having a shorter spire, a wider sutural ramp, a less angular shoulder, especially on the last adult whorl, slightly more close-set spiral sculpture, a narrower aperture, and the last whorl is slightly less constricted at the base. Even on the early teleoconch whorls the shoulder is clearly placed lower in *E. connectens* than in *E. polygonus*.

Distribution – **Middle Miocene**: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Peyrot, 1927); Proto-Mediterranean Sea (Serravallian):

Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1882; Montanaro, 1939). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1989; Ruiz Muñoz, 1997; Landau *et al.*, 2011); western Mediterranean, Estepona Basin, Spain (NHMW collection), north-east Spain (Martinell, 1982a), Roussillon Basin, France (Fontannes, 1879); central Mediterranean, Italy (Bellardi, 1882; Chirli, 2000). Early-late Pliocene: central Mediterranean, Italy (Sacco, 1904; Caprotti, 1974; Malatesta, 1974; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010).

Europhos connectens (Bellardi, 1882)

Plate 25, fig. 13

- 1852 Buccinum polygonum Brocc. Hörnes, p. 160, pl.
 13, figs 14, 15 [non Europhos polygonus (Brocchi, 1814)].
- *1882 Phos connectens Bell., Bellardi, p. 8, pl. 1, fig. 5.
- 1939 *Phos polygonum* var. *connectens* Bell. Montanaro, p. 183, pl. 7, figs 18-24.
- 1958 Phos (Phos) connectens connectens Bellardi Beer-Bistrický, p. 44, pl. 1, fig. 2.
- 1981 *Phos connectens* Bellardi, 1882 Ferrero Mortara *et al.*, p. 95, pl. 19, fig. 8.

Dimensions and material – Maximum height 21.5 mm. Locality 13: RGM 794 563/1 (ex JvdV collection), RGM 783 670/1.

Discussion - Europhos connectens (Bellardi, 1882) differs from Europhos polygonus (Brocchi, 1814) in having a shorter spire, a wider sutural ramp, a less angular shoulder, especially on the last whorl, slightly more close-set spiral sculpture, a narrower aperture, and the last whorl is slightly less constricted at the base. In the Karaman assemblages *Europhos* is rare, nevertheless, specimens clearly can be ascribed to one or other species. It is possible that they represent extremes of a single species as was suggested by Chirli (2000), however, in the Pliocene assemblages visited by the authors (i.e. Guadalquivir and Estepona basins of southern Spain) we have found hundreds of specimens of the E. polygonus morphotype, but none of the E. connectens morphotype. Similarly, in the Atlantic late Miocene Tortonian of Cacela only the E. connectens form is present. Interestingly, the two forms are found to coexist only in the Karaman assemblages and the late Miocene Proto-Mediterranean of Italy. Protoconchs are not well preserved in the Karaman material, but are multispiral with remnants of sculpture characteristic of European Miocene Europhos species in both species.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Beer-Bistricky, 1958), Romania (Beer-Bistrický, 1958); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1882).

Family Nassariidae Iredale, 1916 (1835) Subfamily Nassariinae Iredale, 1916 (1835) Genus *Nassarius* Duméril, 1806

Type species – Buccinum arcularia Linnaeus, 1758, by monotypy. Recent, Indo-Pacific.

Nassarius clathratus group

Nassarius spectabilis (Nyst, 1845) Plate 21, fig. 17; Plate 64, fig. 9

- 1837 Buccinum elegans Duj., Dujardin, p. 298, pl. 20, figs 3, 10 (non J. Sowerby, 1825).
- *1845 Buccinum spectabilis Nyst, p. 577.
- 1852 *Buccinum prismaticum* Brocc. Hörnes, p. 146, pl. 12, figs 13, 14 (*non* Brocchi, 1814).
- Buccinum (a. Caesia) limatum Chemn. Hoernes & Auinger, p. 130, pl. 13, figs 2–7 (non Chemnitz, 1786).
- 1911 Nassa limata Chemnitz Friedberg, p. 88, pl. 5, figs 7, 8 (non Chemnitz, 1786).
- 1938 Nassa (Uzita) spectabilis Nyst Peyrot, p. 217, pl.
 4, figs 41, 50.
- 1952a Nassa (Uzita) spectabilis Nyst, 1843 Glibert, p. 346, pl. 10, fig. 11.
- 1958 *Hinia (Uzita) limata* (Chemnitz) Beer-Bistrický,p. 60, pl. 2, fig. 13 (*non* Chemnitz, 1786).
- 1958 Nassa (Hima) cf. incrassata (Müller) Erünal-Erentöz, p. 68, pl. 11, fig. 1 (non Müller, 1776).
- 1960 Nassa (Hinia) limata (Chemnitz 1786) Kojumdgieva & Strachimirov, p. 177, pl. 44, fig. 11 (non Chemnitz, 1786).
- 1962 Nassa (Tritia) limata Chemnitz Strausz, p. 95, pl. 37, figs 22-24 (non Chemnitz, 1786).
- 1966 Nassa (Tritia) limata Chemnitz, 1786 Strausz, p.
 312, pl. 37, figs 22-24 (non Chemnitz, 1786).
- 1968 Nassa limata Chemnitz, 1782 [sic] Zelinskaya et al., p. 194, pl. 46, figs 3, 4 (non Chemnitz, 1786).
- 1973 *Hinia (Uzita) limata* Chemnitz Steininger *et al.*,p. 424, pl. 6, fig. 11 (*non* Chemnitz, 1786).
- 1976 Nassarius spectabilis spectabilis (Nyst, 1843) Adam & Glibert, p. 41, pl. 2, fig. 4, pl. 5, fig. 10.
- 1985 *Hinia (Uzita) limata* Chemnitz Atanacković, p. 157, pl. 35, figs 9, 10 (*non* Chemnitz, 1786).
- 1993 Nassarius (Hinia) limatus (Chemnitz, 1786) Iljina, p. 91, pl. 11, fig. 29 (non Chemnitz, 1786).
- 1997 *Hinia (Uzita) limata* (Chemnitz, 1786) Bałuk, p.
 15, pl. 2, figs 1, 2 (*non* Chemnitz, 1786).
- Hinia (Uzita) clathrata (Born, 1778) Schultz, p.
 66, pl. 26, fig. 18 (non Born, 1778).
- 2003 *Nassarius limatus* (Chemnitz, 1786) Zlotnik, p. 363, fig. 3, K, L (*non* Chemnitz, 1786).
- 2004 Nassarius spectabilis (Nyst 1843) Harzhauser & Kowalke, p. 21, pl. 2, fig. 20, pl. 3, fig. 1.

Dimensions and material – Maximum height 19.8 mm. Localities 7 & 8: NHMW 1847/0058/0738/1, 1847/-0058/0739/1; locality 12: JvdV/33; locality 13: NHMW 1847/0058/0765/1, 1847/0058/0764/26, JvdV/6, RGM 794 576/1, 783 671/2; locality 17: NHMW 1847/-0058/0766/6, JvdV/4.

Discussion - Although the title page of Nyst's work is dated 1843, it was not published until 1845 (for additional data, see Anderson, 1964, p. 121). Nassarius spectabilis (Nyst, 1845) falls within the Nassarius clathratus species group. It is most similar to Nassarius prysmaticus (Brocchi, 1814) and N. limatus (Deshayes in Lamarck, 1844), but has a multispiral protoconch and so can immediately be distinguished from N. limatus, which has a low paucispiral protoconch of less than two whorls. Nassarius prysmaticus also has a multispiral protoconch, but it is more slender than that of N. spectabilis (for N. prysmaticus dp/hp = 1.03-1.36; Landau *et al.*, 2009b, p. 9). The Turkish shells have a protoconch consisting of 3.25 smooth whorls, with a small nucleus (dp = $875 \ \mu m$, hp = 960 μ m, dp/hp = 0.91, dp1 = 290 μ m, dn = 150 μ m; Pl. 64, fig. 9). A few comma-shaped axial riblets are present just before the transition to the teleoconch, which is marked by a scar and the beginning of the spiral sculpture. The teleoconch of *N. spectabilis* is smaller than that of *N*. prysmaticus, varices are present in some specimens, and there is no prominent sculpture on the inner lip (for further discussion, see Harzhauser & Kowalke, 2004, p. 21).

Distribution – Early Miocene: Paratethys (Burdigalian): Bavaria (Hölzl in Steininger et al., 1973). Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France (Peyrot, 1938; Glibert, 1952a; Adam & Glibert, 1976); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1882; Beer-Bistrický, 1958; Schultz, 1998; Harzhauser & Kowalke, 2004), Poland (Friedberg, 1911; Adam & Glibert, 1976; Bałuk, 1997; Zlotnik; 2003), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1962, 1966), Romania (Hoernes & Auinger, 1882), Ukraine (Zelinskaya et al., 1968), eastern Paratethys (Tarkhanian and Chokrakian): (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (Adam & Glibert, 1976).

Nassarius gilii nov. sp. Plate 26, figs 1, 2

Material and dimensions – Holotype NHMW 1847/-0058/0767, height 28.3 mm, width 16.4 mm; paratype 1 NHMW 1847/0058/0768, height 27.1 mm, width 16.4 mm; paratype 2 NHMW 1847/0058/0769, height 25.8 mm, width 14.6 mm; paratype 3, RGM 783 672; paratype 4 NHMW 1847/0058/1680, height 28.0 mm, width 16.8 mm.

Other material and dimensions - Maximum height

28.0 mm; locality 12: JvdV/7; locality 13: JvdV/1.

Etymology – After Dr Carles Gili, nassariid specialist at the Faculty of Geology in the University of Barcelona, Spain.

Locus typicus – South of Akpınar, Pinarlar Yaylası, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A medium-sized *Nassarius* species of the *N. clathratus* group, with a multispiral protoconch, a teleoconch consisting of somewhat depressed but strongly convex whorls, axial sculpture strongly predominant, with the last whorl squat, convex and strongly constricted at the base, bearing 12-14 axial ribs, the outer lip thick-ened by a narrow varix, and the columellar and parietal calluses hardly expanded, bearing prominent parietal and abapical folds on the columella.

Description - Shell medium-sized, robust; spire scalate, pointed; sculpture predominantly axial. Protoconch abraded, but multispiral, of three convex whorls, with a small nucleus. Teleoconch of seven to eight somewhat depressed, strongly convex whorls, with periphery just below mid-whorl. Suture superficial, undulating. Axial sculpture of 12-14 rounded, weakly prosocline ribs, each narrower than one interspace. Spiral sculpture overrides axial ribs, on early whorls consisting of four elevated, narrow cords, 12 on penultimate whorl; one cord at shoulder slightly more strongly developed, delimiting very indistinct sutural ramp. Last whorl depressed, globose, very strongly constricted at base. Aperture ovate. Outer lip thickened by narrow labral varix, somewhat flared abapically, with nine elongate lirations within, extending deep into aperture, but not extending to lip margin; anal canal well developed, rounded; siphonal canal short, open, very strongly twisted to left and recurved. Columella concave in mid-portion; adapically bearing two parietal ridges, the adapical much stronger, bordering anal canal; abapically one stout fold borders siphonal canal. Parietal callus weakly expanded, closely adherent. Columellar callus thickened, erect, in some specimens bearing weak tubercles. Siphonal fasciole not sharply delimited from base, rounded, bearing weak spiral cords.

Discussion – Nassarius gilii nov. sp. is relatively uncommon in the Karaman assemblages and is found only in the clayey deposits occurring near Akpınar. It is a very distinctive species, having very convex whorls, a globose but rather squat last whorl and the callus on the inner lip is hardly expanded over the venter. It is also one of the largest nassariids found in Karaman. These shell characters separate *N. gilii* from most of its European Neogene congeners. The most similar species is *Nassarius contractus* (Bellardi, 1882) from the late Miocene Tortonian of Italy, which differs in having more depressed spire whorls and an even squatter last whorl, and in having fewer axial ribs (eight on the penultimate whorl vs. 12-14). *Nassarius expectatus* (Bałuk, 1997) from the middle Miocene Paratethys of Poland also has a similar shell shape, but is again squatter than the Turkish species, the teleoconch consists of fewer whorls (5.5 vs. 7-8) resulting in a wider apical angle, and again it has fewer axial ribs (9-11 vs. 12-14).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Nassarius semistriatus group

Nassarius elatus gayeae (Erünal-Erentöz, 1958) Plate 26, figs 3-5; Plate 64, figs 10, 11; Plate 65, fig. 1

- 1958 Nassa (Amyclina) transitens [sic] Bellardi Erünal-Erentöz, p. 66, pl. 10, figs 11, 12 [non Bellardi, 1882 = Nassarius elatus (Gould, 1845)].
- *1958 Nassa (Uzita) gayeae Erünal-Erentöz, p. 70, pl. 11, figs 6-9.

Material and dimensions – Maximum height 13.8 mm. Localities 2 & 3: JvdV/31, RGM 783 953/6, YI 310/5; locality 6: JvdV/50+; localities 7 & 8: NHMW 1847/0058/0770/1, 1847/0058/0772/50+, JvdV/4; locality 9: JvdV/1, YI 311/2; locality 10: YI 313/1; locality 12: JvdV/1; locality 13: NHMW 1847/0058/1455/1, 1847/0058/1456/1, 1847/0058/0771/50+, JvdV/8, RGM 794 577/1, 784 035/1, RGM 783 673/50+, YI 309/50+.

Revised description - Shell small, of medium thickness, bucciniform, with elevated conical spire. Protoconch dome-shaped, consisting of 3.5 convex whorls, with small nucleus (dp = 980-890 μ m, hp = 990-840 μ m, dp/hp = 1.05-0.99, dp1 = 260-210 μ m, dn = 160-100 μ m; Pl. 64, figs 10-11; Pl. 65, fig. 1). Teleoconch commences abruptly, consisting of five weakly convex whorls, with periphery at abapical suture. Suture impressed, linear. Axial sculpture present on early to intermediate whorls, consisting of 15-17 narrow, rounded ribs, each half the width of one their interspace, weakening abapically, obsolete on penultimate and last whorls. Spiral sculpture on first whorl of six weakly developed, flattened cords with narrow interspaces, sculpture mid-whorl rapidly weakening, so that by second whorl only single adapical and one or two abapical cords clearly developed. Last whorl about 65% of total height, weakly constricted at base, with sculpture obsolete between abapical cord and just below mid-whorl, below which cords well developed, strengthening abapically. Aperture pyriform, outer lip thin, prosocline and sinuous in profile, bearing 12-15 subequal lirae within. Anal canal shallow. Siphonal canal wide, open. Columella concave in mid-portion, smooth, except for one sharp fold extending down border of siphonal canal; parietal tooth weak. Columellar callus strongly thickened, clearly delimited, expanded in parietal region, appressed over base. Siphonal fasciole small, short, rounded, separated from base by groove.

Discussion - Comparing the plentiful Pliocene material of Nassarius elatus (Gould, 1845) available to us, it is impossible to consider the Turkish middle Miocene specimens to be conspecific. The Karaman shells have more strongly developed axial sculpture, which persists far longer than in N. elatus. In subadult shells (Pl. 26, fig. 5) the sculpture is really very strong and only disappears on the second half of the last whorl. We have not been able to locate Erünal-Erentöz's material, but in our opinion, such subadult shells were described and illustrated by Erünal-Erentöz (1958, p. 70, pl. 11, figs 6-9) as Nassa (Uzita) gayeae. Without a large amount of comparative material, one could be forgiven for considering the subadult specimens a different species, however, the sculpture is identical to that of the early whorls of the large adult specimens and many intermediate shells are present.

Further comparison with N. elatus shows that not only are the axial ribs much stronger, but they are also more numerous than in N. elatus in most specimens (15-17 vs. 12-15). The protoconch morphology and dimensions are similar, as are the late teleoconch whorls after the axial sculpture has faded out. Similar changes in sculptural detail over geological time are seen in other European Neogene nassariids, such as Nassarius macrodon macrodon (Bronn, 1831) and N. macrodon recidivus (von Martens, 1876), although in this case the reverse is found; the axial sculpture persists further on the teleoconch whorls in the Recent shells. Another example is seen in the Nassarius striatulus/N. ovoideus group (see Landau et al., 2009b, p. 17). We therefore consider these Turkish shells to be a subspecies, Nassarius elatus gayeae (Erünal-Erentöz, 1958) and in view of the new combination we offer a revised description. Comments on comparisons with European congeners hold true as for N. elatus (see Landau et al., 2009b, p. 15).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Nassarius barbarossai nov. sp. Plate 26, fig. 6; Plate 65, fig. 2

Material and dimensions – Holotype NHMW 1847/-0058/1375, height 11.5 mm, paratype 1 NHMW 1847/-0058/1376, height 10.6 mm; paratype 2 NHMW 1847/0058/1720, height 11.3 mm; furthermore one specimen in YI 475, height, 11.6 mm. All from the type locality.

Other material and dimensions: Maximum height 10.0 mm. Localities 7 & 8: YI-312/2

Etymology – Named in honour of the German Holy Roman Emperor Frederick I. Barbarossa, who occupied Karaman in 1190 AD.

Locus typicus – Localities 7 & 8, Akboğazi, Lale river, Karaman Basin, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis - A small *Nassarius* species of the *N. semistriatus* group, with a very solid shell, a paucispiral protoconch of 1.25 whorls with a large nucleus, axial and spiral sculpture restricted to the first two teleoconch whorls, an aperture with a thickened lip, coarsely denticulate within, a thickened but only moderately expanded parietal callus, but with the columellar callus expanded over the base.

Description - Shell small, solid, bucciniform, with elevated conical spire. Protoconch paucispiral, of 1.25 smooth, depressed whorls, with large nucleus (dp = 715 μ m, hp = 480 μ m, dp/hp = 1.49, dp1 = 620 μ m; dn = 390 μ m; Pl. 65, fig. 2). Teleoconch commencing abruptly, of five convex whorls, with periphery at abapical suture on spire whorls. Suture impressed, linear. Axial sculpture present on early spire whorls, consisting of 15 broad, rounded ribs, each wider than one interspace, weakening abapically, obsolete on third whorl. Spiral sculpture on first whorl of seven weakly developed, flattened cords with narrow interspaces, obsolete by third whorl. Penultimate whorl without sculpture. Last whorl about 70% of total height, evenly rounded, weakly constricted at base, bearing a few weak spiral cords on base. Aperture pyriform, outer lip thickened, prosocline in profile, bearing denticles within. Denticles arranged in three groups; abapical denticles small, closest to lip edge; mid-group two, strongly developed; adapical group four, weaker and closer-set. Anal canal shallow. Siphonal canal wide, open. Columella concave in mid-portion, smooth, except for one sharp fold extending down border of siphonal canal. Columellar callus strongly thickened, clearly delimited, moderately expanded over parietal region, appressed and expanded over base. Siphonal fasciole small, short, rounded, separated from base by groove.

Discussion – Nassarius barbarossai nov. sp. is superficially similar to numerous European Neogene nassariids. In the character of its axially sculptured early teleoconch whorls it is similar to Nassarius elatus (Gould, 1845) and Nassarius elatus gayeae (Erünal-Erentöz, 1958), but these have thinner shells, a multispiral protoconch, and differ in apertural characters. Nassarius podolicus (Hoernes & Auinger, 1882) also has sculptured early whorls, but has a more stepped spire and lirae within the outer lip as opposed to well-developed denticles. We do not know the protoconch of this middle Miocene Paratethyan species (see Harzhauser & Kowalke, 2004). Nassarius solidulus (Bellardi, 1882) from the late Miocene of Italy is another species with sculpture only on the early whorls, but has quite another shell shape and aperture, with a triangular parietal callus. If we consider the very solid nature of the shell and the shape of the last two whorls, N. barbarossai is almost identical to the Pliocene to Recent species N. pfeifferi (Philippi, 1844), which also has a paucispiral protoconch, but in this species the early whorls are not sculptured.

Nassarius reticulatus group

Nassarius erunalae nov. sp.

Plate 26, figs 7, 8; Plate 65, fig. 3

Type material and dimensions – Holotype NHMW 1847/0058/1453, height 8.1 mm, localities 7 & 8; paratype 1 NHMW 1847/0058/1454, height 8.0; paratype 2 NHMW 1847/0058/1719 height 7.3 mm furthermore two specimens in YI 478, height 11.0 mm, and YI 326, height 9.0 mm, all locality 17 all from the type locality.

Etymology – Named in honour of Lütfiye Erünal-Erentöz, pioneer in Karaman Neogene molluscan work.

Locus typicus – Localities 7 & 8, Akboğazi, Lale river, Karaman Basin, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Nassarius* species of the *N. reticulatus* group, with a solid, squat shell, a multispiral protoconch, predominantly axial sculpture consisting of very close-set, broad, roundly flattened ribs, which become less numerous abapically, spiral sculpture only clearly developed over the base, and a weakly developed and expanded parietal callus.

Description - Shell small, solid, squat, bucciniform, with short conical spire. Protoconch multispiral, domeshaped, of 2.75 smooth whorls, with small nucleus (dp = 555 μ m, hp = 460 μ m, dp/hp = 1.21; Pl. 65, fig. 3). Junction with teleoconch sharply delimited. Teleoconch of five weakly convex whorls, with periphery at abapical suture on spire whorls. Suture impressed, shallowly undulating. Axial sculpture of prosocline ribs, 16 on first whorl, broadening rapidly and fewer in number abapically, separated by narrow interspaces. Spiral sculpture of six weak spiral cords developed on first whorl, spiral sculpture obsolete on second whorl. Last whorl evenly rounded, 67% of total height, constricted at base, bearing very broad, rounded ribs separated by very narrow interspaces; spiral sculpture strongly developed on base, of four spiral cords strengthening abapically. Aperture pyriform, 40 % of total height, outer lip thickened, bevelled internally, bearing eight irregular denticles within, denticles extending into aperture as lirae. Anal canal marked by rounded notch. Siphonal canal short, open, strongly recurved. Columella concave in mid-portion, bearing small parietal tooth and one to four tubercles abapically, a broad fold extending down border of siphonal canal. Columellar and parietal calluses thickened, sharply delimited, weakly expanded to form small parietal pad adapically. Siphonal fasciole clearly delimited, flattened, bearing flattened spiral cords.

Discussion – (see under Nassarius erentoezae).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Nassarius erentoezae nov. sp. Plate 26, figs 9, 10; Plate 65, fig. 4

Material and dimensions – Holotype NHMW 1847/-0058/0736, height 11.3 mm; paratype 1 NHMW 1847/0058/0737, height 9.8 mm; paratype 2 NHMW 1847/0058/1451, height 6.8 mm; paratype 3 NHMW 1847/0058/1452, height 5.7 mm; furthermore one specimen YI 479, height 10.9 mm; all from localities 7 & 8; paratype 4 NHMW 1847/0058/1718, height 8.7 mm, locality 17.

Other material and dimensions – Maximum height 9.0 mm. Localities 7 & 8: JvdV/5; locality 17: NHMW 1847/0058/1448/1, 1847/0058/1449/1, 1847/0058/1450/1, YI 325/2.

Etymology – Named in honour of Lütfiye Erünal-Erentöz, pioneer in Karaman Neogene molluscan work.

Locus typicus – Localities 7 & 8, Akboğazi, Lale river, Karaman Basin, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Nassarius* species of the *N. reticulatus* group, with a solid, squat shell, a paucispiral protoconch with fine spiral sculpture, teleoconch with predominantly axial sculpture of very close-set, broad, roundly flattened ribs, spiral sculpture only clearly developed over base, and a moderately developed and expanded parietal callus.

Description - Shell small, solid, bucciniform, with short conical spire. Protoconch depressed, paucispiral, of 1.5-1.75 smooth depressed whorls, with large nucleus (dp =825 μ m, hp = 335 μ m, dp/hp = 2.46, dp1 = 715 μ m, dn = 425 μ m; Pl. 65, fig. 4). Protoconch sculptured with very fine, close-set spiral threads. Junction with teleoconch sharply delimited. Teleoconch of four weakly convex whorls, with periphery at abapical suture on spire whorls. Suture impressed, almost linear. Axial sculpture of about 17 prosocline ribs, broadening rapidly abapically, separated by narrow interspaces. Spiral sculpture of six weak spiral cords, weakening further and flattening abapically. Last whorl evenly rounded, 69% of total height, constricted at base, bearing broad, roundly flattened ribs separated by very narrow interspaces; spiral sculpture only clearly developed on base, strengthening abapically. Aperture pyriform, outer lip thickened, bevelled internally, bearing seven coarse, irregular denticles within. Anal canal a small notch. Siphonal canal short, open, strongly recurved. Columella concave in the mid-portion, bearing one or two tubercles abapically; one broad fold extending down border of siphonal canal. Columellar and parietal calluses thickened, sharply delimited, moderately expanded to form small parietal pad adapically. Siphonal fasciole clearly delimited, flattened, bearing growth lines.

Discussion – *Nassarius erunalae* nov. sp. and *Nassarius erentoezae* nov. sp. are closely similar species, as both are rather small and squat with strongly predominant axial sculpture composed of broad flattened ribs. However, they are immediately separated by their protoconch characters. *Nassarius erunalae* has a multispiral, dome shaped protoconch, consisting of 2.75 smooth whorls, with a small nucleus, whereas *N. erentoezae* has a paucispiral protoconch, consisting of 1.5-1.75 whorls, with a medium-sized nucleus. The protoconch of *N. erentoezae* bears a fine spiral sculpture we have not seen in any other European nassariids.

Once the shells are separated according to their protoconch characters, other differences in teleoconch characters become apparent. In N. erunalae the flattened ribs are very broad and become less numerous abapically, whereas in N. erentoezae the number of ribs is roughly constant on all teleoconch whorls. The spiral sculpture on the spire whorls is weak in both species, but in N. erunalae it disappears on the second teleoconch whorl and only reappears on the base, which has fewer, broader and more prominent cords than N. erentozae. In N. erentoezae the weak spiral sculpture is visible throughout. There are also small differences in the apertural dentition and armature. The parietal callus is narrower in E. erunalae and it bears a weak parietal tooth, which is absent in N. erentoezae. Closely similar 'sister' species occurring together, only easily separable by protoconch characters, are not unknown amongst European Neogene nassariids [i.e. Nassarius semistriatus (Brocchi, 1814) and Nassarius martinelli Gili, 1992; see Gili (1992). Nassarius cuvierii (Payraudeau, 1826) and N. unifasciatus (Kiener, 1834); see Moreno & Templado (1994)].

Several species with similarly flattened axial ribs and weak spiral sculpture occur in the European Neogene. Nassarius familiaris (Bellardi, 1882) from the early Miocene Burdigalian of Italy has a more pointed spire than either of the two Turkish species, a more globose last adult whorl, a more elongate aperture with weaker dentition within, and a narrower parietal callus. Nassarius renieri (Bellardi, 1882), also from the Miocene of Italy, has a more slender shell with a very small rounded aperture. None of the Miocene French Atlantic or Paratethyan species are particularly similar. Of the Pliocene to Recent species, the Turkish shells are very similar to N. corrugatus (Brocchi, 1814) [= Nassarius cuvierii (Payraudeau, 1826); see Landau et al., 2009b, p. 26] and N. unifasciatus (Kiener, 1834), which, as mentioned above, are also separated on protoconch characters. However, the Turkish shells differ in being squatter and in having the axial ribs much better defined, especially on the last adult whorl. In N. corrugatus-N. unifasciatus the axial ribs tend to become subobsolete on the last adult whorl. Furthermore, the parietal callus of N. corrugatus-N. unifasciata is very thin, a callus glaze rather than thickened as in the Turkish species.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Nassarius poelensis (Hilber, 1879)

Plate 26, fig. 11

- *1879 Buccinum Pölense Auing. Hilber, p. 424, pl. 1, fig. 11.
- 1882 Buccinum (Tritia) Pölensis Auing. Hoernes & Auinger, p. 146, pl. 13, figs 25, 26.
- 1954 Nassa (Caesia) pölsensis [sic] Hoernes et Auinger
 Csepreghy-Meznerics, p. 42, pl. 5, figs 10, 11, 17, 18.
- 2004 Nassarius poelensis (Hilber, 1879) Harzhauser
 & Kowalke, p. 18, pl. 2, figs 7, 8.
- non 1966 Nassa (Tritia) toulai poelensis Auinger (in Hilber), 1879 Strausz, p. 319, pl. 38, figs 3, 4.

Dimensions and material – Height 12.3 mm. Localities 2 & 3: YI 323/2; localities 7 & 8: NHMW 1847/0058/1377/1; locality 17: YI 327/2 (incomplete).

Discussion - These Turkish shells have a multispiral dome-shaped protoconch composed of 2.75 smooth whorls with a small protoconch. The sculpture is very similar to that of Nassarius reticulatus (Linnaeus, 1758), the typical member of the group, in being composed of relatively broad, rounded, weakly prosocline ribs crossed by strap-like, flattened spiral cords. However, the aperture in the Karaman shell is relatively small and narrow, the outer lip is thickened, and bears coarse teeth within arranged in three groups, the central group most strongly developed. The columella is concave, with a small parietal tooth and several tubercles abapically. The columellar and parietal calluses are strongly thickened and well delimited, but poorly expanded. This is in sharp contrast with many members of the group, which have the parietal callus greatly expanded adapically [i.e. N. reticulatus, N. nitidus (Jeffreys, 1867), N. antiquus (Bellardi, 1882), N. rectus (Dollfus & Dautzenberg, 1886), N. intextus (Dujardin, 1837), N. rideli (Dollfus, 1889) amongst others]. This combination of shell characters matches the few known specimens of Nassarius poelensis (Hilber, 1879). A difference, however, is the lack of the deep pit-like interspaces between axial and spiral ribs of typical N. poelsensis. Therefore, the identification remains provisional.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Harzhauser & Kowalke, 2004), Hungary (Csepreghy-Meznerics, 1954), Poland (Hilber, 1879), Romania (Hoernes & Auinger, 1882); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Nassarius dujardini group

Nassarius coloratus (Eichwald, 1830)

Plate 26, fig. 12; Plate 65, fig. 5

- *1830 Buccinum coloratum Eichwald, p. 222.
- 1852 Buccinum reticulatum Linn. Hörnes, p. 151, pl.
 12, fig. 18 (non Linnaeus, 1758).
- 1853 Buccinum coloratum mihi Eichwald, p. 164, pl. 7, fig. 1.
- 1856 Buccinum coloratum Eich. Hörnes, p. 668, pl. 12, fig. 18.
- 1860 Buccinum Vindobonense Mayer, Mayer, p. 421, pl. 5, fig. 2.
- 1879 Buccinum Vindobonense Mayer Hilber, p. 425, pl. 1, fig. 12.
- 1882 Buccinum (Tritia) vindobonense Ch. Mayer Hoernes & Auinger, p. 145.
- 1911 Nassa colorata Eichw. Friedberg, p. 81, pl. 5, figs 1, 2.
- 1911 Nassa vindobonensis May. Friedberg, p. 83, pl. 5, fig. 3.
- 1950 Nassa (Hima) vindobonensis May. Csepreghy-Meznerics, p. 53, pl. 3, fig. 6.
- 1954 Nassa (Hima) vindobonensis Mayer Csepreghy-Meznerics, p. 43, pl. 5, figs 14, 15.
- 1958 *Hinia (Hinia) colorata colorata* (Eichwald) Beer-Bistrický, p. 53, pl. 2, fig. 10.
- 1960 Nassa (Phrontis) colorata var. vindobonensis Kojumdgieva & Strachimirov, p. 181, pl. 45, fig.
 1.
- 1962 Nassa (Phrontis) vindobonensis Mayer Strausz, p. 98, pl. 39, figs 1-5.
- 1966 Nassa (Phrontis) vindobonensis Mayer, 1860 Strausz, p. 324, pl. 39, figs 1-5.
- 1968 Nassa colorata (Eichwald, 1830) Zelinskaya et al., p. 193, pl. 45, figs 30-32.
- 1970 Nassa colorata Eichwald Bałuk, p. 118, pl. 12, figs 10, 11.
- 1981 Nassa colorata Eichwald Krach, p. 70, pl. 20, figs 9-12.
- 1982 Hinia (Hinia) vindobonensis (Mayer, 1860) Švagrovský, p. 393, pl. 3, fig. 1.
- 1985 *Hinia (Hinia) colorata vindobonensis* (Mayer, 1860) Atanacković, p. 153, pl. 34, figs 13-16.
- 1993 Nassarius (Hinia) coloratus (Eichwald, 1830) Iljina, p. 94, pl. 12, figs 16-18.
- 1998 Hinia (Hinia) colorata vindobonensis (Mayer) Schultz, p. 66, pl. 26, fig. 14, 14a.
- 2004 *Nassarius coloratus* (Eichwald 1830) Harzhauser & Kowalke, p. 17, pl. 2, fig. 5.
- 2009 Hinia (Hinia) colorata vindobonensis (Mayer, 1860) Mikuž, p. 21, pl. 5, fig. 71, pl. 6, figs 72, 73.

Dimensions and material – Maximum height 15.3 mm. Localities 2 & 3: JvdV/35, RGM 783 924/7, YI 324/4; locality 6: NHMW 1847/0058/1499/20; localities 7 & 8: NHMW 1847/0058/0773/1, 1847/0058/0774/6, JvdV/9; locality 10: YI 322/4; locality 13: RGM 783 674/1, YI 320/6; locality 17: NHMW 1847/0058/0775/20, JvdV/10, RGM 784 033/1, RGM 783 986/1, YI 321/14; locality 18: JvdV/6.

Discussion – The protoconch in the Turkish shells is dome shaped, consisting of 2.6 smooth whorls, with the teleoconch boundary sharply delimited (dp = 780 μ m, hp = 530 μ m, dp/hp = 1.47, dp1 = 230 μ m, dn = 115 μ m; Pl. 65, fig. 5).

In contrast to Harzhauser & Kowalke (2004), Mikuž (2009) treated *Nassarius pupaeformis* (Hoernes & Auinger, 1882) and *Nassarius pupaeformis palatinus* (Strausz, 1966) as synonyms of *N. coloratus*. This species differs from *N. coloratus*, however, in its much smaller size and its distinctive sculpture consisting of widely spaced spiral furrows separating broad, flat spiral bands on the last whorl. *Nassarius turgidulus* (Bellardi, 1882), from the Burdigalian of Colli Torinesi in Italy, is possibly a synonym of *N. pupaeformis*, however, we have not seen Italian material to be certain.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852, 1856; Hoernes & Auinger, 1882; Beer-Bistrický, 1958; Švagrovský, 1982; Schultz, 1998; Harzhauser & Kowalke, 2004), Poland (Friedberg, 1911; Bałuk, 1970), Hungary (Csepreghy-Meznerics, 1950, 1954; Strausz, 1962, 1966), Bulgaria (Kojumdgieva & Strachimirov, 1960), Slovenia (Mikuž, 2009), Ukraine (Zelinskaya *et al.*, 1968), eastern Paratethys (Tarkhanian-Konkian): Iljina (1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Nassarius edlaueri (Beer-Bistrický, 1958)

Plate 26, figs 13, 14; Plate 65, fig. 6

- 1852 Buccinum miocenicum Micht. Hörnes, p. 153 (partim, pl. 12, fig. 22 only) [non Michelotti, 1847 = Cyllenina ancillariaeformis (Grateloup, 1834); non fig. 20 = Cyllenina grundensis (Hoernes & Auinger, 1882), non fig. 21 = C. ancillariaeformis].
- 1879 Buccinum obliquum Hilb., Hilber, p. 427, pl. 2, fig. 3 [non Gmelin, 1791 (nomen dubium); non Kiener, 1841 = Nassarius glabratus (Sowerby, 1842)].
- 1882 Buccinum (Uzita) obliquum Hilb. Hoernes & Auinger, p. 135, pl. 13, fig. 33.
- 1911 Nassa obliqua Hilb. Friedberg, p. 79, pl. 4, figs 19, 20.
- 1950 Nassa (Uzita) obliqua Hilb. Csepreghy-Meznerics, p. 54, pl. 3, fig. 8.
- *1958 *Hinia (Hinia) edlaueri* Beer-Bistrický, p. 55, pl. 2, fig. 11.
- 1962 Nassa (Phrontis) dujardini edlaueri Beer-Bistricky – Strausz, p. 99, pl. 39, figs 17-25.
- 1966 Nassa (Phrontis) dujardini edlaueri Beer-Bistricky, 1957 [sic] – Strausz, p. 329, pl. 39, figs 17-25.
- 1967 Hinia (Hinia) edlaueri Beer-Bistricky, 1958 -

Tejkal et al., p. 202, pl. 11B, figs 6, 7.

- 1973 Nassa (Hinia) limata (Chemnitz) 1786 Bohn-Havas, p. 1055, pl. 5, figs 5, 6 (non Nassarius limatus Deshayes in Lamarck, 1844 = Buccinum limatum Chemnitz, 1786; not validated by ICZN).
- 1993 Nassarius (Phrontis) edlaueri (Beer-Bistrický, 1958) – Iljina, p. 86, pl. 11, figs 9-13.
- 2002 Sphaeronassa edlaueri (Beer-Bistrický, 1958) Harzhauser, p. 104, pl. 8, figs 5-7.
- 2004 Nassarius edlaueri (Beer-Bistrický 1958) Harzhauser & Kowalke, p. 25, pl. 3, figs 13, 14.
- 2011 *Nassarius edlaueri* (Beer-Bistrický, 1958) Harzhauser & Cernohorsky, p. 32.
- 2012 Nassarius (Nassarius) edlaueri (Beer-Bistrický 1958) – d'Amico et al., p. 167, pl. 2, fig. 26-27.

Dimensions and material – Maximum height 13.0 mm. Locality 6: JvdV/1; locality 11: JvdV/50+, RGM 794 038/50+; locality 13: YI 307/2; locality 17: NHMW 1847/0058/0776/1, 1847/0058/0777/1, 1847/0058/0778/41, JvdV/34, RGM 794 578/1, RGM 783 985/16; YI 308/28; locality 17a: NHMW 1847/0058/1592/25.

Discussion – Nassarius edlaueri (Beer-Bistrický, 1958) differs from Nassarius schoenni (Hoernes & Auinger, 1882) in having a higher spire, in the absence (or almost so) of spiral sculpture on the early teleoconch whorls and its less inflated last whorl. Harzhauser & Kowalke (2002) discussed the possibility that N. edlaueri was just a form of N. schoenni. The Turkish specimens are closer to the N. edlaueri morphotype than to N. schoenni, and we therefore prefer to consider them to be distinct species. The axial ribs of the Karaman shells are extremely variable, ranging from well-developed in some specimens to absent in others. The protoconch is similar to that reported by Harzhauser & Kowalke (2004), consisting of 2.25-2.5 smooth whorls with a medium-sized nucleus (dp = 695 μ m, hp = 680 μ m, dp/hp = 1.02, dp1 = 380 μ m, dn $= 225 \ \mu m$; Pl. 65, fig. 6).

Distribution – **Early Miocene**: Paratethys (Burdigalian): Austria (Harzhauser, 2002). **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1882; Beer-Bistrický, 1958; Tejkal *et al.*, 1967; Harzhauser & Kowalke, 2004), Hungary (Strausz, 1962, 1966; Bohn-Havas, 1973; Harzhauser & Kowalke, 2004), Poland (Friedberg, 1911; Harzhauser & Kowalke, 2004), eastern Paratethys (Tarkhanian to Konkian): (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (d'Amico *et al.*, 2012).

Nassarius schoenni (Hoernes & Auinger, 1882) Plate 26, fig. 15; Plate 27, fig. 1

1837 Nassa laevigata m., Pusch, p. 122, pl. 11, fig. 8 (nomen oblitum).

- 1852 Buccinum mutabile Linn. Hörnes, p. 154 (partim, pl. 13, fig. 1 only) [non Nassarius mutabilis (Linnaeus, 1758)].
- 1856 Buccinum Dujardini Desh. Hörnes, p. 668 (partim, pl. 13, fig. 1 only) [non Nassarius dujardini (Deshayes, 1844)].
- *1882 Buccinum (Niotha) Schönni Hoernes & Auinger, p. 125, pl. 15, figs 18-20.
- 1882 Buccinum (Niotha) Telleri Hoernes & Auinger, p. 125, pl. 15, fig. 11.
- 1911 Nassa Schönni R. Hoern. i Auing. Friedberg, p. 78, pl. 4, figs 16-18.
- 1952a Nassa schoenni (R. Hoernes et M. Auinger, 1882) - Glibert, p. 335, pl. 9, fig. 10.
- 1954 Nassa (Arcularia) schönni H. et Au. Strausz, p. 28, 108, pl. 4, figs 16-18.
- 1958 *Hinia (Hinia) coarctata telleri* Beer-Bistrický, p. 56, pl. 2, fig. 12.
- 1958 Nassa schönni Hoern. Jovanović & Dolić, p. 96, pl. 1, figs 10, 11.
- 1962 Nassa (Phrontis) dujardini schönni Hoernes & Auinger Strausz, p. 99, pl. 39, figs 26-33.
- ?1963 Nassarius (Nassarius) schoenni (Hoernes-Auinger) Venzo & Pelosio, p. 101, pl. 36, figs 1, 2.
- 1966 Nassa (Phrontis) dujardini schönni Hoernes & Auinger, 1882 Strausz, p. 329, pl. 39, figs 26-33.
- 1967 Arcularia (Arcularia) schoenni (R. Hoernes et Auinger, 1882) Tejkal et al., p. 202, pl. 11B, fig. 11.
- 1968 Nassarius (Nassarius) schönni (Hoernes & Auinger, 1879) Hinculov, p. 143, pl. 35, figs 12, 13.
- 1970 Nassa schoenni schoenni (R. Hörnes & Auinger) Bałuk, p. 118, pl. 12, fig. 13.
- 1973 Nassa (Arcularia) schönni (Hoernes et Auinger)
 1879 [sic] Bohn-Havas, p. 1054, pl. 5, figs 7, 8.
- 1978 Nassa (Phrontis) dujardini schönni Hoernes & Auinger, 1882 – Calzada-Badia et al., p. 116, pl. 1, fig. 2.
- 1982 Nassarius (Phrontis) dujardini dujardini (Deshayes, 1844) Švagrovský, p. 391, pl. 2, fig. 5 [non Nassarius dujardini (Deshayes, 1844)].
- 1985 Nassarius (Phrontis) dujardini schöni [sic] Atanacković, p. 151, pl. 34, figs 3-6.
- 1996 Sphaeronassa schoenni (Hoernes & Auinger) Bałuk & Radwansky, p. 292, pl. 1, fig. 1.
- 1997 Sphaeronassa schoenni (Hoernes & Auinger, 1882) – Bałuk, p. 7, pl. 1, figs 1–3.
- 1978 Nassa (Phrontis) dujardini schönni Hoernes & Auinger, 1882 – Calzada-Badia et al., p. 116, pl. 1, fig. 2.
- 2002 Sphaeronassa schoenni (Hörnes [sic] & Auinger, 1882) – Harzhauser, p. 103, pl. 8, fig. 4.
- 2003 Nassarius schoenni (Hoernes & Auinger) Złotnik, p. 363, fig. 3, C-D
- 2004 Nassarius schoenni (Hoernes & Auinger, 1882) Harzhauser & Kowalke, p. 25, pl. 3, figs 11, 12.
- 2009 Sphaeronassa schoenni (R. Hoernes & Auinger, 1882) – Mikuž, p. 21, pl. 5, figs 66-68.

Dimensions and material – Maximum height 11.7 mm. Locality 18: NHMW 1847/0058/1462/1, JvdV/1, RGM 776 932/1 (ex JvdV collection).

Discussion - This species is widely accepted as Nassarius schoenni (Hoernes & Auinger, 1882) (see Bałuk, 1997; Harzhauser & Kowalke, 2004). Nevertheless, the first available name for this species is Nassa laevigata Pusch, 1837, which referred to a subadult shell that lacks denticles in the inner lip, from the Polish locality of Korytnica. Bałuk (1997) revised this fauna and stated that N. laevigata and N. schoenni are conspecific, without giving Pusch's name priority. For the sake of stability we would greatly appreciate to declare Nassa laevigata a nomen oblitum and Buccinum (Niotha) Schönni a nomen protectum. ICZN Article 23.9.1.2. states that that to be designated as a nomen protectum 'the junior homonym must have been used as its presumed valid name in at least 25 works, published by at least 10 authors in the immediately preceding 50 years and encompassing a span of not less than 10 years'. This is an easy task for N. schoenni, which has been mentioned frequently in various geological and stratigraphical papers, not listed in the synonymy above (e.g.: Mariani & Papp, 1966; Martinell et al., 1982a; Harzhauser et al., 2003; Latal et al., 2006; Zuschin et al., 2004b, 2006; Kern et al., 2010). The problem, however, might be ICZN Article 23.9.1.1. ('the senior homonym has not been used as a valid name after 1899")', which would be obligatory to declare Nassa laevigata a nomen oblitum.

Cernohorsky (1984, p. 138), when discussing the Recent *Nassa laevigata* Marrat, 1877 [= *Nassarius bicallosus* (Smith, 1876)], referred to *Nassa laevigata* Pusch, 1837 as an available taxon. Similarly, Bałuk, 1997, used the name as available taxon although his intention was a different one. Neither of these authors, however, considered Pusch's name *Nassa laevigata* to be the valid name of a species, which allows us to declare *Nassarius schoenni* a *nomen protectum* and *Nassarius laevigatus* a *nomen oblitum*.

Nassarius schoenni (Hoernes & Auinger, 1882) is a very distinctive nassariid and was fully described by Harzhauser & Kowalke (2004, p. 25). The protoconch, which is well preserved in one of the Turkish shells, is exactly as described by Harzhauser & Kowalke (2004), except that the junction with the teleoconch is well delimited by the beginning of axial sculpture.

As discussed by Harzhauser & Kowalke (2004, p. 25), *Nassarius schoenni* is similar to *N. dujardini* (Deshayes, 1844), but differs in having a squatter shell with a lower spire and *N. schoenni* has a bulgy shoulder on the last whorl, giving it a subquadrate shell, whereas the last whorl in *N. dujardini* is rounded. The two have always been considered to co-occur in the middle Miocene Paratethys (see Harzhauser & Kowalke, 2004). However, the two populations are not conspecific. According to Glibert (1952a, p. 335) French specimens have a paucispiral protoconch whereas those from the Paratethys have a multispiral protoconch (Harzhauser & Kowalke, 2004, p. 25). We (BL) have checked this distinction and indeed

found that specimens from the Atlantic middle Miocene Langhian of Pauvrelay, France have a paucispiral protoconch consisting of 1.5 whorls with a large nucleus (typically non-planktotrophic), whereas specimens from the Korytnica Clay of Poland have a multispiral protoconch of 2.5-3 whorls with a small nucleus (typically planktotrophic). In his original description Deshayes (1844, p. 212) included both material from the Touraine of France [referring to shells described as Buccinum callosum Dujardin (1838, p. 88, pl. 20, figs 5 and 7, non Wood, 1828)] and the Paratethys (Nassa laevigata Pusch, p. 122, pl. 11, fig. 8). We here restrict the name to the French Miocene specimens with a paucispiral protoconch. The name Nassarius longitesta Beer-Bistrický, 1958 is available for the Paratethyan shells with a multispiral protoconch. Nassarius schoenni was recorded by Venzo & Pelosio (1963, pl. 36, figs 1, 2) from the late Miocene Messinian of Italy. The specimens they illustrated are in very poor condition and the species has not subsequently been recorded from the Italian Neogene. In view of the importance of the protoconch morphology to be certain of the specific identification, we provisionally exclude this reference from the distribution.

Nassarius schoenni is very uncommon in Karaman and found only in the somewhat brackish assemblage from the hillsides east of Tarlaören.

Distribution – Early Miocene: Paratethys (Burdigalian): Austria (Harzhauser, 2002), Hungary (Kókay in Steininger et al., 1973); Proto-Mediterranean Sea (Burdigalian): Spain (Calzada-Badia et al., 1978). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852, 1856; Hoernes & Auinger, 1882; Beer-Bistrický, 1958; Tejkal et al., 1967; Svagrovský, 1982; Harzhauser & Kowalke, 2004), Hungary (Strausz, 1954, 1962, 1966; Bohn-Havas, 1973; Harzhauser & Kowalke, 2004), Poland (Friedberg, 1911; Bałuk, 1970, 1997; Bałuk & Radwansky, 1996), Romania (Hoernes & Auinger, 1882; Hinkuloc, 1968; Nicorici & Sagatovici, 1973), Bosnia (Atanacković, 1985), Slovenia (Mikuž, 2009), Serbia (Jovanović & Dolić, 1958); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Nassarius doliolum (Eichwald, 1830)

Plate 27, figs 2, 3; Plate 65, fig. 7

- *1830 Nassa doliolum Eichwald, p. 223.
- 1831 Buccinum obliquatum Dubois de Montpereux, p. 26, pl. 1, figs 6, 7.
- 1833 Nassa bistriatum Andrzejowski, p. 439, pl. 13, fig.4.
- 1848 Buccinum Rosthornis 'Partsch', Hörnes in Cžjžek, p. 17, nr. 151.
- 1852 Buccinum Rosthorni Partsch Hörnes, p. 140, pl. 12, figs 4, 5.
- 1853 Buccinum doliolum mihi Eichwald, p. 168, pl. 7, fig. 5a, b.
- 1879 Buccinum collare Hilb., Hilber, p. 422, pl. 1, fig. 6.

- 1882 Buccinum (Tritia) Rosthorni Partsch Hoernes & Auinger, p. 140.
- 1882 Buccinum (Tritia) collare Hilb. Hoernes & Auinger, p. 141, pl. 13, figs 8, 9.
- 1911 Nassa Rosthorni Partsch Friedberg, p. 64, pl. 4, figs 1, 2.
- 1950 Nassa rosthorni Csepreghy-Meznerics, p. 51, pl. 3, fig. 4.
- 1958 *Hinia (Uzita) rosthorni rosthorni* (Partsch) Beer-Bistrický, p. 61, pl. 2, fig. 14.
- 1958 Nassa (Nassa) subventricosa Cossmann et Peyrot – Erünal-Erentöz, p. 61, pl. 10, figs 3-5.
- 1958 Nassa (Nassa) subventricosa mut. bifida Cossm. et Peyrot – Erünal-Erentöz, p. 63, pl. 10, fig. 6.
- 1960 Nassa (Uzita) rosthorni (Partsch in Hoernes 1856)
 Kojumdgieva & Strachimirov, p. 180, pl. 44, fig. 19.
- 1962 Nassa (Tritia) rosthorni Partsch Strausz, p. 97, pl. 38, figs 27-31.
- 1966 Nassa (Tritia) rosthorni Partsch (in Hauer et in Hörnes), (1837) 1856 – Strausz, p. 321, pl. 38, figs 27-31.
- 1968 Nassa rosthorni (Partsch in M. Hoernes, 1856) Zelinskaya et al., p. 196, pl. 46, figs 16, 17.
- 1969 Nassa (Uzita) rosthorni (Partsch in Hörnes) Atanacković, p. 205, pl. 10, figs 12-15.
- 1973 Nassa rosthorni (Partsch in Hörnes) 1856 Bohn-Havas, p. 1055, pl. 5, figs 1, 2.
- 1981 Nassarius (Uzita) cf. rosthorni (M. Hoernes, 1856) – Švagrovský, p. 148, pl. 47, fig. 6.
- 1982 Nassarius (Nassarius) rosthorni (Partsch in Hörnes, 1856) Švagrovský, p. 391, pl. 2, fig. 4.
- 1985 *Hinia (Uzita) rosthorni* (Partsch *in* Hörnes, 1856) – Atanacković, p. 154, pl. 35, figs 3-6.
- 1997 *Hinia* (?*Uzita*) rosthorni (Partsch in Hörnes, 1856)
 Bałuk, p. 17, pl. 1, figs 9-12.
- 1998 Hinia (Uzita) rosthorni (Partsch) Schultz, p. 66, pl. 26, fig. 16.
- 2003 Hinia rosthorni (Partsch in Hörnes) Mikuž, p.
 308, pl. 10, fig. 25 (not seen).
- 2004 *Nassarius doliolum* (Eichwald 1830) Harzhauser & Kowalke, p. 16, pl. 2, figs 1, 3.
- 2007 *Nassarius rosthorni* (Partsch *in* Hörnes) Fözy & Szente, p. 296, fig. 2 (not seen).
- 2009 *Hinia (Uzita) rosthorni* (Partsch *in* Hörnes, 1856) – Mikuž, p. 22, pl. 6, figs 74-76.

Dimensions and material – Maximum height 37.2 mm. Localities 2 & 3: JvdV/50+, RGM 783 937/9, YI 299/16; locality 6: NHMW 1847/0058/1496/17, JvdV/6, RGM 783 858/2; localities 7 & 8: JvdV/2; locality 9: RGM 783 829/7; locality 10: YI 300/6; locality 12: JvdV/17; locality 13: NHMW 1847/0058/0891/1, 1847/0058/0892/1, 1847/0058/0893/28, JvdV/24, RGM 783 675/33, YI 300/50+; locality 17: NHMW 1847/0058/0893/25, JvdV/24, RGM 776 847/1 (ex JvdV collection), RGM 783 784/11, YI 301/38. Exact locality unknown: AÜ LE-K-222/2.
Nassarius doliolum (Eichwald, 1830) forma tonsura (Hilber, 1897)

Plate 25, figs 14-16

- 1879 Buccinum übergang von collare zu tonsura Hilb., Hilber, p. 423, pl. 1, fig. 7.
- *1879 *Buccinum tonsura* Hilb., Hilber, p. 423, pl. 1, fig. 8.
- 1882 Buccinum (Tritia) Hilberi Hoernes & Auinger, p. 141, pl. 13, figs 10, 11.
- 1882 Buccinum (Tritia) tonsura Hilb. Hoernes & Auinger, p. 142, pl. 13, fig. 16.
- 1954 Nassa tonsura Hilber Csepreghy-Meznerics, p. 41, pl. 5, fig. 23.
- 1960 Nassa (Uzita) rosthorni var. hilberi (Hoernes und Auinger) – Kojumdgieva & Strachimirov, p. 180, pl. 44, fig. 20.
- 1968 Nassarius (Uzita) rosthorni tonsura (Hilber) Hinkulov, p. 145, pl. 36, figs 2-4.
- 2004 *Nassarius doliolum* (Eichwald 1830) Harzhauser & Kowalke, p. 16, pl. 2, fig. 2.
- 2006 Nassarius tonsura (Hilber, 1879) Bałuk, p. 212, pl. 15, figs 1, 2.

Dimensions and material – Maximum height 22.1 mm. Localities 2 & 3: YI 328/1; locality 10: YI 303/1; locality 17: NHMW 1847/0058/0732-1847/0058/0734/3, 1847/0058/0732/38, JvdV/9, RGM 783 785/1, RGM 783 248/1, YI 304/7.

Discussion – The *Nassarius doliolum/collare/hilberi/ tonsura* species complex was discussed by Harzhauser & Kowalke (2004, p. 16), who concluded that they represent a single polymorphic species. The forms *hilberi/tonsura* differ from *doliolum/collare* in having sinuous axial rugae on the last whorl.

Within the Turkish populations both of these morphotypes are distinguished, and whilst some shells seem to be intermediate, most specimens can be placed fairly easily within one or the other group. The protoconch is the same in both morphotypes, high dome-shaped, consisting of three smooth elevated whorls, with a small nucleus and the teleoconch boundary sharply delimited (dp = 710 μ m, hp = 810 μ m, dp/hp = 0.88, dp1 = 300 μ m, dn = 145 μ m, doliolum morphotype; Pl. 65, fig. 7).

We accept the position taken by Harzhauser & Kowalke (2004) and record both morphotypes in the Turkish middle Miocene, referring to the rugose shells by the informal rank 'forma *tonsura* (Hilber, 1897)'. For further discussion see Harzhauser & Kowalke (2004, p. 16).

Nassarius toulai (Hilber, 1879), also from the middle Miocene Paratethys of Poland, is similar to *N. doliolum* (Eichwald, 1830) forma *tonsura*, but differs in being smaller, in having a more developed and more widely expanded parietal callus and in having coarser denticles within the outer lip.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1879; Beer-Bistrický, 1958; Svagrovský, 1981, 1982; Schultz, 1998; Harzhauser & Kowalke, 2004), Hungary (Strausz, 1962, 1966; Bohn-Havas, 1973), Poland (Friedberg, 1911; Bałuk, 1997), Romania (Hoernes & Auinger, 1879), Bosnia (Atanacković, 1969; 1985), Bulgaria (Kojumdgieva & Strachimirov, 1960), Slovenia (Mikuž, 2003, 2009), Ukraine (Zelinskaya *et al.*, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Nassarius incrassatus group

Nassarius asperulus (Brocchi, 1814) Plate 27, fig. 4; Plate 65, fig. 8

- *1814 Buccinum asperulum, Brocchi, p. 339, pl. 5, fig. 8.
 2009b Nassarius asperulus (Brocchi, 1814) Landau et al., p. 34, pl. 7, figs 1-3, pl. 18, fig. 2 (with additional synonyms).
- 2011 Nassarius asperulus (Brocchi, 1814) Landau et al., p. 26, pl. 12, fig. 14 (with additional synonyms).

Dimensions and material – Maximum height 10.6 mm. Localities 2 & 3: YI 314/1; locality 17: NHMW 1847/0058/0746/6, JvdV/2, RGM 776 923/1 (ex JvdV collection), RGM 794 579/1.

Discussion –This is the first record of *Nassarius asperulus* (Brocchi, 1814) in the Miocene. The protoconch in the Turkish shells is dome-shaped, consisting of 3.25 smooth, convex whorls, with a small nucleus. Its dimensions (dp = 800 μ m, hp = 715 μ m, dp/hp = 1.12, dp1 = 210 μ m, dn = 95 μ m; Pl. 65, fig. 8) fit well within the ranges given by Landau *et al.* (2009b, p. 35) for Pliocene shells. The teleoconch boundary is delimited by the beginning of the spiral sculpture (for further discussion see Landau *et al.*, 2009b, p. 35).

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: northeastern Atlantic, Guadalquivir Basin (González Delgado, 1989; Gili, 1991; Landau *et al.*, 2011); western Mediterranean, Estepona Basin, Spain (Landau *et al.*, 2009b); central Mediterranean, Italy (Bellardi, 1882; Chirli, 2000). Early-late Pliocene: western Mediterranean, Alpes Maritimes, France (Chirli & Richard, 2008); central Mediterranean, Italy (Bellardi, 1882; Sacco, 1904; Ruggieri *et al.*, 1959; Cavallo & Repetto, 1992). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1911).

Nassarius serraticosta group

Nassarius serraticosta (Hörnes, 1852) Plate 27, fig. 5; Plate 66, fig. 1

> 1831 Buccinum serraticosta, Bronn, p. 23 (nomen nudum).

- *1852 Buccinum serraticosta Bronn Hörnes, p. 147, pl. 12, fig. 15.
- 1958 *Hinia* (*Uzita*) serraticosta (Bronn) Beer-Bistrický, p. 72, pl. 2, fig. 15.
- 1968 Nassa serraticosta (Bronn, 1831) Zelinskaya et al., p. 196, pl. 46, fig. 22.
- 1973 Nassa (Uzita) serraticosta (Bronn) 1831 Bohn-Havas, p. 1056, pl. 5, figs 10, 11.
- 1985 Hinia (Uzita) serraticosta Bronn Atanacković, p. 155, pl. 34, figs 19, 20.
- 1993 Nassarius (Hinia) serraticosta serraticosta (Bronn, 1831) – Iljina, p. 93, pl. 12, figs 4, 5.
- 2004 Nassarius serraticosta (Hörnes 1852) Harzhauser & Kowalke, p. 23, pl. 3, figs 4-6, pl. 6, figs 1, 2.
- 2009b Nassarius serraticosta (Bronn, 1831) Landau et al., p. 41, pl. 8, figs 8-11, pl. 19, fig. 2 (with additional synonyms).
- 2011 Nassarius serraticosta (Bronn, 1831) Landau et al., p. 26, pl. 13, fig. 2 (with additional synonyms).

Dimensions and material – Maximum height 6.4 mm. Localities 2 & 3: JvdV/1; locality 6: JvdV/1; localities 7 & 8: NHMW 1847/0058/0745/1; locality 13: NHMW 1847/0058/0743/2, YI 331/3; locality 17: NHMW 1847/0058/0744/6, JvdV/4, RGM 776 926/1 (ex JvdV collection), RGM 794 580/1.

Discussion – Bronn (1831) is usually referred to as the author of this species, however, he mentioned only the name without giving any diagnosis or description, so his name is a *nomen nudum*. Therefore, the authorship passes to Hörnes (1852) (see Harzhauser & Kowalke, 2004).

The protoconch in the Turkish shells is dome-shaped, consisting of 3.25 smooth, convex whorls, with a small nucleus. Its dimensions (dp = 735 μ m, hp = 705 μ m, dp/hp = 1.04, dpl = 145 μ m, dn = 65 μ m; Pl. 66, fig. 1) fit well within the ranges given by Landau *et al.* (2009b, p. 41) for Pliocene shells. The teleoconch boundary is delimited by the beginning of the spiral sculpture (for further discussion see Landau *et al.*, 2009b, p. 41).

Distribution - Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Peyrot, 1925). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (van Voorthuysen, 1944), Germany (Sorgenfrei, 1958; A.W. Janssen, 1972; Mostafavi, 1978; Wienrich, 2001). Middle Miocene: Proto-Mediterranean Sea (Burdigalian-Langhian): Colli Torinesi, Italy (Bellardi, 1882); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Beer-Bistrický, 1958; Harzhauser & Kowalke, 2004), Hungary (Strausz, 1966; Bohn-Havas, 1973; Harzhauser & Kowalke, 2004), Poland (Friedberg, 1928; Bałuk, 1997), Bosnia (Atanacković, 1985; Harzhauser & Kowalke, 2004), eastern Paratethys (Zelinskaya et al., 1968; Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, Italy (Bellardi, 1882; Montanaro, 1939; Venzo & Pelosio, 1963). Early Pliocene: northeastern Atlantic, Guadalquivir Basin (González Delgado, 1989; Landau *et al.*, 2011); western Mediterranean, Estepona Basin, Spain (Landau *et al.*, 2009b), northeast Spain (Almera & Bofill, 1898; Martinell, 1982a; Martinell & Domènech, 1985; Gili, 1991), Roussillon Basin, France (Fontannes, 1879; Gili, 1991); central Mediterranean, Italy (Bellardi, 1882; Caprotti, 1974; Chirli, 2000). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); western Mediterranean, Alpes Maritimes, France (Gili, 1991; Chirli & Richard, 2008); central Mediterranean, Italy (Bellardi, 1882; Ruggieri *et al.*, 1959; Malatesta, 1974; Cavallo & Repetto, 1992). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1911).

Nassarius pseudoserrulus nov. sp.

Plate 27, figs 6, 7; Plate 66, fig. 2

Material and dimensions – Holotype NHMW 1847/-0058/0730, height, 7.4 mm; paratype 1 NHMW 1847/0058/0731, height 7.3 mm; paratype 2 NHMW 1847/0058/1374, height 7.2 mm; paratype 3 NHMW 1847/0058/1565, height 6.6 mm; paratype 4 NHMW 1847/0058/1566, height 7.4 mm; furthermore one specimen in YI/470, height 7.4 mm. All from the type locality

Etymology – Name reflecting close affinity to *Nassarius serrulus* (Bellardi, 1882).

Locus typicus – Locality 13, Pınarlar Yaylası, Akpınar, Karaman Basin, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Nassarius* species with a pointed, multispiral protoconch, four shouldered teleoconch whorls with a well-developed, narrow sutural ramp, predominantly axial sculpture, with spiral and axial elements narrow, the cords subobsolete between the ribs, and an ovate aperture, denticulate within.

Description - Shell small, of medium thickness. Protoconch pointed dome-shaped, of 3.75 smooth convex whorls, with a small nucleus (dp = 1032 μ m, hp = 945 μ m, dp/hp = 1.09, dp1 = 185 μ m, dn = 105 μ m; Pl. 66, fig. 2). Last half protoconch whorl bearing 4-5 opisthocyrt riblets. Junction with teleoconch marked by appearance of spiral sculpture. Teleoconch of four convex, shouldered whorls, with periphery at mid-whorl. Sutural ramp well-developed, but narrowing abapically. Suture impressed. Axial sculpture of 9-10 prominent, elevated, relatively narrow, rounded, orthocline ribs, each about one third the width of one interspace. Spiral sculpture overrides axial ribs, of narrow rounded cords separated by broad interspaces, four on first teleoconch whorl, increasing abapically to 9-10 on the last whorl. Cords subobsolete in interspaces between ribs. Aperture ovate, outer lip rounded, thickened by moderate labral varix, denticulate within, slightly flared abapically. Columella narrowly calloused, devoid of folds or parietal tooth. Anal canal weak; siphonal canal short, open, strongly recurved; siphonal fasciole with 5-6 narrow spiral cords.

Discussion – These Turkish shells are similar to the Pliocene Mediterranean species *Nassarius serrulus* (Bellardi, 1882), but differ in having a less scalate spire, a steeper subsutural ramp and more numerous axial ribs. The protoconch in the Turkish shells is markedly pointed dome-shaped, consisting of 3.75 smooth convex whorls. The number of whorls is similar to that in *N. serrulus*, but the protoconch is taller and more pointed than that figured for *N. serrulus* by Landau *et al.* (2009b, pl. 20, fig. 4).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Nassarius granularis (Borson, 1820)

Plate 27, fig. 8; Plate 66, fig. 3

- 1814 Buccinum verrucosum L. Brocchi, p. 650 (non Bruguière, 1798).
- *1820 Nassa Granularis nobis, Borson, p. 219.
- 1847 Nassa granularis Borson Michelotti, p. 213, pl. 13, fig. 4.
- 1882 Nassa verrucosa (Brocch.) Bellardi, p. 115, pl.
 7, figs 17, 18.
- 1904 Nassa verrucosa var. minutepercostata Sacc., Sacco, p. 68, pl. 16, fig. 18.
- 1939 Nassa (Hima) verrucosa Br. Montanaro, p. 124, pl. 9, figs 1, 2.

Dimensions and material – Maximum height 8.6 mm. Locality 13: NHMW 1847/0058/0905/1.

Discussion – We ascribe a single shell to Nassarius granularis (Borson, 1820). As the name would suggest, the shell is characterised by its very granular sculpture, with small but strong tubercules developed at the sculptural intersections. This species is similar to the Pliocene Mediterranean species Nassarius quadriserialis (Bellardi, 1882), but differs in having a wider shell, the whorls are more convex and the base is more constricted. Moreover, the axial ribs are clearly prosocline in *N. quadriserialis*, whereas in *N. granularis* they are orthocline. The protoconch in the Turkish shells is dome-shaped, consisting of 3.5 smooth convex whorls, with a small nucleus (dp = 970 μ m, hp = 900 μ m, dp/hp = 1.07, dp1 = 250 μ m, dn = 130 μ m; Pl. 66, fig. 3)

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1882; Montanaro, 1939). *Nassarius intersulcatus* (Hilber, 1879) Plate 27, fig. 9; Plate 66, fig. 4

- *1879 Buccinum intersulcatum Hilb., Hilber, p. 12, pl. 2, fig. 2.
- 1882 Buccinum (Hima) intersulcatum Hilber Hoernes & Auinger, p. 137, pl. 15, fig. 22.
- 1966 Hinia (Uzita) intersulcata (Hilb.) Kókay, p. 61, pl. 8, fig. 23.
- 1997 Hinia (Hinia) styriaca (Auinger in Hilber, 1879)
 Bałuk, p. 11 (partim, pl. 4, figs 2, 3 only) (non Buccinum styriacum Hilber, 1879).

Dimensions and material – Maximum height 6.2 mm. Localities 2 & 3: JvdV/3), YI 329/1; locality 6: JvdV/1; locality 17: NHMW 1847/0058/1468/1, 1847/0058/1469/5, JvdV/6, RGM 784 034/1, 783 168/8, YI 330/1.

Discussion – This species is similar to the Paratethyan middle Miocene species *Nassarius styriacus* (Hilber, 1879), from which it differs in its elongate shell, the convex spire whorls and the higher number of axial ribs. As pointed out by Harzhauser & Kowalke (2004) it is also characterised by a faint spiral incision close to the posterior suture, which is absent in *N. styriacus*.

The protoconch of the Karaman shells is dome-shaped, consisting of 2.8-3.0 whorls (dp = 630 μ m, hp = 500 μ m, dp/hp = 1.26, dp1 = 210 μ m, dn = 90 μ m; Pl. 66, fig. 4), similar to that of the probably related species *Nassarius styriacus*, figured by Harzhauser & Kowalke (2004, pl. 6, figs 10-12).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Styrian Basin, Austria (Hoernes & Auinger, 1882; Harzhauser & Kowalke, 2004), Hungary (Kókay, 1966), Poland (Bałuk, 1997); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Nassarius mutabilis group

Nassarius pascaleae nov. sp. Plate 27, figs 10-14

Type material and dimensions – Holotype NHMW 1847/0058/0898, height 18.8 mm, locality 13; paratype 1 NHMW 1847/0058/0900, height 22.6, locality 17; paratype 2 NHMW 1847/0058/0901, height 20.0, locality 17; paratype 3 NHMW 1847/0058/0971, height 24.3, locality 17; paratype 4 NHMW 1847/0058/0972, height 21.3, locality 17; paratype 5 NHMW 1847/0058/1267, height 20.7, locality 13.

Etymology – Named after Pascale Paques, partner of the senior author.

Locus typicus – Locality 13, Pınarlar Yaylası, Akpınar, Karaman Basin, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Other material and dimensions – Maximum height 24.7 mm. Localities 7 & 8: JvdV/5; locality 10: YI 317/1; locality 12: JvdV/1; locality 13: NHMW 1847/0058/0899/1; locality 17: NHMW 1847/0058/0902/8, JvdV/4, YI 306/3; YI 480/1, YI 481/1.

Diagnosis – A medium-sized *Nassarius* species of the *N. mutabilis* group, with a relatively solid shell, a multispiral protoconch, weak spiral sculpture consisting of fine close-set cords covering most of the teleoconch, no axial sculpture, one broad varix per later adult whorl, an aperture with short lirae within the outer lip and a moderately thickened and expanded parietal callus.

Description - Shell of medium size and thickness, ovate; spire tall, conical; last teleoconch whorl moderately inflated. Protoconch tall dome-shaped, consisting of about three whorls, with a small nucleus. Teleoconch of five convex whorls, with periphery at or just above abapical suture on spire. Suture superficial, linear. Spiral sculpture of fine, irregular, flattened spiral cords separated by narrow grooves. Axial sculpture absent. One prominent broad varix per whorl developed on later whorls. Last whorl moderately globose, 67-70% of total height, evenly convex, weakly constricted at base. Aperture 43-45% of total height, wide, pyriform; outer lip slightly thickened adapically, somewhat flared abapically, prosocline in profile, bearing short lirae within. Anal canal poorly developed. Siphonal canal short, narrow, open, strongly recurved. Columella deeply concave in mid-portion, bearing 1-2 narrow parietal folds and 1-3 narrow folds abapically. Parietal callus thickened, sharply delimited, moderately expanded and adherent. Columellar callus thick, adherent over base. Siphonal fasciole flattened, bearing narrow cords, separated from base by narrow groove.

Discussion - A medium-sized nassariid species belonging within the N. mutabilis group that cannot be ascribed to any known species is present in the Karaman assemblages. Apart from the size, which is smaller than usual for this species group, the Turkish shells are characterised by having poorly developed spiral sculpture, which is subobsolete at mid-whorl in many specimens, a globular last whorl, the outer lip is only modestly flared abapically and the columellar and parietal callus are thickened, but only moderately expanded and not shield-like as in many members of this species group. Most specimens bear a broad, flattened varix on the penultimate and last whorls. The protoconch is tall, dome-shaped, multispiral, consisting of just over three whorls with a small nucleus. There is, however, quite some variability within the species, especially in the relative spire height and the strength of the spiral sculpture.

These Turkish shells are similar to *Nassarius tornatus* (Bellardi, 1882) (syntype figured by Ferrero Mortara *et al.*, 1981, pl. 20, fig. 6) from the late Miocene Tortonian

of Italy in size, shape, spire height, and extent of ventral callus. They differ, however, in their ornament, as the Italian shells have much more regular spiral cords, which are wider than in *N. pascaleae* nov. sp. Moreover, they do not develop the broad varix so characteristic for *N. pascaleae* nov. sp. Montanaro (1939) treated *N. tornatus* as a 'forma' of *Nassarius instabilis* (Bellardi, 1882), with which it coexists in the late Miocene Italian deposits. This is possibly correct, however, *N. instabilis* has a much more typical shell for this species group, with a broader, shorter spire, a more globose last adult whorl, a wider aperture and a thinner outer lip, which is more strongly flared abapically. We have insufficient Italian material at hand to understand the intraspecific variability within this group.

Erünal-Erentoz illustrated three nassariids belonging to the N. mutabilis group: Nassa (Nassa) sp. aff. instabilis (Bellardi) (1958, pl. 10, fig. 7), Nassa (Nassa) mutabile (Linné) (1958, pl. 10, fig. 8) and Nassa (Nassa) obliquata cf. var. longoastensis Sacco (1958, pl. 10, fig. 9). However, none of these were from Serravallian deposits, but were from younger Turkish assemblages. In contrast, the N. mutabilis group is well represented in the middle Miocene Atlantic Aquitaine Basin assemblages, but does not seem to have extended into the middle Miocene Paratethys (see Harzhauser & Kowalke, 2004) nor into the early-middle Miocene North Sea Basin (see Gürs, 2002). The group is again well represented in the late Miocene Proto-Mediterranean of Italy. In the Pliocene the group became diverse in the Mediterranean (Bellardi, 1882; Chirli, 2000; Landau et al., 2009b) and adjacent Atlantic (Landau et al., 2009b, 2011), but again did not extend northwards to the North Sea Basin (Harmer, 1918). Today Nassarius mutabilis (Linnaeus, 1758) is found in West Africa, the Mediterranean and the Black Sea, but does not extend further north (Poppe & Goto, 1991). We therefore conclude that this is a relatively thermophilic nassariid species group.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Group unknown

Nassarius larandicus nov. sp.

Plate 27, fig. 15; Plate 28, figs 1-4; Plate 66, fig. 6

? 1958 *Nassa (Uzita) inaequicostata* Bellardi n. var. – Erünal-Erentöz, p. 70, pl. 11, figs 4, 5 [*non* Bellardi, 1882 *= Nassarius turritus* (Bronn, 1820)].

Material and dimensions: Holotype NHMW 1847/-0058/0895, height 14.9 mm; paratype 1 NHMW 1847/0058/0896, height 15.8 mm; paratype 2 NHMW 1847/0058/1457, height 17.0 mm; paratype 3 NHMW 1847/0058/1458, height 14.0 mm; paratype 4 NHMW 1847/0058/1459, height 13.0 mm; paratype 5 NHMW 1847/0058/1460, height 12.9 mm; paratype 6 RGM 794 525, height 11.5 mm; paratype 7 RGM 776 944, height

14.8 mm; paratype 8 RGM 776 945, height 15.7 mm; paratype 9 RGM 776 946, height 15.4 mm; paratype 10 RGM 776 947, height 14.6 mm; furthermore two specimens in YI 476, height 16.0 mm, and YI 477, height 15.9 mm.

Other material and dimensions – Maximum height 18.4 mm. Localities 2 & 3: YI 316/14; localities 7 & 8: NHMW 1847/0058/1463/1, 1847/0058/1463/1, 1847/0058/0740/24, JvdV/5; locality 9: YI 319/1; locality 12: JvdV/6; locality 13: NHMW 1847/0058/0895/1, 1847/0058/0896/1, 1847/0058/0897/50+; JvdV/14, RGM 783 676/8, YI 315/50+; locality 17: YI 318/2.

Etymology – From Laranda, ancient name for city of Karaman, destroyed by Perdiccas around 322 BC.

Locus typicus – Locality 13, Pınarlar Yaylası, Akpınar, Karaman Basin, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small-medium sized *Nassarius* species with a multispiral protoconch, a tall spire composed of evenly convex whorls, relatively subdued sculpture, with ribs becoming obsolete on the last two teleoconch whorls, and very weak spiral sculpture that persists throughout, a relatively small ovate aperture, a thin outer lip, with or without lirae internally, and a narrow band of columellar and parietal callus without teeth or tubercles.

Description – Shell small to medium sized, relatively thin-shelled, slender fusiform, with tall conical spire. Protoconch pointed dome-shaped, multispiral, of 3.5 convex whorls, with small nucleus (dp = 1272 μ m, hp = 1190 μ m, dp/hp = 1.07, dp1 = 360 μ m, dn = 190 μ m, Pl. 66, fig. 6). A single suprasutural cord develops after 1.5 whorls; axial riblets on the last quarter protoconch whorl. Junction with teleoconch sharply delimited. Teleoconch of 6-7 convex whorls, with periphery at adapical suture on spire. Suture impressed, linear. Axial sculpture of 11-12 weakly prosocline, slightly arcuate, rounded ribs, narrower than their interspaces, weakening abapically. Some gerontic specimens with varix on last two whorls. Spiral sculpture of about 11 fine, weak, flattened, closeset cordlets, overriding axial sculpture. Last whorl about 55% of total height, convex, rounded at base. Aperture small, ovate; outer lip thin, regularly rounded, weakly prosocline and sinuous in profile, smooth or weakly lirate within; anal canal not developed; siphonal canal relatively short, open, twisted to left and recurved. Columella concave; abapically with thin ridge delimiting siphonal canal. Columellar and parietal calluses weakly thickened, sharply delimited, forming a narrow callus band. Siphonal fasciole flattened, bearing spiral cords.

Discussion – Unfortunately, we have not been able to locate Erünal-Erentöz's material, but this is probably the same as the shell she illustrated as *Nassa* (*Uzita*) *inaequi*-

costata Bellardi n. var. (Erünal-Erentöz, 1958, pl. 11, figs 4, 5). It has nothing in common with Nassa inaequicostata Bellardi, 1882, which is a synonym of the large, solid species Nassarius turritus (Bronn, 1820) (see Landau et al., 2009b, p. 51). This is one of the most common nassariids in the Karaman assemblages, especially in the Pinarlar Yaylasi deposits, where it can be found in its hundreds. The shells are quite variable in width and in the strength of the ribs on the last whorl, which can be relatively well-developed to obsolete. About one third of the shells bear a broad varix on the last adult whorl and a few specimens have one on the penultimate whorl. It is unclear in which nassariid group to place this species. Nassarius schroekingeri (Hoernes & Auinger, 1882) from the middle Miocene Paratethys of Romania is similar in having a tall, slender shell with axial sculpture weakening on the last whorl, but the axial ribs are far broader and the spiral sculpture on the base differs in being stronger with fewer cords. Nassarius schlotheimi (Beyrich, 1854) from the Miocene North Sea Basin shows some similarity to N. larandicus nov. sp. in shape and sculpture, but the ribs persist onto the last adult whorl and the columella is strongly excavated in the mid-portion.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Naytiopsis Thiele, 1929

Type species – Buccinum granum Lamarck, 1822, by monotypy. Recent, Mediterranean.

Naytiopsis karreri (Hoernes & Auinger, 1882) Plate 28, fig. 5

- *1882 *Buccinum (Nassa) Karreri* Hoernes & Auinger, p. 123, pl. 14, figs 25, 27, 28, ?26.
- 2004 *Naytiopsis karreri* (Hoernes & Auinger 1882) Harzhauser & Kowalke, p. 28 (*partim*, pl. 3, fig. 19, pl. 6, figs 7-9 only).

Dimensions and material – Maximum height 8.9 mm. Localities 7 & 8: NHMW 1847/0058/0741/1.

Discussion – Harzhauser & Kowalke (2004) placed *Nassa explorata* Boettger, 1906 and *Nassa hypertropha* Boettger, 1906 in synonymy with *Naytiopsis karreri* (Hoernes & Auinger, 1882), considering the differences in shape to be extremes in the variation within one species. However, the two species described by Boettger (1906) and figured clearly by Zilch (1934, pl. 16, figs 98, 99) have no axial sculpture on the early teleoconch whorls. Although the strength and persistence of axial sculpture in nassariid species is extremely variable [*i.e. Nassarius elatus* (Gould, 1845); see Landau *et al.*, 2009b, p. 14], its absolute presence or absence is a species-specific character. Interestingly, both forms co-occur in the Karaman assemblages.

Landau et al. (2009b) placed Nassa subecostata Bellardi,

1882 in synonymy with *Nassarius elabratus* (Doderlein, 1862) from the late Miocene of Italy and the Pliocene northeast Atlantic and Mediterranean. *Nassarius elabratus* and *Naytiopsis karreri* are superficially similar with axial sculpture on the early whorls and smooth adult whorls, but differ in the character of the siphonal canal, which is much broader in *N. subecostata*, a character of the genus *Naytiopsis*. *Nassa subecostata* may well be a synonym of *N. karreri*, although we have not seen any specimens of the Italian species. Even if so, the name proposed by Hoernes & Auinger would have priority, as the date of Bellardi's work is 10th December 1882 (Marshall, 1991).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hoernes & Auinger, 1882; Harzhauser & Kowalke, 2004), Romania (Hoernes & Auinger, 1882); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Naytiopsis hypertropha (Boettger, 1906)

Plate 28, fig. 6; Plate 66, fig. 7

- 1906 Nassa explorata Boettger, p. 23, no. 86.
- *1906 Nassa hypertropha Boettger, p. 24, no. 87.
- 1934 Nassa explorata Boettger, 1906 Zilch, p. 255, pl.
 16, fig. 98.
- 1934 *Nassa hypertropha* Boettger, 1906 Zilch, p. 255, pl. 16, fig. 99.
- 2004 *Naytiopsis karreri* (Hoernes & Auinger 1882) Harzhauser & Kowalke, p. 28 (*partim, non* pl. 3, fig. 19, pl. 6, figs 7-9, syntypes of *N. karreri*).

Dimensions and material – Maximum height 10.6 mm. Localities 7 & 8: NHMW 1847/0058/0742/1, RGM 776 848/1 (ex JvdV collection).

Discussion – As discussed above, we accept that Nassa explorata Boettger, 1906 and Nassa hypertropha Boettger, 1906 probably represent two extreme forms of the same species (Harzhauser & Kowalke, 2004). However, we do not accept their synonymy with Naytiopsis karreri (Hoernes & Auinger, 1882), which has axial ribs on the early teleoconch whorls that are absent in Naytiopsis hypertropha (Boettger, 1906). The specimens from the Karaman Basin are closer to the N. hypertropha than to the N. explorata morphotype. As first revisers (ICZN, Art. 24.2), we select the name Naytiopsis hypertropha (Boettger, 1906) as the valid one for this species. The protoconch in the Turkish specimens is low dome-shaped, consisting of just over three whorls (Pl. 59, fig. 7).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Boettger, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Cyllene Gray in Griffith & Pidgeon, 1834

Type species – Cyllene owenii Gray *in* Griffith & Pidgeon, 1834, by original designation. Recent, West Africa.

Cyllene desnoyersi (de Basterot, 1825)

Plate 28, fig. 9

- *1825 Nassa Desnoyersi de Basterot, p. 50, pl. 2, fig. 13.
- 1845 Buccinum Desnoyersi De Bast. Grateloup, pl. 36, fig. 22.
- 1852 Buccinum lyratum Lam. Hörnes, p. 152, pl. 12, fig. 19 (non Lamarck, 1822).
- 1875b *Cyllene Desnoyersi* Basterot Tournouër, p. 332, pl. 15, fig. 1.
- 1875b *Cyllene Desnoyersi* var. *aquitanica* Tournouër, p. 332, pl. 15, fig. 2.
- 1875b Cyllene Desnoyersi var. bisinuata Tournouër, p. 332, pl. 15, fig. 3.
- 1903 Cyllene Desnoyersi var. turonica Peyrot, p. 6, pl. 3, fig. 13.
- 1904 *Cyllene Desnoyesri* var. *taurocrassa* Peyrot, p. 57, pl. 14, figs 50, 51.
- 1904 *Cyllene Desnoyesri* var. *taurangusta* Peyrot, p. 57, pl. 14, fig. 52.
- 1911 Cyllene ancillariaeformis Grat. Friedberg, p. 106, text-fig. 28 (non Grateloup, 1834).
- 1927 Cyllene Desnoyersi (Basterot) Peyrot, p. 216, no. 962, pl. 4, figs 9-14.
- 1927 *Cyllene Degrangei* Peyrot, p. 219, no. 963, pl. 4, figs 15, 16.
- 1952a *Cyllene (Cyllene) desnoyersi turonica* Peyrot, 1903 Glibert, p. 347, pl. 10, fig. 12.
- 1959 Buccinum lyratum Olivi Stevanović & Milošević, p. 93, pl. 2, fig. 8.
- 1997 *Cyllene (Cyllene) desnoyersi* (Basterot, 1825) Bałuk, p. 19, pl. 5, figs 1-3.
- 2001a *Cyllene desnoyersi* (Basterot, 1825) Lozouet *et al.*, p. 61, pl. 26, fig. 11.
- 2004 *Cyllene desnoyersi* (Basterot, 1825) Harzhauser & Kowalke, p. 30, pl. 4, fig. 3.

Dimensions and material – Maximum height 14.0 mm. Locality 17: NHMW 1847/0058/1656/1, 1847/0058/0747/1 (juvenile).

Discussion – Cyllene desnoyersi (de Basterot, 1825) is represented in the Karaman assemblages by one adult and one juvenile shell. However, this is a very distinctive species with prominent, rounded nodules around the shoulder angulation. For discussion see Harzhauser & Kowalke (2004, p. 30).

Distribution – Early Miocene: northeastern Atlantic (Aquitanian-Burdigalian): Aquitaine Basin, France (Peyrot, 1928; Lozouet *et al.*, 2001a); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1904). Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France, (Peyrot, 1928), (Langhian): Loire Basin, France (Peyrot, 1903; Glibert, 1952a); Paratethys (Langhian-Serravallian): Poland (Friedberg, 1911; Bałuk, 1997), Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1882; Harzhauser & Kowalke, 2004), Romania (Hoernes & Auinger, 1882); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Cyllenina Bellardi, 1882

Type species – Buccinum ancillariaeformis Grateloup, 1834, by subsequent designation (Cossmann, 1901). Early Miocene, France.

Cyllenina ancillariaeformis (Grateloup, 1834) Plate 28, figs 7, 8

- *1834a Buccinum ancillariaeformis Nob., Grateloup, p. 212.
- 1845 *Buccinum ancillariaeformis* Grat Grat, pl. 36, fig. 3.
- 1847 Nassa miocenica mihi., Michelotti, p. 205, pl. 17, fig. 1.
- 1852 Buccinum miocenicum Mich. Hörnes, p. 153 (partim, pl. 12, fig. 21 only).
- 1882 Buccinum (Uzita) miocenicum Michi. Hoernes & Auinger, p. 135, pl. 13, fig. 32.
- 1882 Cyllenina ancillariaeformis (Grat.) Bellardi, p. 162, pl. 10, fig. 17.
- 1901 *Cyllenina ancillariaeformis* (Grat.) Cossmann, p. 155, pl. 5, figs 22, 23.
- 1911 *Cyllene ancillariaeformis* Grat. Friedberg, p. 106, text-figs 28, 29.
- 1926 *Cyllene (Cyllenina) ancillariaeformis* (Grateloup) – Peyrot, p. 220, no. 964.
- 1926 *Cyllene (Cyllenina) ancillariaeformis* mut. *helvetica* Peyrot, p. 220, no. 965, pl. 4, figs 17, 18.
- 1939 *Cyllene (Cyllenina) ancillariaeformis* (Grat.) Montanaro, p. 180, pl. 7, figs 1-7, 10-15.
- 1954 Nassa nodosocostata Hilb. Strausz, p. 30, 70, 108, pl. 4, fig. 97.
- 1966 Cyllenina ancillariaeformis Grateloup, 1840 [sic]– Strausz, p. 338, pl. 37, figs 6, 7.
- 1973 Nassa (Uzita) nodosocostata (Hilber) 1879 Bohn-Havas, p. 1056, pl. 5, fig. 16.
- 1999 *Cyllene (Cyllenina) ancillariaeformis* (de Grateloup, 1834) – Landau & Marquet, fig. 1/4.
- 2004 *Cyllenina ancillariaeformis* (Grateloup, 1834) Harzhauser & Kowalke, p. 30, pl. 4, figs 4-7.

Dimensions and material – Maximum height 13.8 mm. Locality 18: JvdV/5, RGM 794 052/1 (ex JvdV collection), RGM 794 053/1 (ex JvdV collection).

Discussion – The shells from Turkey are rather slender compared with some of the late Miocene Tortonian specimens from Montegibbio, Italy. They also have the parietal callus less well-developed. However, this species is somewhat variable in shell shape, as shown by the series illustrated by Montanaro (pl. 7, figs 1-7, 10-15).

Cyllenina ancillariaeformis (Grateloup, 1834) is found

only in the somewhat brackish assemblage from the hillsides east of Tarlaören. In the Paratethys it is also associated with low-salinity brackish environments. For further discussion and comparisons with congeners see Harzhauser & Kowalke (2004, p. 32).

Distribution – Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France, (Peyrot, 1926); Paratethys (Langhian-Serravallian): Hungary (Strausz, 1966; Harzhauser & Kowalke, 2004), Poland (Friedberg, 1911; Harzhauser & Kowalke, 2004), Vienna Basin, Austria (Hörnes, 1852, Hoernes & Auinger, 1882; Harzhauser & Kowalke, 2004); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1882; Cossmann 1901; Montanaro, 1939; Landau & Marquet, 1999).

Family Columbellidae Swainson, 1840 Subfamily Columbellinae Swainson, 1840 Genus *Columbella* Lamarck, 1799

Type species – Voluta mercatoria Linnaeus, 1758, by monotypy. Recent, Western Atlantic.

Columbella rustica (Linnaeus, 1758) Plate 28, fig. 10

- *1758 Voluta rustica Linnaeus, 731.
- 1901 *Columbella rustica* (Lin.) Cossmann, p. 232, pl. 10, fig. 3.
- 1911 Columbella rustica L. sp. Cerulli-Irelli, p. 255, pl. 23, fig. 59.
- 1965 Pyrene (Pyrene) rustica (L.) Ruggieri & Greco, p. 53, pl. 7, fig. 12.
- 2003 Columbella rustica (Linné, 1758) Giannuzzi-Savelli et al., p. 238, figs 537-559.

Dimensions and material – Maximum height 10.9 mm. Locality 13: NHMW 1847/0058/0748/1.

Discussion – The single shell from the Akpınar deposits is somewhat worn, but falls well within the wide range of variability seen in Recent specimens (see Giannuzzi-Savelli et al., figs 537-559). The colour pattern is well preserved in the Turkish shell, and is again the same as that of Recent specimens. We have provisionally ascribed it to this species, although we note that in the Recent populations specimens found in the eastern Atlantic south of Senegal seem to be a distinct species, with a multispiral rather than a paucispiral protoconch as in Columbella rustica (Linnaeus, 1758) (Oliverio, 1995). Unfortunately the protoconch is not preserved in the Turkish specimen. It is surprising to find this shell in the Turkish deposits, as it is by far the oldest record of the species. Until now the oldest fossil records are from the early Pleistocene of Italy (Cerulli-Irelli, 1911) and other central Mediterranean localities (NHMW collection).

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1911). Pleistocene indet.: western Mediterranean, France (Cossmann, 1901). Late Pleistocene: central Mediterranean, Italy (Ruggieri & Greco, 1965). Recent: eastern Atlantic and Mediterranean south to Senegal (Oliverio, 1995).

Genus Costoanachis Sacco, 1890

Type species – Columbella (Anachis) turrita Sacco, 1890, by original designation. Miocene, Italy.

Costoanachis terebralis (Grateloup, 1834)

Plate 28, fig. 11; Plate 66, fig. 8; Plate 67, fig. 1

- *1834b Nassa terebralis Grateloup, p. 271, no. 512.
- 1837 Buccinum pulchellum Duj., Dujardin, p. 299.
- 1845 Buccinum terebrale Grat., Grateloup, pl. 36, fig. 35.
- 1852 Columbella corrugata Bon. Hörnes, p. 120, pl.
 11, fig. 8 [non Costoanachis corrugata (Brocchi, 1814)].
- 1880 Columbella (Anachis) Gümbeli Hoernes & Auinger, p. 102, pl. 11, figs 8-11.
- 1900 *Columbella (Anachis) pulchella* Dujardin Ivolas & Peyrot, p. 208, pl. 1, figs 2, 4.
- 1901 Anachis corrugata Bon. Cossmann, p. 237, pl.
 10, figs 6, 7 [non Costoanachis corrugata (Brocchi, 1814)].
- 1925 Anachis terebralis (Grateloup) Peyrot, p. 62, no. 856, pl. 1, figs 65-79.
- 1925 *Anachis terebralis* var. *aturensis* Peyrot, p. 64, no. 857, pl. 1, figs 72, 80.
- 1925 Anachis terebralis var. perlonga Peyrot, p. 64, no. 858, pl. 1, fig. 81.
- 1925 Anachis corrugata var. pulchella Nyst Kautsky, p. 101, pl. 7, fig. 27.
- 1944 Anachis (Costoanachis) gümbeli (Hoernes & Auinger) van Voorthuysen, p. 80, pl. 8, figs 4-8.
- 1952a Pyrene (Anachis) terebralis Grateloup, 1834 Glibert, p. 317, pl. 8, fig. 14.
- 1954 Pyrene (Anachis) gümbeli Hoernes és Auinger Csepreghy-Meznerics, p. 39, pl. 5, fig. 9.
- Anachis terebralis Grateloup 1834 Kojumdgieva & Strachimirov, p. 186, pl. 45, fig. 13.
- 1962 Columbella (Anachis) terebralis Grateloup Strausz, p. 88, pl. 34, figs 11, 12.
- 1964 *Anachis* (*Costoanachis*) *pulchella* (Dujardin 1837) Anderson, p. 248, pl. 22, fig. 182.
- 1964 Anachis terebralis Grateloup, 1834 Brébion, p. 407, pl. 9, fig. 32.
- 1966 Columbella (Anachis) terebralis Grateloup, 1847 – Strausz, p. 295, pl. 34, figs 11, 12.
- 1972a Anachis (Costoanachis) gümbeli (Hoernes und Auinger, 1880) – Nordsieck, p. 76, pl. 18, fig. 104.
- 1984a Anachis (Costoanachis) terebralis (Grateloup,

1834) – A.W. Janssen, p. 228, pl. 9, fig. 17, pl. 61, fig. 10.

- 1993 Anachis terebralis (Grateloup, 1834) Iljina, p. 97, pl. 13, fig. 3.
- 1995 Anachis terebralis (Grateloup, 1834) Bałuk, p. 239, pl. 33, figs 1-5.
- 2001a *Costoanachis terebralis* (Grateloup, 1834) Lozouet *et al.*, p. 63, pl. 28, fig. 6.
- 2001 *Anachis (Costoanachis) terebralis* (Grateloup, 1834) Wienrich, p. 479, pl. 78, fig. 3, pl. 95, figs 7, 8.

Dimensions and material – Maximum height 5.6 mm. Localities 2 & 3: JvdV/2; locality 6: JvdV/2; localities 7 & 8: NHMW 1847/0058/0749/1; locality 12: JvdV/1; locality 13: NHMW 1847/0058/1284/29, JvdV/13, RGM 784 032/2; YI 347/7; locality 17: JvdV/4.

Discussion – Costoanachis terebralis (Grateloup, 1834) is similar to Costoanachis corrugata (Brocchi, 1814), but differs in having a smaller shell, more closely set axial ribs and in the absence of spiral sculpture. The protoconch is multispiral, tall and dome-shaped (Pl. 67, fig. 1), similar to that illustrated by other authors (A.W. Janssen, 1984a, pl. 9, fig. 17; Wienrich, 2001, pl. 78, fig. 3). It does not show the microsculpture illustrated by A.W. Janssen (1984a, pl. 9, fig. 17) and Wienrich (2001, pl. 78, fig. 3) for this species, but the surface is slightly eroded. The Karaman shells are all fairly constant in shape and sculpture. Bałuk (1995, pl. 33, figs 1-5) showed quite a range of sculpture for the middle Miocene Paratethyan population from Poland. If this sculptural range is accepted as intraspecific variation, some of the species described by Boettger from Romania are probably synonyms of C. terebralis [i.e. Columbella (Nitidella) embryonalis Boettger, 1906]. However, a more detailed study including protoconch morphology is required to be certain.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian-Burdigalian): Aquitaine Basin, France (Peyrot, 1925; Lozouet et al., 2001a). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (van Voorthuysen, 1944; Nordsieck, 1972a; A.W. Janssen, 1984a), Germany (Kautsky, 1925; Anderson, 1964; Wienrich, 2001). Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France, (Peyrot, 1925), (Langhian): Loire Basin, France (Ivolas & Peyrot, 1900; Glibert, 1952a); Paratethys (Langhian-Serravallian): Poland (Bałuk, 1995), Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1880), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1962, 1966), eastern Paratethys (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (Brébion, 1964), (Tortonian): Cacela Basin, Portugal (NHMW collection).

Genus Mitrella Risso, 1826

Type species – Mitrella flaminea Risso, 1826 (= Murex scriptus Linnaeus, 1758), by subsequent designation (Cox, 1927). Recent, Mediterranean.

Mitrella borsoni (Bellardi, 1848)

Plate 28, fig. 12; Plate 67, fig. 2

- *1848 Columbella Borsoni Bellardi, p. 14, pl. 1, fig. 11. 1866 Columbella Borsoni? Bell. - Pereira da Costa, p. 71, pl. 14, fig. 1.
- 1890a Columbella (Clinurella) borsoni Bell. - Sacco, p. 45, pl. 2, fig. 52.
- 1904 Atilia Borsoni var. ventrosocoarctata Sacc., Sacco, p. 94, pl. 19, fig. 58.
- 1918 Columbella (Columbellopsis) Borsoni (Bellardi) -Harmer, p. 309 (partim, pl. 33, fig. 21 only).
- 1938 Columbella (Alia) turonensis Mayer - Peyrot, p. 212 (partim, pl. 4, figs 23, 28 only) [non pl. 4, figs 26-27 = Mitrella polonica (Pusch, 1837)].
- 1952a Pyrene (Atilia) borsoni Bellardi, 1848 - Glibert, p. 312, pl. 7, fig. 12.
- 1964 Mitrella (Atilia) borsoni Bellardi, 1848 - Brébion, p. 401.
- 1981 Columbella (Clinurella) borsoni Bellardi, 1848 -Ferrero Mortara et al., p. 182, pl. 57, fig. 11.

Dimensions and material - Maximum height 10.1 mm. Localities 2 & 3: YI 344/3; localities 7 & 8: NHMW 1847/0058/0750/1, 1847/0058/0751/7, JvdV/4, RGM 794 526/1; locality 13: YI 334/13.

Discussion - The shell illustrated here from Turkey probably fits within the range of variability of Mitrella borsoni (Bellardi, 1848), although the spire whorls are slightly less scalate than those of the syntype illustrated by Ferrero Mortara et al. (1981, pl. 57, fig. 11). The protoconch is tall, multispiral, composed of about four strongly convex whorls (Pl. 67, fig. 2). The shape of the last whorl and aperture are consistent with those of M. borsoni. Mitrella scalaris (Sacco, 1890) from the middle Miocene of Italy is of similar size and shape, but differs in having an outer lip that is more flared and somewhat alate adapically. Mitrella vialensis (Sacco, 1890) and M. minima (Sacco, 1890), both from the Pliocene of Italy, are also similar in shape but have a more contricted base. These two Pliocene species differ in M. minima not having denticles within the outer lip.

Distribution - Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France (Peyrot, 1938; Glibert, 1952a); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (Brébion, 1964), (Tortonian): Cacela Basin, Portugal (NHMW collection); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1890a).

Mitrella cf. borsoni (Bellardi, 1848) Plate 28, fig. 13

cf. *1848 Columbella Borsoni Bellardi, p. 14, pl. 1, fig. 11.

Dimensions and material - Maximum height 7.2 mm. Locality 12: JvdV/1; locality 13: NHMW 1847/0058/0752/1, 1847/0058/0753/1, JvdV/8, RGM 783 677/1.

Discussion – Specimens from the Pinarlar Yaylası deposits resemble Mitrella borsoni (Bellardi, 1848), but differ in having a less deeply impressed suture, a slightly weaker labial varix and a shorter siphonal canal. They are also closely similar in size and shape to Mitrella vialensis (Sacco, 1890) and M. minima (Sacco, 1890), both from the Pliocene of Italy, but both of these have a more deeply impressed suture and a more constricted base. They possibly represent a distinct, unnamed species, but more material is required for a decision.

Distribution - Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Mitrella fallax (Hoernes & Auinger, 1880)

Plate 28, figs 14-16; Plate 67, fig. 3

- 1852 Columbella subulata Bell. [sic] - Hörnes, p. 121, pl. 11, figs 11, 13 (non Murex subulatus Brocchi, 1814).
- *1880 Columbella (Mitrella) fallax Hoernes & Auinger, p. 96.
- 1911 Columbella (Atilia) fallax Hoernes & Auinger -Friedberg, p. 38, pl. 2, fig. 5.
- 1911 Columbella (Anachis) subnassoides Friedberg, p. 40, pl. 2, fig. 6.
- 1952a Pyrene (Atilia) fallax Hoernes et Auinger - Glibert, p. 311, pl. 7, fig. 11.
- 1954 Pyrene (Mitrella) fallax Hoernes & Auinger -Csepreghy-Meznerics, p. 39, pl. 5, figs 4-6.
- 1954 Pyrene (Mitrella) miopedemontana Sacco Csepreghy-Meznerics, p. 39, pl. 5, figs 3, 7.
- 1962 Columbella (Atilia) fallax miopedemontana Sacco - Strausz, p. 103, pl. 42, figs 10-17.
- 1962 Columbella (Atilia) fallax Hoernes & Auinger -Strausz, p. 103, pl. 42, figs 18-21.
- 1966 Columbella (Atilia) fallax Hoernes & Auinger, 1880 - Strausz, p. 292, pl. 42, figs 18-21.
- 1966 Columbella (Atilia) fallax miopedemontana Sacco, 1889 - Strausz, p. 292, pl. 42, figs 10-17.
- 1967 Mitrella (Atilia) fallax (R. Hoernes et Auinger, 1880) - Tejkal et al., p. 204, pl. 11B, figs 12-14.
- 1968 Mitrella fallax (R. Hoernes et Auinger, 1879 [sic]) - Zelinskaya et al., p. 207, pl. 48, figs 13, 14.
- 1970 Pyrene (Atilia) fallax R. Hoernes & Auinger -Bałuk, p. 118, pl. 12, fig. 4.
- 1971 Mitrella (A.) fallax R. Hoernes - Stancu et al., p. 125, pl. 7, fig. 12.
- 1972 Pyrene (Mitrella) fallax Hoernes et Auinger -Csepreghy-Meznerics, p. 28, pl. 10, figs 20, 21.

- 1981 Columbella (Atilia) fallax R. Hoernes i Auinger, 1882 - Krach, p. 71, pl. 24, fig. 24.
- 1995 Pyrene (Atilia) fallax (Hoernes & Auinger, 1880) - Bałuk, p. 237, pl. 31, figs 5-7.
- 2002 Pyrene (Atilia) fallax (Hörnes & Auinger, 1880) -Harzhauser, p. 99, pl. 6, fig. 17.
- 2009 Pyrene (Atilia) fallax (Hörnes & Auinger, 1880) -Mikuž, p. 25, pl. 7, figs 91, 92.
- non 1960 Mitrella (Atilia) falax [sic] (Hoernes und Auinger 1880) - Kojumdgieva & Strachimirov, p. 183, pl. 45, fig. 6 [? = Mitrella semicaudata (Bellardi, 1849)].
- non 1963 Mitrella (Macrurella) fallax (Hoernes-Auinger) -Venzo & Pelosio, p. 92, pl. 35, figs 17-19.

Dimensions and material - Maximum height 18.4 mm. Localities 2 & 3: JvdV/20, YI 237/4; localities 7 & 8: NHMW 1847/0058/0756/1, 1847/0058/0757/1, 1847/-0058/0758/16, JvdV/17, YI 348/4; locality 9: RGM 783 833/2, YI 342/3; locality 12: JvdV/10; locality 13: NHMW 1847/0058/0754/1, 1847/0058/0755/50+, JvdV/10, RGM 784 036/1, 783 678/43, YI 335/50+; locality 17: RGM 783 786/1, YI 339/6.

Discussion – The shells from Turkey have a tall domeshaped protoconch composed of about three weakly convex whorls (Pl. 67, fig. 3). Mitrella miopedemontana (Sacco, 1890) from the Burdigalian-Langhian Colli Torinesi, Italy and Mitrella inedita (Sacco, 1890), which may well be conspecific, differ from Mitrella fallax (Hoernes & Auinger, 1880) in being slightly wider, and in having a more constricted base than M. fallax. The shells illustrated under this name by Venzo & Pelosio (1963, pl. 35, figs 17-19) do not seem conspecific with the Paratethyan shells and are excluded from the distribution.

Distribution – Early Miocene: Paratethys (Burdigalian): Austria (Harzhauser, 2002). Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France, (Glibert, 1952a); Paratethys (Langhian-Serravallian): Poland (Bałuk, 1970, 1995), Vienna Basin, Austria (Hörnes, 1852; Tejkal et al., 1967), Hungary (Strausz, 1962, 1966), Slovenia (Mikuž, 2009), Romania (Stancu et al., 1971), Ukraine (Zelinskaya et al., 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Mitrella aff. inedita (Bellardi in Sacco, 1890) Plate 29, figs 1-3; Plate 67 fig. 4

- aff. *1890a Columbella (Tetrastomella) inedita Bellardi in Sacco, p. 42, pl. 2, fig. 44.
- aff. 1904 Atilia inedita var. parvuloplicata Sacco, p. 94, pl. 19, fig. 56.
- Atilia inedita var. angulosolabiata Sacco, p. 94, aff. 1904 pl. 19, fig. 57.
- aff. 1981 Columbella (Tetrastomella) inedita Bellardi, 1890 - Ferrero Mortara et al., p. 181, pl. 57, fig. 6.

Dimensions and material - Maximum height 21.7 mm. Locality 12: JvdV/2; locality 13: NHMW 1847/0058/0759-1847/0058/0761/3, 1847/0058/0762/50+, RGM 794 527/1, YI 336/25; locality 17: 340/1.

Discussion - The shells from Turkey have a tall multispiral protoconch composed of about 3.5 convex whorls (Pl. 67, fig. 4). Several closely similar Mitrella species were described by Bellardi in Sacco (1890a) from the late Miocene, Tortonian, Po Basin of Italy. Our shells from Turkey are not identical to any of these species. However, they seem to be related to the Mitrella inedita group. The Turkish shells differ from Mitrella inedita (Bellardi in Sacco, 1890) in having slightly convex spire whorls as opposed to straight-sided whorls in M. inedita. Mitrella addita (Bellardi in Sacco, 1890) described from the same Italian deposits, has similar spire whorls, but the adult whorl has a more constricted base and fewer spiral cords on the siphonal fasciole. The Tortonian Italian species Mitrella angulosolabiata (Sacco, 1904) is comparable with the Turkish species in its rather broad apical angle and weakly convex whorls (see Robba, 1968, p. 536, pl. 41, fig. 4) but differs in its shorter last whorl and more angular base.

Mitrella aff. *inedita* differs from the shells identified here as Mitrella fallax (Hoernes & Auinger, 1880) in having a broader, more regularly rounded last whorl, with a more constricted base, and in having fewer but stronger spiral cords on the siphonal fasciole.

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Mitrella kostejana (Boettger, 1906)

Plate 29, figs 4, 5; Plate 67, fig. 5

- *1906 Columbella (Mitrella) kostejana Boettger, p. 16, no. 60.
- 1834 Pyrene (Atilia) kostejana (Boettger) - Zilch, p. 253, pl. 16, fig. 87.
- 1995 Pyrene (Atilia) kostejana (Boettger, 1906) -Bałuk, p. 235, pl. 32, figs 3, 4.

Dimensions and material - Maximum height 6.9 mm. Localities 2 & 3: YI 345/1; locality 17: NHMW 1847/0058/0763/1, 1847/0058/0906/1, 1847/0058/0907/-50+, JvdV/9, RGM 794 528/1, RGM 783 987/30, YI 333/25.

Discussion - Mitrella kostejana (Boettger, 1906) is characterised by its very small, slender shell, not exceeding 8.0 mm in height, its rounded whorls separated by a shallow suture, strong dentition within the outer lip, the adapical tooth more strongly developed than the others, its short siphonal canal, and its fasciole bearing weak spiral sculpture. The protoconch is dome-shaped, composed of about three weakly convex whorls (Pl. 67, fig. 5). The same colour pattern as is preserved in the Turkish shells can be seen in the specimens illustrated by Bałuk (1995, pl. 32, figs 3, 4) from the middle Miocene Paratethys of Poland. In shape it is somewhat similar to *Mitrella erythrostoma* (Bellardi, 1848) and *Mitrella semicaudata* (Bellardi, 1848), both from the Pliocene of Italy, but these species are much larger.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1995), Romania (Boettger, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Mitrella linguloides (Bellardi *in* Sacco, 1890) Plate 29, figs 6, 7

- *1890a *Columbella (Mitrella) linguloides* Bellardi *in* Sacco, p. 36, pl. 2, fig. 30.
- 1981 *Columbella (Mitrella) linguloides* Bellardi, 1890 Ferrero Mortara *et al.*, p. 179, pl. 58, fig. 13.

Dimensions and material – Maximum height 26.5 mm. Locality 13: NHMW 1847/0058/1684/1; locality 17: NHMW 1847/0058/0908/1, 1847/0058/0908/1, 1847/0058/0910/8, JvdV/2, YI 338/2.

Discussion – Mitrella linguloides (Bellardi in Sacco, 1890) is a very distinctive species, characterised by its very solid slender shell, with a tall, acute spire, made up of numerous straight-sided whorls, and tall but weakly inflated last whorl. It is also the largest of the Turkish Mitrella species. This is the first report of M. linguloides outside the late Miocene Italian assemblages. Mitrella acuminata (Bellardi in Sacco, 1890) from the Italian late Miocene Tortonian deposits is extremely similar, differing in its smaller size, its less acute spire with weakly convex rather than straight-sided whorls, and the last whorl is proportionally shorter. Both species are described from Stazzano in Italy and they might be synonymous.

Mitrella prolixa (Bellardi, 1890) from the early Pliocene of Italy also has a slender, tall-spired shell, but differs in being smaller and in having a constricted base, whereas the constriction is weak in *M. linguloides*.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Colli Tortonesi, Italy (Bellardi & Sacco, 1890a).

Mitrella polonica (Pusch, 1837)

Plate 29, figs 8, 9

- *1837 Nassa columbelloides var. polonica m., Pusch, p. 123, pl. 11, fig. 9.
- 1852 Columbella curta Bell. Hörnes, p. 118, pl. 11, figs 2-6 [non Mitrella curta (Dujardin, 1837)].
- 1869 Columbella helvetica Mayer, p. 282, pl. 10, fig. 2.
- 1869 Columbella turonica Mayer, p. 285, pl. 10, fig. 5.
- 1880 Columbella curta Duj. Hoernes & Auinger, p. 93, pl. 7, figs 15-20.

- 1911 *Columbella curta* Duj. Friedberg, p. 33, text-fig. 8, pl. 2, fig. 1, ?2,
- 1927 Columbella (Alia) turonensis Mayer (emend.) Peyrot, p. 54, no. 848, pl. 1, figs 34, 35.
- 1927 Columbella (Alia) turonensis depressior Peyrot, p. 56, no. 850, pl. 1, figs 60, 61.
- 1938 Columbella (Alia) turonensis Mayer Peyrot, p.
 203 (partim, pl. 4, figs 26, 27 only) [non pl. 4, figs 23, 28 = Mitrella borsoni (Bellardi, 1848)].
- 1952a *Columbella (Alia) turonica* Mayer, 1969 Glibert, p. 319, pl. 8, fig. 4.
- 1960 *Columbella (Alia) curta* (Dujardin 1837) Kojumdgieva & Strachimirov, p. 182, pl. 45, fig. 2.
- 1962 Columbella (Alia) helvetica Mayer Strausz, p. 104, text-fig. 121, pl. 42, figs 31, 32, pl. 43, figs 1, 2.
- 1966 *Columbella (Alia) helvetica* Mayer, 1969 (*'curta* Auct.') Strausz, p. 288, pl. 42, figs 31, 32, pl. 43, figs 1, 2.
- 1972 Columbella (Alia) helvetica May. Csepreghy-Meznerics, p. 28, pl. 10, figs 13, 14.
- 1995 Pyrene (Alia) polonica (Pusch, 1837) Bałuk, p. 234, pl. 31, figs 8-10.
- 2002 *Pyrene (Alia) polonica* (Pusch, 1837) Harzhauser, p. 98, pl. 6, fig. 16.

Dimensions and material – Maximum height 15.7 mm. Locality 11: JvdV/8; locality 13: YI 239/1; locality 17: NHMW 1847/0058/0911/1, 1847/0058/0912/1, 1847/-0058/0913/26, JvdV/15, RGM 783 964/7, YI 241/23.

Discussion – Mayer (1869) was correct in separating the mitrellid shells identified by Hörnes as *Columbella curta* from *Mitrella curta* (Dujardin, 1837) from the Atlantic middle Miocene of France, as the real *M. curta* has a much squatter spire and a strongly inflated last whorl. However, the earliest name for these shells was shown by Bałuk (1995) to be *Mitrella polonica* (Pusch, 1837). Bałuk (1995) stressed the variability of the species and synonymised *Columbella helvetica* Mayer, 1869 with *Columbella turonica* Mayer, 1869. However, we agree with Glibert (1952a, p. 318) in placing the shells illustrated by Hoernes & Auinger (1880, pl. 7, figs 15-20), from the middle Miocene Paratethys of Romania, in the synonymy of *M. curta* rather than of *M. polonica* as suggested by Bałuk (1995).

Specimens from the Atlantic early Miocene Aquitanian of the Aquitaine Basin described by Peyrot (1928) as *Columbella (Alia) turonensis aquitanica* were considered by Lozouet *et al.* (2001a) to be a distinct species, *Mitrella aquitanica*. Certainly the shell figured by Lozouet *et al.* (2001a, pl. 28, fig. 9) is quite different from *M. polonica*, and closer in shape to *M. semicaudata* (Bellardi, 1848).

Distribution – Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Peyrot, 1928); Paratethys (Burdigalian): Austria (Harzhauser, 2002). Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Peyrot, 1928), (Langhian): Loire Basin, France (Peyrot, 1938; Glibert, 1952a); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852); Poland (Friedberg, 1911; Bałuk, 1995), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1962, 1966; Csepreghy-Meznerics, 1972), Romania (Hoernes & Auinger, 1880); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Mitrella semicaudata (Bellardi, 1848)

Plate 29, fig. 10

- *1848 *Columbella semicaudata* Bonelli m.s., Bellardi, p. 8.
- 1852 *Columbella semicaudata* Bon. Hörnes, p. 117, pl. 11, fig. 10.
- ? 1866 Columbella semicaudata Bon. Pereira da Costa, p. 70, pl. 14, fig. 2.
- 1911 *Columbella semicaudata* Bon. Friedberg, p. 36, pl. 2, fig. 3.
- 1890a Columbella (Mitrella) semicaudata Bon. Sacco, p. 40, pl. 2, fig. 39.
- 1911 Columbella (Mitrella) semicaudata Bon. Cerulli-Irelli, p. 305, pl. 23, figs 60-63.
- 1952a Columbella (Alia) semicaudata Bonelli, 1825 Glibert, p. 321, pl. 8, fig. 5.
- 1956 *Pyrene (Mitrella) semicaudata* Bon. Csepreghy-Meznerics, p. 403, pl. 7, figs 16, 17.
- 1962 Columbella (Mitrella) semicaudata Bonelli Strausz, p. 104, pl. 42, figs 23, 24.
- 1964 Mitrella semicaudata Bonelli, 1825 Brébion, p. 401.
- 1966 Columbella (Mitrella) semicaudata Bonelli (in Bellardi), 1849 [sic] – Strausz, p. 290, pl. 42, figs 23, 24.
- 1975 *Mitrella semicaudata* (Bonelli) Fekih, p. 126, pl. 38, fig. 12.
- 1981 Columbella (Mitrella) semicaudata Bellardi, 1848, Bonelli, m.s. – Ferrero Mortara et al., p. 180, pl. 56, fig. 11.
- 1995 Pyrene (Mitrella) semicaudata (Bellardi, 1849 [sic]) – Bałuk, p. 235, pl. 31, figs 1-3.
- 2002 *Mitrella semicaudata* (Bonelli, 1825) Chirli, p. 10, pl. 5, figs 7-12, pl. 6, figs 1, 2.
- 2011 Mitrella semicaudata (Bellardi, 1848) Landau et al., p. 28, pl. 14, fig. 1.
- ?non 1952a Columbella (Alia) semicaudata Bonelli, 1825 Glibert, p. 321, pl. 8, fig. 5.
- non 1992 Mitrella semicaudata (Bellardi, 1848, Bonelli, m.s.) – Cavallo & Repetto, p. 116, fig. 295 [= Mitrella erythrostoma (Bellardi, 1848)].

Dimensions and material – Maximum height 14.0 mm. Locality 13: NHMW 1847/0058/0914/1, 1847/0058/0915/2, JvdV/5, YI 337/2.

Discussion – As illustrated by Chirli (2002, pl. 5, figs 7-12, pl. 6, figs 1, 2), *Mitrella semicaudata* (Bellardi, 1848) is variable in shape. The Turkish specimens have

a rather low spire and a globose last whorl, similar to the syntype illustrated by Ferrero Mortara *et al.* (1981, pl. 56, fig. 11), although taller-spired forms with a less inflated last whorl are also present (Glibert, 1952a, pl. 8, fig. 5; Chirli, 2002, pl. 5, figs 5, 6). Like the Polish specimens discussed by Bałuk (1995), the Turkish shells tend to be smaller than Pliocene forms in our collections.

Distribution – Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France, (Glibert, 1952a); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856), Poland (Friedberg, 1911; Bałuk, 1995), Hungary (Hörnes, 1856; Csepreghy-Meznerics, 1956; Strausz, 1962, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (Brébion, 1964), ?(Tortonian): Cacela Basin, Portugal (Periera da Costa, 1866). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (NHMW collection); central Mediterranean, Italy (Chirli, 2002); Tunisia (Fekih, 1975). Late Pliocene: Central Mediterranean, Italy (Sacco, 1890a). Early Pleistocene: Central Mediterranean, Italy (Cerulli-Irelli, 1911).

Mitrella teres (Bellardi, 1890)

Plate 29, fig. 11; Plate 67, fig. 6

- *1890a *Columbella (Tetrastomella) teres* Bellardi *in* Sacco, p. 43, pl. 2, fig. 46.
- 1981 *Columbella (Tetrastomella) teres* Bellardi, 1890 Ferrero Mortara *et al.*, p. 182, pl. 57, fig. 7.
- 2002 *Mitrella teres* (Bellardi, 1890) Chirli, p. 11, pl. 6, figs 7-12.

Dimensions and material-Maximum height 15.7 mm. Locality 17: NHMW 1847/0058/0916/1, 1847/0058/0917/16, JvdV/30, RGM 784 037/1, RGM 783 988/25 fragments, YI 238/8.

Discussion – The Turkish specimens we ascribe to *Mitrella teres* (Bellardi, 1890) are slightly different from the Pliocene shells illustrated by Chirli (2002, pl. 6, figs 7-12) from the early Pliocene of Italy in having straighter-sided spire whorls and in having the shoulder of the last whorl slightly more angular. Otherwise, their size, elongate slender shape, aperture, which lacks the labial callus usually found in columbellids, and long siphonal canal are comparable. The protoconch of the Turkish specimens is bulbous, paucispiral, consisting of about 1.25 whorls with a large nucleus, suggesting direct development (Pl. 67, fig. 6). It is difficult to tell from the illustrations given by Chirli (2002), but Italian specimens seem to have the same type of protoconch. Stratigraphically, this is the oldest record of the species.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1890). **Early Pliocene**: central Mediterranean, Italy (Sacco, 1890a; Chirli, 2002).

Genus Orthurella Sacco, 1890

Type species – Columbella elongata Bellardi, 1848, by subsequent designation (Cossmann, 1901). Miocene, Italy.

Note - The large number of Italian Miocene and Pliocene species placed in Macrurella by Sacco, 1890 are quite inhomogenous and provide a rather vague definition of that (sub)genus. Later, Cossmann (1901) chose Fusus nassoides Grateloup as the type species of Macrurella but, unfortunately, illustrated a Pliocene shell, which in our opinion is not conspecific with the French Miocene species. Cossmann's position in considering the Miocene and Pliocene shells to be conspecific obviously led him to treat the subgenus Orthurella Sacco, 1890 as synonym of Macrurella. The type species of Orthurella is Columbella elongata Bellardi, 1848 from the Tortonian of Italy. It agrees fully with the morphology of Orthurella convexula, including the long canal and cyrtoconoid spire, but develops delicate spiral threads on the last whorl (see Ferrero Mortara et al., 1981). Some of the Turkish shells also have very weak spiral sculpture on most of the last whorl (Pl. 29, fig. 13) and further Italian late Miocene material is required to be certain they are indeed distinct species. The protoconch is broken in all the Turkish shells. It is preserved in material from the middle Miocene Romanian Paratethys and is dome-shaped, multispiral, consisting of about 3.5 whorls. Therefore, species of the Macrurella and Orthurella have a similar type of protoconch (see Wienrich, 2001, pl. 78, fig 1).

Orthurella convexula Sacco, 1904

Plate 29, figs 12-14; Plate 79, fig. 12

- 1852 Columbella nassoides Bell. Hörnes, p. 122, pl.
 11, fig. 9 (non Fusus nassoides Grateloup, 1827).
- *1904 Orthurella elongata Bell. var. convexula Sacc., Sacco, p. 95, pl. 19, figs 59, 60.
- 1958 Pyrene (Macrurella) nassoides (Grateloup) Erünal-Erentöz, p. 58, pl. 9, figs 6, 7 (non Fusus nassoides Grateloup, 1827).
- 1960 Mitrella (Macrurella) nassoides (Grateloup 1840) – Kojumdgieva & Strachimirov, p. 185, pl. 45, fig. 10 (non Fusus nassoides Grateloup, 1827).
- 1962 Columbella (Macrurella) nassoides Grateloup Strausz, p. 103, pl. 42, figs 6, 7 (non Fusus nassoides Grateloup, 1827).
- 1966 Columbella (Macrurella) nassoides Grateloup, 1847 – Strausz, p. 294, pl. 42, figs 6, 7 (non Fusus nassoides Grateloup, 1827).
- 1995 Pyrene (Macrurella) nassoides (Grateloup, 1840)
 Bałuk, p. 237, pl. 31, fig. 4 (non Fusus nassoides Grateloup, 1827).
- 1998 Pyrene (Macrurella) nassoides (Grateloup) Schultz, p. 66, pl. 26, fig. 10 (non Fusus nassoides Grateloup, 1827).

- 2007 Columbella (Mitrella) nassoides Grateloup Tițã,
 p. 548, fig. 5a (non Fusus nassoides Grateloup, 1827).
- 2010 Mitrella (Macrurella) nassoides (Grateloup 1827)
 Caze et al., p. 32, fig. 5L (non Fusus nassoides Grateloup, 1827).

Dimensions and material – Maximum height 40.2 mm. Localities 2 & 3: JvdV/25, YI 240/14; locality 6: NHMW 1847/0058/1498/8, RGM 783 860/1; localities 7 & 8: NHMW 1847/0058/0920/7, JvdV/15, RGM 783 890/3; locality 9: JvdV/30, RGM 783 832/50+, YI 341/1; locality 10: YI 343/2; locality 12: JvdV/27; locality 13: NHMW 1847/0058/0918/1, 1847/0058/0953/1, 1847/0058/0954/1, 1847/0058/0919/25, JvdV/50+, RGM 777 872/2 (ex JvdV collection), RGM 783 679/50+, MTA 2013/055/10; YI 234/50+; locality 17: YI 236/1.

Discussion – For more than 160 years the middle Miocene Badenian shells from the Vienna Basin have been identified as *Macrurella nassoides* (Grateloup, 1827), ever since Hörnes (1852) considered them conspecific with the Pliocene shells described by Bellardi (1890) as *Columbella (Macrurella) nassoides* (Grat.). *Fusus nassoides* Grateloup, 1827 is actually based on early Miocene Aquitanian shells from the Aquitaine Basin. If correct, this would mean that the species was exceptionally long-lived, originating during the early Miocene and persisting until the late Pliocene.

On closer examination it becomes clear that several different species are possibly hidden in M. nassoides, as used in the literature. The French early or early and middle Miocene species Fusus nassoides has a relatively stout, fusiform shell, with almost flat-sided whorls and a relatively short, deflected siphonal canal. It is unclear when this species first appeared, as Peyrot (1925) stated that the "topotype" is from Saubrigues, which is middle Miocene Langhian in age, but he referred to Grateloups (1845, pl. 24, figs 41, 42) figures, and the specimens they were based on were stated by Grateloup (1845) to be from Dax, which is a Burdigalian locality. The original description by Grateloup (1827, p. 15) also refers to Dax as the provenance of his material. We consider the following references to refer to Macrurella nassoides (Grateloup, 1827):

- *1827 Fusus nassoides Grat., Grateloup, p. 15.
- 1833 Fusus nassoides Grat. Grateloup, p. 39.
- 1845 *Fusus nassoides* Grat. Grateloup, pl. 24, figs 41, 42.
- 1925 *Atilia (Macrurella) nassoides* (Grateloup) Peyrot, p. 73, no. 866, pl. 1, figs 57, 69, 89-91.

Distribution (of *Macrurella nassoides*) – **Early Miocene**: (Grateloup, 1827, 1845). **Middle Miocene**: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France, (Peyrot, 1925).

Mediterranean Pliocene shells ascribed to *Macrurella* nassoides (i.e. Sacco, 1890a; Pelosio, 1966; Malatesta, 1974;

Caprotti, 1976; Chirli, 1988, 2002; Cavallo & Repetto, 1992; Chirli & Richard, 2008; Sosso & dell'Angelo, 2010) are more slender with a higher spire, nearly flat whorls and a longer canal compared to early Miocene specimens of *M. nassoides*. These shells tend to form coeloconoid spire profiles. *Columbella (Macrurella) pronassoides* Sacco, 1890 is probably conspecific with the Pliocene shells and could be used for this Pliocene Mediterranean species. We consider the following references to refer to *Macrurella pronassoides* (Sacco, 1890):

- 1848 *Columbella nassoides* Grat. Bellardi, p. 16, pl. 1, fig. 13.
- *1890a Columbella (Macrurella) pronassoides Sacc., Sacco, p. 51, pl. 2, fig. 66.
- 1890a *Columbella (Macrurella) nassoides* (Grat.) Sacco, p. 51, pl. 2, fig. 67.
- 1901 Atilia (Macrurella) nassoides (Grat.) Cossmann, p. 244, pl. 10, fig. 25.
- 1967 *Mitrella (Macrurella) nassoides* (Grateloup 1827) – Pelosio, p. 135, pl. 40, fig. 16.
- 1974 *Mitrella (Macrurella) nassoides* (Grateloup, 1827) Malatesta, p. 315, pl. 26, fig. 1.
- 1975 Atilia (Macrurella) nassoides (Grateloup) Fekih, p. 129, pl. 38, fig. 15.
- 1976 Mittella nassoides (Grateloup, 1827) Caprotti,
 p. 10, pl. 16, fig. 2.
- 1981 Columbella (Macrurella) pronassoides Sacco in Bellardi, 1890 – Ferrero Mortara et al., p. 184, pl. 56, fig. 16.
- 1986 *Mitrella (Macrurella) nassoides* Grateloup Martinell & Domènech, p. 119, pl. 1, fig. 14.
- 1988 Mitrella nassoides (Grateloup, 1827) Chirli, p. 21, pl. 8, fig. 2.
- 1992 *Mitrella (Macrurella) nassoides* (Grateloup, 1827) Cavallo & Repetto, p. 116, fig. 293.
- 2002 Mitrella (Macrurella) nassoides (Grateloup, 1834) – Chirli, p. 15, pl. 8, figs 9-12, pl. 9, figs 1-3.
- 2008 Mitrella nassoides (Grateloup, 1827) Chirli & Richard, p. 43, pl. 7, figs 8-10.
- 2008 Mitrella nassoides (Grateloup, 1827) Duerr, p. 153, figs 4-6.
- 2010 *Mitrella nassoides* (Grateloup, 1827) Sosso & dell'Angelo, p. 42, p. 59, unnumbered fig. top centre.

Distribution (of *Macrurella pronassoides*) – Early Pliocene: western Mediterranean, Estepona Basin, Spain (NHMW collection); Roussillon Basin, France (Fontannes, 1879; Chirli & Richard, 2008); central Mediterranean, Italy (Bellardi, 1848; Sacco, 1890a; Pelosio, 1967; Chirli, 2002); Tunisia (Fekih, 1975). Early-late Pliocene: western Mediterranean, France (Martinell & Domènech, 1986); central Mediterranean, Italy (Malatesta, 1974; Chirli, 1988; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010).

The North Sea Basin shells ascribed to *Macrurella nas-soides* (*i.e.* Kautsky, 1925; van Voorthuysen, 1944; Glibert, 1952b; Sorgenfrei, 1958; Anderson, 1964; Nord-

sieck, 1972a; A.W. Janssen, 1984a; Moths & Piehl, 1988; Moths, 1989; Wienrich, 2001; Moths *et al.*, 2010) are again different. They are smaller than the forms mentioned above, with a deeply impressed, very narrowly canaliculate suture, the aperture is very small, and the siphonal canal is shorter than in any of the above and hardly deflected. The name *Macrurella attenuata* (Beyrich, 1854) is available for this North Sea Basin form. We consider the following references *Macrurella attenuata*:

- *1854 Columbella attenuata Beyrich, p. 108, pl. 6, fig. 5.
 1854 Columbella nassoides Grat. Beyrich, p. 110, pl. 6, figs 6, 7.
- 1907 Columbella nassoides Grat. Ravn, p. 108, pl. 4, fig. 7.
- 1925 Atilia (Macrurella) attenuata Beyr. Kautsky, p. 102, pl. 7, fig. 29.
- 1925 Atilia (Macrurella) nassoides Grat. Kautsky, p. 103, pl. 7, fig. 30.
- 1944 *Mitrella (Macrurella) nassoides* (Grateloup 1840) – van Voorthuysen, p. 76, pl. 9, figs 6-11.
- 1952b Pyrene (Atilia) nassoides Grateloup, sp. 1840 Glibert, p. 98, pl. 7, fig. 15.
- 1958 Pyrene (Atilia) nassoides (Grateloup) Sorgenfrei, p. 206, pl. 43, fig. 140.
- 1964 *Mitrella (Macrurella) nassoides* (Grateloup 1827) – Anderson, p. 246, pl. 22, fig. 180.
- 1972a Pyrene (Macrurella) nassoides (Grateloup) Nordsieck, p. 76, pl. 18, fig. 103.
- 1984a *Mitrella (Macrurella) nassoides* (Grateloup, 1827) A.W. Janssen, p. 229, pl. 9, fig. 18.
- 1988 Columbellopsis attenuata (Brocchi) Moths & Piehl, p. 205, pl. 7, fig. 28.
- 1989 *Mitrella (Macrurella) nassoides* (Grateloup, 1834) Moths, p. 111, pl. 14, fig. 67.
- 2001 *Mitrella (Macrurella) nassoides* (Grateloup, 1834) – Wienrich, p. 476, pl. 78, fig. 1, pl. 95, figs 1, 2.
- 2010 *Mitrella (Macrurella) nassoides* (Grateloup, 1834) Moths *et al.*, p. 52, pl. 38, figs 7, 8.

Distribution (of *Macrurella attenuata*) – **Early-middle Miocene**: North Sea Basin (late Burdigalian-Langhian): Belgium (Nyst, 1845; Glibert, 1952b), Netherlands (van Voorthuysen, 1944; Nordsieck, 1972a; A.W. Janssen, 1984a), Germany (Beyrich, 1854, Kautsky, 1925; Anderson, 1964; Wienrich, 2001; Moths *et al.*, 2010), Denmark (Ravn, 1907; Sorgenfrei, 1958).

The Langhian and Serravallian Paratethyan shells usually identified as *Mitrella nassoides*, as well as the Turkish species, are characterised by their long, straight siphonal canal, the gently contracted base, which results in a comparatively long last whorl. The whorls are slightly convex in most specimens (although this character is variable) and tend to be cyrtoconoid. These shells belong to the genus *Orthurella* Sacco, 1890 (see note above under genus).

One further character of note is the very clear colour pattern seen on some of the Turkish shells, and enhanced by UV light (Pl. 79, fig. 12) consisting of close-set vertical zig-zag lines similar to that illustrated for a middle Miocene Romania specimen by Caze *et al.* (2010).

Distribution (of Orthurella convexula) – Middle Miocene: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1995), Vienna Basin, Austria (Hörnes, 1852; Schultz, 1998), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1962, 1966), Romania (Tiţã, 2007; Caze *et al.*, 2010); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Stazzano (Sacco, 1904).

Family Melongenidae Gill, 1871 (1854) Subfamily Melongeninae Gill, 1871 (1854)

Note – Family names cited with two dates (the second one in parentheses) are those ruled by Article 40(2) of ICZN: 'If ... a family-group name was replaced before 1961 because of the synonymy of the type genus, the replacement name is to be maintained if it is in prevailing usage. A name maintained by virtue of this Article retains its own author (and date, the first date cited) but takes the priority of the replaced name'.

Genus Melongena Schumacher, 1817.

Type species – M. fasciata Schumacher, 1817 (= *Murex melongena* Linnaeus, 1758), by monotypy. Recent, Caribbean.

Note – Vermeij & Raven (2009) argued that the Old World representatives assigned to *Melongena* should be separated from the New World lineage, which includes the type species, at genus or subgenus level. They discussed the long spines on the shoulder region and the rather conical last whorl as potential criteria to define an Old World lineage. These vague characters will need further investigation to justify a clear separation and at present we retain the European Oligocene-Miocene species in *Melongena*.

Melongena jaapi nov. sp. Plate 30, figs 1-6

- 1866 Pyrula lainei Bastérot Fischer, p. 239 [non Melongena lainei (de Basterot, 1825)].
- 1958 Galeodes cornuta (Agassiz) Erünal-Erentöz, p. 60, pl. 10, figs 1-2 [non Melongena cornuta (Agassiz, 1843)].

Material and dimensions – Holotype NHMW 1847/-0058/0823, height 87.4 mm, width 71.8 mm; paratype 1 NHMW 1847/0058/0822, height 88.6 mm, width 64.3 mm; paratype 2 NHMW 1847/0058/0824, height 94.2 mm, width 75.4 mm; paratype 3 NHMW 1847/0058/0825, height 94.4 mm, width 62.5 mm; paratype 4 NHMW 1847/0058/0826, height 97.4 mm, width 73.1 mm; paratype 5 RGM 783 792, height 85.4 mm, width 62.2 mm; paratype 6 RGM 783 793, height 90.8 mm, width

63.6 mm; paratype 7 RGM 783 794, height 98.4 mm, width 63.3 mm; paratype 8 NHMW 1847/0058/0827, height 107.1 mm, width 76.3 mm; paratype 9 NHMW 1847/0058/1643, height 104.0 mm, width 93.3 mm; paratype 10 NHMW 1847/0058/1644, height 108.6 mm, width 68.9 mm; furthermote two specimens in YI 482, height 123.0 mm, width: 105.0 mm, and YI 483, height 133.0 mm, width: 83.0 mm.

Other material – Maximum height 205.0 mm. Localities 2 & 3: JvdV/1, YI 467/2; locality 6: RGM 783 861/1; localities 7 & 8: JvdV/2; locality 13: JvdV/2, RGM 783 680/1, YI 294/1; locality 17: NHMW 1847/0058/0828-1847/0058/0835/7, 1847/0058/1645-1847/0058/1647/3, JvdV/50+, RGM 783 795/5; MTA 2013/043/2; YI 285/24.

Etymology – Named after Jaap van der Voort, who has so kindly put his wonderful collection of Turkish fossil shells at our disposal.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A large-sized, pyriform *Melongena* species, of moderate thickness, with a short to very depressed spire, spiral sculpture of narrow, close-set cords, a greatly expanded last whorl with 1-2 rows of tubercles or spines at the shoulder, the spines forming and elevated crest on the last half-whorl of most specimens.

Description – Shell large-sized, of moderate thickness, pyriform, spire low to very low, last whorl greatly inflated. Protoconch missing in all specimens. Teleoconch of about five low, angular whorls, becoming more depressed abapically. On first three whorls shoulder placed below mid-whorl, with flat to concave sutural ramp above, straight-sided below. Axial sculpture of nine ribs, subobsolete over sutural ramp, nodulose at shoulder, prominent and rounded below, each slightly narrower than one interspace. Spiral sculpture of narrow, subequal, irregular, close-set cords crossing axial ribs. Suture deeply impressed on early whorls, narrowly but deeply canaliculate on later whorls. Penultimate whorl depressed, last whorl riding up over abapical half.Last whorl greatly inflated, 91-95% of total height, weakly inflated, roundly angled or angular at shoulder, shoulder located immediately below to a short distance below suture. Sculpture of 1-2 rows of spines on shoulder, developed into a spinous or smooth crest on many specimens. One further row of spines developed on base of most specimens, absent from a few. Aperture large, 70-80% of total height, ovate, outer lip simple, without varix, bearing small denticles on inner edge, smooth within; anal canal a v-shaped notch; siphonal canal relatively long, straight, wide, open. Columella widely and shallowly excavated, smooth. Parietal callus moderately thickened, well delimited, expanded over more than half of venter. Columellar callus expanded, closely appressed in most specimens. Siphonal fasciole narrow, rounded, bearing scars of former siphonal canals; small umbilical chink present or closed by callus.

Variability – A huge degree of variability is usual in the shells of Melongena species, and Melongena jaapi nov. sp. is no exception. The spire can be moderately elevated to almost completely flat or concave, with only the first few teleoconch whorls elevated. The last whorl rides up over the abapical half of the penultimate whorl to a variable degree, so that the spinous shoulder can either be above the abapical suture or placed at the bottom of a canaliculate suture. The spiral sculpture consist of narrow rounded ribs of subequal strength in most specimens, or is subobsolete on the last whorl of some large specimens, but in some shells the ribs above the shoulder on the sutural platform of the last whorl strengthen towards the periphery. The apertural characters are fairly constant, although the parietal and columellar calluses vary in thickness and a narrow umbilical chink is present in some specimens, but is is closed by callus in others. The most remarkable and variable character of this new species is the shape of the shoulder and shoulder spines. In some specimens (about 10%) the shoulder is round, and the spines are reduced to tubercles. In most specimens of this morphotype the spire is taller than in most other specimens. In most adult specimens (90%), the adapical row of shoulder spines on the second half of the last adult whorl forms an elevated crest, the sutural platform behind being markedly concave on many specimens. The elevation and composition of this crest, whether formed just by the adapical row of spines or by both rows, separate or fused, differs in each specimen.

Discussion – The presence of this Melongena species in the Turkish deposits was first reported by Fischer (1866) and it has subsequently been identified as either Melongena cornuta (Agassiz, 1843) or M. lainei (de Basterot, 1825). However, as already pointed out by Lozouet et al. (2001a, p. 62), the Turkish shells are not conspecific with either of these two well-known European Neogene species, which represent characteristic phenotypes of two Melongena lineages of the Oligocene and Miocene of the western Tethys, Paratethys and proto-Mediterranean Sea area. Among the oldest species is the rather small Rupelian species Melongena laxecarinata (Michelotti, 1861) from Italy. This species is poorly defined but seems to be also present in the Rupelian of the Thrace Basin in Turkey (NHMW collection). From this area it was described also as Galeodes (Galeodes) thraciensis nov. sp. (Erentöz) in Lebküchner (1974, p. 12) and as Galeodes laxecarinata thraciense (Erentöz) in the plate captions of the same paper. The series of papers by Erentöz (1963-1970) referred to by Lebküchner (1974) were never published and the figure illustrated by the author has no description. Therefore, Galeodes (Galeodes) thraciensis is a nomen nudum (ICZN 13, a, i). The small size and biconical outline of this species, due to the stout last whorl and the high, moderately gradate spire, allow a clear separation from M. jaapi.

The large species Melongena semseviana (Erdös, 1900) possibly represents a descendent of the older species M. laxecarinata. This late Rupelian to Chattian Oligocene species is characterised by a high and extraordinarily gradate spire and by huge spines on the shoulder. It is known from Hungary, Slovenia and Greece (Báldi, 1973; Mikuž, 1999; Harzhauser, 2004) and was originally described from Hungary by Erdös (1900). Later, Hoernes (1906) and Knett (1912) overlooked this reference when describing the same species from Slovenia as Melongena deschmanni Hoernes, 1906 and Melogena rotkyana Knett, 1912 (see also Mikuž, 1999 for discussion). This species can easily be separated from *M. jaapi*, as it has a gradate spire and slender last whorl. The Aquitanian to Burdigalian descendant of this lineage is probably Melongena lainei (de Basterot, 1825), from the early Miocene of the Aquitaine Basin. Melongena lainei is widespread in the proto-Mediterranean and Paratethys area (Lozouet et al., 2001). It has been recorded from the early Miocene of Greece (Harzhauser, 2004), from SW Turkey (Bukowski, 1916) and from the Sivas Basin in Turkey (Stchepinsky, 1939). Its variability is reflected by several varietal and subspecies names (e.g. Melongena (Pyrula) Lainei de Basterot v. bicingulata Stchepinsky, 1939), which should be treated as synonyms. Melongena lainei differs from *M. jaapi* in having a smaller, much more solid shell, with a squatter, less pyriform shape. The spiral cords are far more strongly developed and are separated by deep interspaces, and the single row of shoulder spines in M. lainei is more strongly developed and recurved.

A second group or lineage is represented by the Rupelian to Chattian species Melongena basilica (Bellardi, 1872), which has a low spire and poorly incised sutures. This species is recorded from the Oligocene of Italy and Hungary (Báldi, 1973) and seems to be present in the Rupelian of the Thrace Basin, from where it was described as Galeodes cf. minax (Grateloup)? by Erentöz in Lebküchner (1974). A potential early to middle Miocene descendent is Melongena cornuta (Agassiz, 1843), which is characterised by its convex sutural ramp and low spire. Melongena cornuta differs from M. jaapi in attaining a larger maximum size (190 mm NHMW collection, vs. 110.5), in having much weaker spiral sculpture and in having the shoulder spines placed much lower, resulting in a more broadly convex sutural ramp (see Dollfus, 1888; Lozouet et al., 2001a; Harzhauser, 2002). There is far less intraspecific variability within M. cornuta than in M. jaapi. M. cornuta is present in the Burdigalian of Turkey, recorded by Stchepinsky (1939) from the Sivas Basin, but is not known so far from the Serravallian of the Karaman high plain.A further species was described by Strausz (1943) as Melongena pseudobasilica from the Paratethyan middle Miocene. It is smaller than typical M. *cornuta*, has a conical spire and lacks the convex sutural ramp. Csepreghy Meznerics (1950) described Galeodes (Volema) cornuta hungarica from the middle Miocene of Hungary [indicated subsequently in the same paper as a full species Galeodes (Volema) hungarica (Csepreghy Meznerics, 1950, p. 113)]. The illustrated shell ranges well within the variability of M. pseudobasilica as discussed

by Strausz (1966, *e.g.* pl. 58, fig. 4) and consequently is considered here to be a synonym. The rich Paratethys collections in NHMW contain many shells of *M. pseudobasilica* type, suggesting that *Melongena pseudobasilica* is merely a slender and higher-spired variant of *Melongena cornuta*.

Lozouet *et al.* (2001a, p. 62) discussed the occurrence of this Turkish species in the Neogene of Crete in deposits of possible Tortonian age, based on a personal communication by Didier Merle. We have not been able to confirm this record. Material at hand from the Tortonian of Crete (NHMW collection) includes *Melongena*, but it is not conspecific. According to Lozouet *et al.* (2001a), in Crete it was found in a brackish assemblage in association with *Terebralia* and *Granulolabium*. Whilst there are a few *Terebralia* specimens in the Seyithasan assemblage, they are far from common, and we consider this outcrop to represent a shallow, fully marine environment.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Fischer, 1866; Erünal-Erentöz, 1958). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Crete (Lozouet *et al.*, 2001a).

Family Fasciolariidae Gray, 1853 Subfamily Fasciolariinae Gray, 1853 Genus *Aurantilaria* Snyder, Vermeij & Lyons, 2012

Type species – Fasciolaria aurantiaca Lamarck, 1816, by original designation. Recent, Indo-Pacific.

Aurantilaria tarbelliana (Grateloup, 1845) Plate 31, fig. 1

- *1845 Fasciolaria Tarbelliana Grateloup, pl. 23, fig. 14.
 1854 Fasciolaria Tarbelliana Grat. Hörnes, p. 298, pl. 33, figs 1-4.
- 1867 Fasciolaria Tarbelliana Grat. Pereira da Costa,p. 187, pl. 22, figs 3-9, pl. 23, fig. 1a-b.
- 1890 Fasciolaria Tarbelliana Grat. Varietas inermis Hoernes & Auinger, p. 262, pl. 30, fig. 5.
- 1890 Fasciolaria Tarbelliana Grat. Varietas nodosa Hoernes & Auinger, p. 262, pl. 30, figs 6, 7.
- 1901 Fasciolaria (Pleuroploca) Tarbelliana Grat. Cossmann, p. 39, pl. 2, fig. 7.
- 1904 Pleuroploca tarbelliana (Grat.) Sacco, p. 28, pl. 8, fig. 14.
- 1904 Pleuroploca tarbelliana var. tauroventrosa Sacc., Sacco, p. 28, pl. 8, fig. 15.
- 1904 Pleuroploca tarbelliana var. taurocostulatissima Sacc., Sacco, p. 28, pl. 8, fig. 16.
- 1904 Pleuroploca tarbelliana var. dertomagna Sacc., Sacco, p. 28, pl. 8, fig. 17.
- 1928 Fasciolaria (Pleuroploca) tarbelliana Grateloup Peyrot, p. 71, no. 1029, pl. 7, figs 12, 13.
- 1928 Fasciolaria (Pleuroploca) tarbelliana mut. praecedens Peyrot, p. 73, pl. 7, figs 14, 15.
- 1935 Fasciolaria (Pleuroploca) tarbelliana Grat. Montanaro, p. 62, pl. 4, fig. 17.

- 1962 *Fasciolaria (Pleuroploca) tarbelliana* Grateloup Strausz, p. 80, pl. 28, figs 14, 15, pl. 29, fig. 1.
- 1963 Fasciolaria (Pleuroploca) tarbelliana Grat. –
 Venzo & Pelosio, p. 110, pl. 38, figs 22, 23.
- 1966 Fasciolaria (Pleuroploca) tarbelliana Grateloup, 1840 – Strausz, p. 353, pl. 28, figs 14, 15, pl. 29, fig. 1.
- 1989 *Fasciolaria (Pleuroploca) tarbelliana* Grateloup, 1840 – González-Delgado, p. 295, pl. 6, figs 1, 2.
- 1994 Fasciolaria (Pleuroploca) tarbelliana nodosa Hoernes & Auinger – Nikolov, p. 53, pl. 3, figs 1, 2, pl. 4, figs 1-6.
- 1995 *Fasciolaria tarbelliana* Grateloup, 1840 Bałuk, p. 248, pl. 36, figs 3-5.
- 1997 Fasciolaria tarbelliana Grateloup Ruiz Muñoz et al., p. 64, pl. 37, figs 3, 4.
- 1998 Pleuroploca tarbelliana (Grateloup, 1840) Muñiz Solis, p. 2, pl. 1, figs A-D.
- 2011 *Pleuroploca tarbelliana* (Grateloup, 1840) Landau *et al.*, p. 28, pl. 14, figs 3, 4.

Dimensions and material – Maximum height 170.0 mm. Localities 2 & 3: JvdV/1; locality 12: JvdV/2, YI 288/1; locality 13: JvdV/3; locality 17: JvdV/11, RGM 783 790/1, YI 287/2.

Discussion – Fasciolaria tarbelliana Grateloup, 1845 has been placed within the genus or subgenus *Pleuroploca* Fischer, 1884 by most authors. However, in a revision of the Fasciolariinae Snyder *et al.* (2012) erected the genus *Aurantilaria* for fasciolariid shells differing from *Pleuroploca* by lacking columellar folds abapical to the entrance fold and by having a consistently higher spire.

Peyrot (1928) separated the French early Miocene Aquitanian-Burdigalian specimens from the middle Miocene Langhian shells, the early Miocene specimens being somewhat larger, with a higher, narrower spire, a slightly shorter siphonal canal and weaker, more irregular spiral sculpture, naming them *Fasciolaria (Pleuroploca) tarbelliana* mut. *praecedens* Peyrot, 1928. This description fits the early Pliocene specimens from the Guadalquivir Basin, Huelva, more closely than the middle Miocene form, which suggests that the differences reflect environmental factors rather than an evolutionary trend.

In the French Atlantic early Miocene Aquitanian of the Aquitaine Basin Aurantilaria michelottiana (Grateloup, 1845) [= Turbinella tritonina Grateloup, 1845 = Fasciolaria jouanneti Mayer, 1864 = ?Fasciolaria (Pleuroploca) sacvi Peyrot, 1928 = F. (P.) aquitaniensis Peyrot, 1928, see Lozouet et al., 2001a] has a stockier shell, with the shoulder nodules less developed and more rounded in most specimens, and a shorter siphonal fasciole that A. tarbelliana. Aurantilaria nodifera (Dujardin, 1837) from the middle Miocene Langhian of the Loire Basin, France, differs from A. tarbelliana in having a shorter spire, a longer siphonal canal and different spiral sculpture (Glibert, 1952a). The large, nearly smooth, broadly fusiform shells from the Langhian of Grund in Austria, described as variety inermis by Hoernes & Auinger (1890) are extreme morphs, which occur together with the more typical form of *A. tarbelliana* at the same locality.

Snyder *et al.* (2012) discussed the geographical restriction of the genus since the Pliocene. This is also mirrored in the distribution of *A. tarbelliana*. Although widespread in the Miocene northeastern Atlantic, Proto-Mediterranean Sea and Paratethys, *A. tarbelliana* was restricted in the early Pliocene to the northeastern Atlantic and Mediterranean southern coast of Iberia (Muñiz Solis, 1998; Landau *et al.*, 2011), and does not seem to have been present in the rich early Pliocene central Mediterranean assemblages. *A. tarbelliana* is not found in the European late Pliocene.

Distribution - Early Miocene: northeastern Atlantic (Burdigalian-Aquitanian): Aquitaine Basin, France (Peyrot, 1928). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Grateloup, 1845; Peyrot, 1928); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1854; Hoernes & Auinger, 1890), Poland (Bałuk, 1995), Hungary (Strausz, 1962, 1966), Romania (Hoernes & Auinger, 1890); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, Italy (Sacco, 1904; Montanaro, 1935; Venzo & Pelosio, 1963). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González-Delgado, 1989; Ruiz Muñoz et al., 1997; Landau et al., 2011), western Mediterranean, Estepona Basin, Spain (Muñiz Solis, 1998).

Subfamily Peristerniinae Tryon, 1880 Genus *Tarantinaea* Monterosato, 1917

Type species – Murex lignarius Linnaeus, 1758, by monotypy. Recent, Mediterranean.

Tarantinaea hoernesii (Seguenza, 1875)

Plate 31, figs 2, 3; Plate 67, fig. 7

- 1854 Fasciolaria fimbriata Br. Hörnes, p. 299, pl.
 33, figs 5-7 [non Tarantinaea fimbriata (Brocchi, 1814)].
- *1875 Fasciolaria Hörnesii Seguenza, p. 280 [nom. nov. pro Fasciolaria fimbriata Br. in Hörnes, p. 299, pl. 33, figs 5-7, non Tarantinaea fimbriata (Brocchi, 1814)].
- 1880 *Fasciolaria fimbriata* var. *Hörnesi* [*sic*] Seguenza – Fontannes, p. 78.
- 1901 *Fasciolaria (Pleuroploca) hoernesi [sic]* Seguenza – Cossmann, p. 40.
- 1935 Lathyrus Gastaldii Bell. Montanaro, p. 64, pl. 5, figs 10, 11 (non Latirus Gastaldii Bellardi, 1884).
- ?1959 Fasciolaria fimbriata amplectens Ruggieri et al., p. 64, pl. 14, fig. 80 [nom. nov. pro Fasciolaria fimbriata Br. in Hörnes, p. 299, pl. 33, figs 5-7 (unnecessary replacement), non Tarantinaea fimbria-

ta (Brocchi, 1814), ? non Tarantinaea hoernesi (Seguenza, 1875)].

- 1960 Fasciolaria fimbriata var. hoernesi [sic] Seguenza
 Kojumdgieva & Strachimirov, p. 187, pl. 45, figs
 15, 17.
- 1962 Fasciolaria (Pleuroploca) fimbriata Brocchi var.
 Strausz, p. 80, pl. 29, fig. 2 [non Tarantinaea fimbriata (Brocchi, 1814)].
- 1966 Fasciolaria (Pleuroploca) fimbriata Brocchi, 1814 var. – Strausz, p. 353, pl. 29, fig. 2 [non Tarantinaea fimbriata (Brocchi, 1814)].
- 1995 Fasciolaria fimbriata (Brocchi, 1814) Bałuk,
 p. 248, pl. 36, fig. 6 [non Tarantinaea fimbriata (Brocchi, 1814)].
- 1998 Fasciolaria (Pleuroploca) fimbriata Brocchi Schultz, p. 68, pl. 27, fig. 9 [non Tarantinaea fimbriata (Brocchi, 1814)].

Dimensions and material-Maximum height 64.8 mm. Locality 12: JvdV/1; locality 13: NHMW 1847/0058/0921/1, 1847/0058/1465/1, 1847/0058/0922/4, JvdV/8, RGM 783 681/2, YI 293/1; locality 17: NHMW 1847/0058/1659/1.

Discussion – We follow Snyder *et al.* (2012) in placing *Murex fimbriatus* Brocchi, 1814 and allied species within the Peristerniinae Tryon, 1880, and tentatively within the genus *Tarantinaea* Monterosato, 1917 (for further discussion see Snyder *et al.*, 2012, p. 55).

Workers early on realised that the shells figured by Hörnes (1854, pl. 33, figs 5-7) as Fasciolaria fimbriata Brocchi from the middle Miocene Paratethys were not conspecific with those described by Brocchi (1814, p. 419, pl. 8, fig. 8) from the Mediterranean Pliocene. The Paratethyan shells differ in having a wider apical angle, in having a lower spire with the whorls less stepped, in having sharper sculpture with more strongly developed secondary cords and in having better developed columellar folds. Most Pliocene specimens have two very weak folds placed abapically, in many specimens not visible unless the outer lip is broken. In the Paratethyan shells these folds are visible and more prominent, with two further weaker folds placed adapically in many specimens. The protoconch in the Turkish shells is multispiral, dome-shaped, consisting of three whorls, with a welldelimited comma-shaped scar at the teleoconch junction. In contrast, Pliocene specimens of Tarantinaea fimbriata from Estepona (Spain) and Italy have a paucispiral protoconch (Muñiz Solis, 1998, p. 8; Bruno dell'Angelo pers. comm.), supporting the separation at species level.

Seguenza (1875, p. 280) erected the name *Fasciolaria hörnesii* for Hörnes' Austrian specimens, but he considered shells from the Pliocene of Altavilla, Italy to be conspecific with the Paratethyian shells. Ruggieri *et al.* (1959) considered Seguenza's replacement name to be invalid, as Seguenza proposed the name for the illustrations in Hörnes (1854), but then attributed shells from the Pliocene of Altavilla to this species. However, this replacement name was unnecessary (Snyder, 2003, p. 111). Ruggieri *et al.* (1959, pl. 14, fig. 80) figured a 'holotype' for *Fasciolaria hörnesi* from Altavilla, however,

the true syntypes are Hörnes' specimens in the NHMW collection. The shell illustrated by Ruggieri *et al.* (1959) is much closer in shape to the Paratethyan specimens, although the character of the secondary spiral sculpture is quite different, especially on the sutural ramp, which has far fewer but wider and stronger secondary cords than in the Paratethyan shells. The Altavilla shell does not represent *T. fimbriata*, as we understand it, either, and is possibly another species within this species group: *T. amplectens* (Ruggieri, Bruno & Curti, 1959) (we have not seen another specimen similar to that illustrated by Ruggieri *et al.*, 1959).

This possibly indicates that an evolutionary lineage existed from the middle to late Miocene *Tarantinaea hoernesii* (Seguenza, 1875) to the Pliocene and early Pleistocene *T. fimbriata*, coinciding with a change in larval strategy, with *T. amplectens* as a Pliocene offshoot.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1854; Schultz, 1998), Poland (Bałuk, 1995), Hungary (Strausz, 1962, 1966), Bulgaria (Kojumdgieva & Strachimirov, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian), Po Basin, Italy (Montanaro, 1935).

Genus Polygona Schumacher, 1817

Type species – Polygona fusiformis Schumacher, 1817 (= *Murex infundibulum* Gmelin, 1791), by monotypy. Recent, Western Atlantic.

Note – Vermeij & Snyder (2006) placed the Miocene species group *Turbinella Lynchi* de Basterot, 1825, *Turbinella crassa* Michelotti, 1847 (= *Turbinella subcraticulata* d'Orbigny, 1852) together with *Lathyrus crassus vindobonensis* Csepreghy-Meznerics, 1956 in *Polygona* Schumacher, 1817. This species name is probably a younger synonym of *Lathyrus erinaceus* Peyrot, 1928 described from the Serravallian of France.

Polygona vermeiji nov. sp.

Plate 31, figs 4, 5

Type material and dimensions – Holotype NHMW 1847/0058/0923, height 16.9 mm, locality 13; paratype 1 RGM 776 852 (ex JvdV collection), height 16.9 mm, localities 2 & 3.

Other material - Known only from type material.

Etymology – Named after Geerat J. Vermeij of the University of California at Davis (USA) in recognition of his important contribution to the systematics of the Peristerniinae.

Locus typicus – Locality 13, Pınarlar Yaylası, Akpınar, Karaman Basin, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A *Polygona* species with a small, squat shell, low conical spire, short siphonal protuberance bent to the left, rounded spire whorls, predominantly axial sculpture with eight broad, rounded ribs, a small aperture, and non-beaded lirae within the outer lip.

Description – Shell small, squat fusiform, with a short spire and a relatively short siphonal protuberance. Protoconch worn, but multispiral, low dome-shaped, consisting of about three whorls, one or two sinuous riblets present on last quarter whorl, protoconch boundary sharply delimited by prosocline scar. Teleoconch of six convex whorls. Suture impressed, undulating. Spiral sculpture on the first teleoconch whorl consists of four rounded cords, with one secondary thread in each interspace from third teleoconch whorl. Axial sculpture of eight broad, rounded ribs, each wider than one interspace, weaker on subsutural ramp, somewhat swollen mid-whorl. Spiral sculpture crosses axial ribs. Close-set axial growth lines present, elevated into lamellae, especially at suture and between spiral cords, rendering surface scabrose. Last whorl slightly inflated, sutural ramp weakly concave, convex below, base strongly constricted, bearing seven primary spiral cords. Aperture small, ovate, outer lip thin, bearing seven lirae within, extending some distance within aperture. Adapical sinus weakly developed. Siphonal canal open, narrow, relatively short, slightly curved posteriorly and to left. Columella excavated, bearing one blunt parietal denticle and three oblique columellar folds on abapical half of columella, strengthening abapically. Columellar callus closely appressed, sharply delimited, thickened, weakly expanded over ventral side of last whorl. Siphonal fasciole rounded, bearing closeset spiral cords.

Discussion – The Turkish shells are reminiscent of the Paratethyan species *Polgona vindobonensis* (Csepreghy-Meznerics, 1956) but can be separated clearly at the species level. *Polygona vermeiji* nov. sp. is stockier, with shorter spire whorls, the last whorl is shorter and contracts rapidly into the short canal, whilst this transition is less abrupt in *P. vindobonensis* which has a longer canal. The spire angle of *P. vindobonensis* ranges around 40-45° but it attains about 50° in *P. vermeiji*.

Polygona vindobonensis was originally described as a subspecies of *Polygona crassa* (Michelotti, 1847), which occurs in the early Miocene Atlantic of France and Proto-Mediterranean of Italy. However, the Paratethyan shell clearly differs in being smaller, squatter, lowerspired, in having more convex whorls and in having the axial ribs weaker on the sutural ramp and therefore less clearly aligned down the vertical axis of the shell. The sculpture of the spiral ribs of *P. vindobonensis* varies from very prominent with small spines at the intersections with the axial ribs, to moderately sharp. The more spiny specimens from Romania in NHMW are indistinguishable from *Lathyrus erinaceus* Peyrot, 1928 from

the Serravallian of France. Therefore, *P. vindobonensis* is possibly a synonym of *P. erinacea*.

The extremely rare Paratethyan species *Polygona? pleurotomoides* (Hoernes & Auinger, 1890) is a delicate species with beaded spiral ribs and weak axial sculpture and is not related to the species discussed above .

Polygona vermeiji nov. sp. is extremely rare in the Turkish assemblages, and is known from only two small shells from the Pınarlar Yaylası deposits.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Pseudolatirus Bellardi, 1884

Type species – Fusus bilineatus Hörnes, 1853, by subsequent designation (Cossmann, 1901), Miocene, Europe.

Pseudolatirus ligusticus (Bellardi, 1884)

Plate 30, figs 7, 8

- 1854 Fusus lamellosus Borson Hörnes, p. 289, pl. 31, fig. 16 (non Aptyxis lamellosus (Borson, 1821)].
- *1884 *Latirus (Peristernia) ligusticus* Bell., Bellardi, p. 46, pl. 2, fig. 25.
- 1981 *Latirus ligusticus* Bellardi, 1884 Ferrero Mortara *et al.*, p. 145, pl. 40, fig. 2.

Dimensions and material – Maximum height 15.8 mm. Locality 13: NHMW 1847/0058/1696/1, 1847/0058/-1697/2.

Discussion – This species is superficially similar to Aptyxis lamellosus (Borson, 1821), reported from the late Miocene and Pliocene of Italy, but differs in having a small posterior sinus, a weak parietal tooth and two columellar folds. These characters place it in the subfamily Peristerniinae Tryon, 1880 rather than Fusininae Swainson, 1840, which do not have folds on the columella. It is also superficially similar to the Recent Mediterranean species Fusinus pulchellus (Philippi, 1844), but again this does not have columellar folds and has a paucispiral protoconch, whereas the protoconch in the Turkish shells is multispiral, consisting of 3.5 whorls, with the last protoconch whorl strongly carinate. The teleoconch sculpture in the Turkish species consists of nine elevated rounded axial ribs and close-set spiral sculpture of alternating strength, similar to the syntype illustrated by Ferrero Mortara et al. (1981, pl. 40, fig. 2). The two shells illustrated here (Plate 30, figs 7, 8) show some variability in the convexity of the whorls, but are otherwise constant in sculpture.

The shell illustrated by Hörnes (1854, pl. 31, fig. 16; Figure 24/2) as *Fusus lamellosus* shows the same apertural characters; the posterior notch, parietal tooth and columellar folds are identical, and in our opinion the Paratethyan specimens are conspecific with the shells from Turkey.



Figure 24. Pseudolatirus ligusticus (Bellardi, 1884), both lot NHMW 1856/0001/0566, Steinebrunn, Vienna Basin, Austria, middle Miocene, Badenian. Height fig. 24/1: 20.4 mm, 24/2: 19.6 mm (Photos Mathias Harzhauser).

Bellardi (1884) described a closely similar species from the late Miocene of Italy, *Pseudolatirus cognatus*. This species differs primarily in having more convex whorls and a more inflated last whorl. A larger series of shells would be needed to separate the two convincingly.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1854), Czech Republic (NHMW coll.); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Early Pliocene**: Mediterranean Sea, Italy (Bellardi, 1884).

Subfamily Fusininae Swainson, 1840 Genus Aptyxis Troschel, 1868

Type species – Murex syracusanus Linnaeus, 1758, by original designation. Recent, Mediterranean.

Aptyxis aff. *palatinus* (Strausz, 1954) Plate 31, fig. 6; Plate 67, fig. 8

- aff. *1954 Fusus (Streptochetus) clavatus palatinus Strausz, p. 31, pl. 4, fig. 100.
- aff. 1966 Fusus (Aptyxis) lamellosus palatinus Strausz, p. 345, pl. 26, fig. 13, pl. 27, figs 1, 2.

Dimensions and material – Height 29.3 mm. Localities 2 & 3: NHMW 1847/0058/1466/1; RGM 794 022/1.

Discussion – This species is characterised by its relatively small size and its paucispiral protoconch of 1.5 whorls with a large, bulbous first whorl. The last half whorl of the protoconch has several prosocline scars. The teleoconch consists of 7.5 convex whorls, with the periphery at mid-whorl. The suture is impressed. The axial sculpture consists of eight wide, rounded ribs, swollen mid-whorl, weakening towards the sutures. The spiral sculpture on early spire whorls consists of three ribs, with two further, weaker ribs on the subsutural area. A single secondary spiral cord is intercalated in each interspace from the fifth whorl on. The aperture is ovate, the outer lip is deeply lirate within, and the columella bears three weak folds. The siphonal canal is long, straight, open, and slightly bent to the right.

Aptyxis lamellosus (Borson, 1821) from the Pliocene of Italy is very similar in sculpture, but has a shorter siphonal canal. It is also separated by its protoconch, which is multispiral, consisting of 3.5 whorls (Chirli, 2000, p. 119). This species has been reported extensively in the Paratethys (i.e. Hörnes, 1854; Hoernes & Auinger, 1890; Csepreghy-Meznerics, 1954; Strausz, 1966). However, all these illustrations show shells with a longer siphonal canal than that of the Italian Pliocene specimens, and they probably represent a distinct species, especially the shells illustrated by Hörnes (1854, pl. 31, fig. 16), which are distinctly more slender and have a taller spire. Aptyxis palatinus (Strausz, 1954), from the middle Miocene Badenian of Hungary, is even closer to the Turkish species. The poor figures given by Strausz (1954, 1966) show a shell with less evenly convex spire whorls and stronger spiral sculpture. They could conspecific with Turkish specimens, but without better illustrations and protoconch data we hesitate to consider them to be conspecific.

Closely similar is the Recent Mediterranean *Aptyxis pulchellus* (Philippi, 1844), which also has a paucispiral protoconch. However, the spiral sculpture in the Recent species is stronger, the spiral cords are more elevated and the last whorl is shorter and more rounded, resulting in a small nearly circular aperture, rather than the more elongated ovate aperture of Turkish specimens. Numerous closely similar shells were described by Bellardi (1884) from the Italian Neogene. A revision of this group, including protoconch morphology, is required.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Streptochetus Cossmann, 1889

Type species – Fusus intortus Lamarck, 1803, by original designation. Eocene, France.

Streptochetus ornatus (d'Orbigny, 1852)

Plate 31, figs 7-9; Plate 67, fig. 9; Plate 80, fig. 1.

- 1845 *Fasciolaria valenciennesii* Grateloup, pl. 23, fig. 4 (*non* Kiener, 1840b).
- *1852 Fasciolaria ornata d'Orbigny, p. 71, no. 1284

(nom. nov. pro Fasciolaria valenciennesii Grateloup, 1847, non Kiener, 1840b).

- 1853 Fusus Valenciennesi Grat. Hörnes, p. 287, pl. 31, figs 13-15.
- 1904 Dolicholatirus? Valenciennesi (Grat.) Sacco, p. 28, pl. 7, figs 29, 30.
- 1912 Fusus Valenciennesi Grat. Schaffer, p. 142, pl. 50, figs 6-8.
- 1912 Fusus Valenciennesi Grat. Friedberg, p. 159 (partim, pl. 9, fig. 8 only).
- 1928 Streptochetus? dispar Peyrot, p. 65, no. 1026, pl. 6, figs 38, 39.
- 1935 *Dolicholatirus Valenciennesi* (Grat.) Montanaro, p. 60, pl. 4, fig. 14.
- 1950 Latirus (Dolicholatirus) dispar Peyrot 1928 Csepreghy-Meznerics, p. 55, pl. 2, fig. 14.
- 1958 Fusus clavatus (Brocchi) Erünal-Erentöz, p. 71, pl. 11, fig. 10 [non Fusinus clavatus (Brocchi, 1814)].
- 1960 Latirus (Dolicholatirus) dispar Peyrot 1928 Kojumdgieva & Strachimirov, p. 188, pl. 46, fig. 1.
- 1962 Fusus (Streptochetus) valenciennesi Grateloup Strausz, p. 78, pl. 27, figs 5-10.
- 1966 Fusus (Streptochetus) valenciennesi Grateloup, 1840 – Strausz, p. 347, pl. 27, figs 5-10.
- 1968 Latirus valenciennesi (Grateloup, 1840) Zelinskaya et al., p. 208, pl. 48, figs 27, 28.
- 1981 Fusus (Streptochetus) valenciennesi Grateloup Krach, p. 74, pl. 18, figs 1, 2.
- 1995 *Latirus valenciennesi* (Grateloup, 1840) Bałuk, p. 247, pl. 36, figs 1, 2.
- 1998 Latirus (Latirus) valenciennesi (Grateloup) Schultz, p. 68, pl. 27, fig. 4.

Dimensions and material – Maximum height 82.3 mm. Localities 2 & 3: JvdV/4, RGM 783 923/3, YI 297/21; locality 6: JvdV/2, RGM 783 859/1; locality 7: JvdV/2, locality 9: JvdV/1, RGM 783 834/1; locality 11: JvdV/1; locality 13: JvdV/10, RGM 974 021/3, YI 298/1; locality 17: NHMW 1847/0058/1089-1847/0058/1091/3, 1847/0058/1092/14, JvdV/50+, RGM 784 007/1, 783 791/50+, MTA 2013/044/8, YI 296/50+; locality 18: JvdV/2.

Discussion – Cadée & Janssen (1994) considered the genus Streptochetus Cossmann, 1889 to be restricted to the Eocene in Europe and the Miocene species referred to this genus by many authors were placed in the genus/subgenus Streptodictyon Tembrock (1961). Species of the genus Streptodictyon are characterised by having a multispiral sculptured protoconch, whereas Streptochetus species have a paucispiral protoconch. The shells from Turkey have a paucispiral protoconch with a large bulbous nucleus (Pl. 67, fig. 9) suggesting direct development. We therefore follow Snyder (2003) in placing this species in the genus Streptochetus.

Streptochetus ornatus (d'Orbigny, 1852) is very common in the sandy deposits of Seyithasan, where it attains a large size. As seen in the series illustrated, there is some variation in the slenderness of the shell, the strength of the axial ribs, which are subobsolete over the last whorl on many specimens, and the length of the siphonal canal. This species is very common in the middle Miocene of the Paratethys. Paratethyan shells differ from Turkish ones in their more prominent axial ribs on the spire whorls and last whorl, and by their coarser spiral ribs. Specimens with reduced axial sculpture are normal in the Karaman material, are extremely rare in the Paratethys and only represented by very large, old specimens, and even these specimens differ in their coarser spiral sculpture. Having said this, specimens with stronger axial sculpture also occur in the Turkish deposits, especially in specimens from the Akpınar deposits. It is possible that these are merely different ecophenotypes of one species. Under UV light the axial ribs in the Turkish shells can be seen to have a different colour from their interspaces (Pl. 80, fig. 1).

Distribution – Early Miocene: Paratethys (Aquitanian): Austria (Schaffer, 1912). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Peyrot, 1928); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1853; Schultz, 1998), Poland (Friedberg, 1912; Bałuk, 1995), Hungary (Strausz, 1962, 1966), Bulgaria (Kojumdgieva & Strachimirov, 1960), Ukraine (Zelinskaya *et al.*, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1904; Montanaro, 1935).

(Superfamily Volutoidea Rafinesque, 1815)

Note – Families in this section (Volutidae to Volutromitridae) were traditionally placed in the Volutoidea Rafinesque, 1815, but were transferred to the Muricoidea Rafinesque, 1815 by Bouchet & Rocroi (2005). They are here separated from the rest of the Muricoidea due to a *lapsus* discovered too late to rearrange such a large part of this work.

Family Volutidae Rafinesque, 1815 Subfamily Volutinae Rafinesque, 1815 Tribe Lyriini Pilsbry & Olsson, 1954 Genus Lyria Gray, 1847

Lyria taurinia (Michelotti, 1847)

Plate 32, fig. 1; Plate67, fig. 10; Plate 80, fig. 2

- 1820 Voluta papillaris nobis, Borson, p. 205, pl. 1, fig. 8 (non Gmelin, 1791).
- 1825 Voluta taurinia Bonelli, no. 2532 (unpublished).
- 1837 *Voluta magorum* Broc. var. Pusch, p. 117, pl. 11, fig. 2a, b (*non* Brocchi, 1814).
- *1847 Voluta Taurinia Bon., Michelotti, p. 319.
- 1852 Voluta taurinia Bon. Hörnes, p. 95, pl. 9, figs 14-16.
- 1880 Voluta taurinia Bon. Hoernes & Auinger, p. 72.
- 1890a *Lyria taurinia* (Bon.) var. A, B et C. Sacco, p. 8, pl. 1, figs 5a, b, 6.
- 1904 *Lyria taurinia* var. *subplanulata* Sacc., Sacco, p. 89.
- 1904 Lyria taurinia var. perventrosa Sacc., Sacco, p. 89.

- 1904 Lyria taurinia var. magnoventrosa Sacc., Sacco, p. 89.
- 1912 *Lyria taurinia* Bon. Friedberg, p. 121, pl. 6, fig. 8a, b.
- 1925 Lyria taurinia Bon. Kautsky, p. 132, pl. 9, fig. 12.
- 1955 *Lyria (Lyria) taurinia* Bon. Korobkov, pl. 77, fig. 1a, b.
- 1956 *Lyria taurinia* (Bonelli) Csepreghy-Meznerics, p. 415, pl. 9, figs 9, 10.
- 1958 *Lyria taurinia* (Bonelli) Erünal-Erentöz, p. 86, pl. 15, figs 5-8.
- 1960 *Lyria (Lyria) taurinia* (Bonelli 1825) Kojumdgieva & Strachimirov, p. 155, pl. 61, fig. 9.
- 1966 *Lyria taurinia* Bonelli, 1826 Strausz, p. 374, pl. 41, figs 11-14.
- 1973 Lyria taurinia (Bonelli) 1825 Bohn-Havas, p. 1118, pl. 6, fig. 18, pl. 10, fig. 1.
- 1990 Lyria (Lyria) picturata (de Grateloup, 1834) A.W. Janssen, p. 117 (partim, pl. 1, figs 3-6, 9 only).
- 1997 *Lyria (Lyria) picturata* (Grateloup, 1834) Bałuk, p. 41, pl. 13, figs 1-5 (*non* Grateloup, 1834).
- 1998 *Lyria (Lyria) taurinia* (Bonelli) Schultz, p. 70, pl. 28, fig. 11.
- 2007 Lyria taurinia Bonelli Tiţã, p. 548, fig. 5i.

Dimensions and material – Maximum height 70.2 mm. Localities 2 & 3: JvdV/33, RGM 783 919/4, YI 466/2; locality 6: JvdV/1, RGM 783 854/2; localities 7 & 8: JvdV/7, RGM 783 884/1; locality 9: JvdV/2, RGM 783 823/1; locality 10: YI 3/1; locality 12: JvdV/5, RGM 783 951/1; locality 13: NHMW 1847/0058/0342/12, JvdV/46, RGM 783 689/25, MTA 2013/045/11, YI 2/25 + 3 juveniles; locality 17: NHMW 1847/0058/0341/1, 1847/0058/0342/26, JvdV/31, RGM 777874/1 (ex JvdV coll.), RGM 783 787/27, RGM 794529/1, MTA 2013/046/15, YI 1/40; locality 18: JvdV/1. Exact locality unknown AÜ-LE-K-230/1.

Discussion – A.W. Janssen (1990) re-described and reviewed this species, and considered *Voluta taurinia* Michelotti, 1847 to be a junior subjective synonym of *Lyria picturata* (Grateloup, 1834). Janssen retained *Voluta oliva* Grateloup, 1845, which differs from *L. picturata* in having a more elevated spire, as a distinct 'forma'. The rank of 'forma' is not recognised by the Code of Zoological Nomenclature.

Bałuk (1997), whilst accepting A.W. Janssen's (1990) taxonomic position, noted that there were small differences in colour pattern between the French Aquitaine Basin shells and those from the Proto-Mediterranean Sea and Paratethys. As can be seen from the specimens illustrated from Saubrigues, Langhian of France (Fig. 25), as well as the specimens illustrated by Peyrot (1928, pl. 11, figs 38-44), the French shells have a colour pattern composed of three broad bands of vertical flammules, whereas all the Tethyan and Paratethyan material, and the type of *Lyria taurinia* (Michelotti, 1847), have a completely different colour pattern of narrow spiral stripes, which is preserved in most shells (Pl. 32, fig. 1; see also Bohn-Havas, 1973, pl. 10, fig. 1). The pattern is further enhanced under UV light, where irregular axial lines can be seen joining the spiral lines, giving the surface a vaguely chequered appearance (Pl. 80, fig. 2). Janssen (1990) also described a pattern of spiral stripes in his specimen from the late Burdigalian-Langhian of the North Sea Basin, confirmed by a well-preserved specimen from the same Miste deposits in the JvdV collection. Apart from the difference in colour pattern, the French shells have a smaller adult size, 36-42 mm (Peyrot, 1928), whereas some Turkish shells attain 70 mm in height. We have not seen the protoconch of the French specimens, reported to be smooth and paucispiral by Peyrot (1928), but that of the Turkish shells is dome-shaped, consisting of 2.5 whorls with a medium-sized nucleus (dp = 990 μ m, hp = 1040 μ m, dp/ hp = 0.95, dp1 = 510 μ m, dn = 300 μ m; Pl. 67, fig. 10).



Figure 25. Lyria picturata (Grateloup, 1834), middle Miocene, Langhian, Saubrigues, Aquitaine Basin, France; 1. Height: 35.6 mm (A. Cluzaud collection), 2. Height: 38.5 mm (J.-F. Lesport collection; photographs courtesy A. Cluzaud)

With such obvious differences in colour pattern, we feel it is unlikely that *L. picturata* and *L. taurinia* are conspecific. In order to be clear which specimens we consider to represent each species, we give below the synonymy of *Lyria picturata* (Grateloup, 1834)

- 1827 Voluta Mitraeformis Grateloup, p. 16 (non Lamarck, 1811).
- *1834b Voluta picturata Nob. Grateloup, p. 293.
- 1845 Voluta picturata Grat. Grateloup, pl. 39, figs 5-11.
- 1845 *Voluta oliva* Grateloup, pl. 46, Supplément, pl. I, fig. 8.

- 1928 Lyria picturata Grateloup Peyrot, p. 145, no.
 1080 [sic error for 1081], pl. 11, figs 38-44.
- 1928 *Lyria picturata* mut. *primitiva* Peyrot, p. 147, no. 1082, pl. 11, figs 9, 10.
- 1928 Lyria oliva (Grateloup) Peyrot, p. 147, no. 1083, pl. 11, figs 4-6.
- 1990 *Lyria* (*Lyria*) *picturata* (de Grateloup, 1834) A.W. Janssen, (*partim*, pl. 1, figs 1-2, 7 only).

Lyria taurinia is relatively common in both the clayey and sandy facies in the Karaman Basin deposits, where it grows to a larger size than the specimens reported by Sacco (maximum height: 55 mm; 1890a, 1904) from the Burdigalian Colli Torinesi of Italy, or the Langhian-Serravallian Paratethys (maximum height: 56 mm, Bałuk, 1997; 40 mm, Kojumdgieva & Strachimirov, 1960).

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Borson, 1820; Michelotti, 1847; Sacco, 1890a). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (A.W. Janssen, 1990), Germany (Kautsky, 1925). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1880; Schultz, 1998), Poland (Pusch, 1837; Friedberg, 1912; Bałuk, 1997), Hungary (Strausz, 1962, 1966; Csepreghy-Meznerics, 1956; Bohn-Havas, 1973), Bulgaria (Kojumdgieva & Strachimirov, 1960), Romania (Tiţã, 2007); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Subfamily Athletinae Pilsbry & Olsson, 1954 Genus *Athleta* Conrad, 1853

Type species – Voluta rarispina Lamarck, 1811, by original designation. Miocene, Europe.

Athleta ficulina (Lamarck, 1811)

Plate 32, fig. 2; Plate 67, fig. 11; Plate 68, fig. 1; Plate 80, fig. 3

- *1811 Voluta ficulina Lamarck, p. 79.
- 1814 Voluta coronata Brocchi, p. 306, pl. 15, fig. 7.
- 1814 Voluta affinis Brocchi, p. 306, pl. 15, fig. 8.
- 1845 *Voluta ficulina* Lam. Grateloup, pl. 38, figs 4, 6, 10, 11.
- 1845 Voluta affinis Al. Brong. Grateloup, pl. 38, figs 16, 17, 20.
- 1852 *Voluta ficulina* Lam. Hörnes, p. 92, pl. 9, figs 11, 12.
- 1897 Voluta ficulina Lam. Wolff, p. 284, pl. 27, fig. 14.
- 1904 Athleta ficulina (Lk.) Sacco, p. 91, pl. 19, figs 32, 33.
- 1904 Athleta ficulina var. anticelaevis Sacc., Sacco, p. 91, pl. 19, fig. 34.
- 1904 Athleta ficulina var. angustesulcata Sacc., Sacco, p. 91, pl. 19, fig. 35.
- 1914 *Volutolithes ficulina* Lam. Telegdi-Roth, p. 27, pl. 2, figs 4, 6, 7, 11.

- 1928 Volutolithes (Athleta) ficulina Lamarck Peyrot, p.
 151, no. 1085, pl. 10, figs 12, 14-17, pl. 11, fig. 11.
- 1928 Volutolithes (Athleta) ficulina Lamarck var. sulcata Grateloup – Peyrot, p. 153, no. 1086, pl. 11, figs 33-35.
- 1928 Volutolithes (Athleta) ficulina Lk. var. subaffinis
 d'Orb. Peyrot, p. 154, no. 1086bis, pl. 11, figs
 36, 37.
- 1936 *Volutolithes ficulina* n. var. *bistriata* Noszky, p. 72, pl. 5, fig. 77.
- 1955 Volutolithes (Neoathleta) affinis (Brocchi 1814) Rossi Ronchetti, p. 254, fig. 136.
- 1958 Athleta ficulina ficulina (Lam.) Seneš, p. 159, pl.22, figs 304-311.
- 1958 Volutolithes (Athleta) ficulina (Lamarck) Erünal-Erentöz, p. 83, pl. 12, figs 19, 20, pl. 13, figs 1, 2, 15.
- 1962 Athleta ficulina (Lamarck 1811) Hölzl, p. 183, pl. 10, fig. 3.
- 1964 Volutolithes (Athleta) ficulina (Lamarck) Râileanu & Negulescu, p. 178, pl. 15, figs 2, 3 [non fig. 1 = Athleta rarispina (Lamarck, 1811)].
- 1964 Athleta ficulina (Lamarck 1811) Anderson, p. 268, text-figs 17, 18.
- 1966 Voluta (Athleta) ficulina rarispina Lamarck, 1811
 Strausz, p. 372 (pars), pl. 65, figs 4, 8, 9 (non Voluta rarispina Lamarck, 1811).
- 1973 Athleta ficulina (Lamarck, 1811) Báldi, p. 307, pl. 43, figs 1-2.
- 1975 Athleta ficulina Lamarck, 1811 Báldi & Steininger, p. 346, pl. 5, figs 3, 4.
- 1978 Voluta affinis Brocchi, 1814 Pinna & Spezia, p.
 166, pl. 60, fig. 5.
- 1984a *Athleta (Athleta) ficulina* (Lamarck, 1811) A.W. Janssen, p. 248, pl. 64, figs 11, 12.
- 2001 *Athleta (Athleta) ficulina* (Lamarck, 1811) Wienrich, p. 508, pl. 89, figs 2, 3.
- 2004 *Athleta ficulina* (Lamarck 1811) İslamoğlu, p. 159, pl. 4, fig. 1.
- 2009 *Athleta (Athleta) rarispina* (Lamarck, 1811) Mikuž, p. 26, pl. 7, fig. 100.

Dimensions and material – Maximum height 82.7 mm. Localities 2 & 3: JvdV/8; locality 6: NHMW 1847/0058/1494/1, RGM 783 856/1; locality 9: JvdV/7, RGM 783 824/8, YI 5/5; locality 12: JvdV/10, RGM 783 952/5; locality 13: NHMW 1847/0058/0313-1847/0058/0324/13, 1847/0058/1676-1847/0058/1679/4, JvdV/38, RGM 777875/1 (ex JvdV coll.), RGM 784 029/1, RGM 783 690-783691/24, MTA 2013/047/1, YI 4/13. Exact locality unknown AÜ-LE-K-229/3.

Discussion – Lozouet *et al.* (2001a) considered *Voluta ficulina* and *Voluta rarispina* Lamarck, 1811 to constitute a single species, with several usually separable, but intergrading morphotypes. The most important forms are the *ficulina* morphotype, which is usually large, relatively elongate, with 8-10 sharp spines at the shoulder of the last whorl and irregular flat spiral bands developed down the entire dorsum of most specimens, and the *rarispina* morphotype, which has a stockier shell, with 4-8 spines at the

shoulder of the last whorl and spiral sculpture reduced to a few weak cords on the abapical half of the shell. The protoconch is paucispiral, consisting of 1.5-1.75 smooth whorls, with a large nucleus, and is indistinguishable in the two forms (Pl. 67, fig. 11; Pl. 68, figs 1, 2). Moreover, *Athleta rarispina* has only three blunt columellar folds, whereas *A. ficulina* has less prominent but more numerous folds.

Based on the plentiful Turkish material it is not possible to synonymise the two forms. In the Karaman deposits the two morphotypes are very clearly distinct, with no intermediate forms. Furthermore, there is also a distinct difference between their colour patterns, which are preserved in the Turkish shells when seen under UV light. Athleta ficulina has a pattern of numerous rows of very small axially elongate squares (Pl. 80, fig. 3), whereas A. rarispina has a similar pattern, but the squares are larger and there are fewer rows (Pl. 80, fig. 4). In the Turkish assemblages they also occur in different facies; the ficulina morphotype is found in the clayey deposits and the rarispina morphotype in the sandy ones. This suggests that they possibly represent ecophenotypes, however, in the Paratethyan assemblages both forms occur in the same deposits, and are relatively easily distinguished. Sexual dimorphism is also not a possibility, as the forms occur in different assemblages in the Karaman area, and we note that the *rarispina* morphotype does not occur in the Miocene of the North Sea Basin.

Another distinct species is Athleta haueri (Hörnes, 1852). This species is typically found in clayey deposits of the Paratethys, suggesting that it favoured slightly deeper habitats than the two Karaman species. It was first recorded as a very rare species from the shallow marine fauna of Gainfarn in the Vienna Basin by Hörnes (1852), but is more common in Romania (Nicorici, 1972), Bulgaria (Kojumdgieva & Strachimirov, 1960) and Poland (Bałuk, 1977). It is well characterised by its slender ovoid shell, subobsolete spines, densely spaced spiral grooves on the last whorl and the presence of three oblique columellar folds. The columellar folds and the reduced spines possibly point to a closer relationship of this species to Athleta rarispina than to A. ficulina. Hypothetically, A. haueri might thus represent a deepwater offshoot of the A. rarispina lineage, which - as discussed above - is usually found in (shallower) sandy depositional environments.

The roots of *Athleta ficulina* reach back to the Oligocene. Clearly conspecific shells are known from the Egerian (Chattian or Aquitanian) of the Paratethys (Báldi, 1973). Numerous additional taxa have been described from the Oligocene of Italy by Michelotti (1861) and Bellardi *in* Sacco (1890a) [*e.g. Voluta neglecta* Michelotti, 1961; *V. herberti* Michelotti, 1861; *Volutolithes* (*Neoathleta*) *obliquus* Bellardi *in* Sacco, 1890; *Volutolithes* (*Neoathleta*) *obliquus* Bellardi *in* Sacco, 1890]. The taxonomic status of most of these taxa needs revision but all seem to differ from *A. ficulina* and *A. rarispina* in their smaller size, their more slender and conical last whorl and their narrower aperture.

Distribution – Late Oligocene or earliest Miocene: Paratethys: Hungary (Telegdi-Roth, 1914; Báldi, 1973). Early Miocene: northeastern Atlantic (Aquitanian-Burdigalian): Aquitaine Basin, France (Peyrot, 1928); Paratethys: Romania (Râileanu & Negulescu, 1964); Germany (Hölzl, 1962); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1890a, 1904), Turkey (late Burdigalian): Kasaba Basin (İslamoğlu, 2004). Earlymiddle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (A.W. Janssen, 1984a), Germany (Anderson, 1964; Wienrich, 2001). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Grateloup, 1845, Peyrot, 1928), (Serravallian): Portugal (NHMW collection); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1880; Schultz, 1998), Poland (Bałuk, 1970, 1997), Hungary (Strausz, 1962, 1966), Romania (Hoernes & Auinger, 1880), Bulgaria (Kojumdgieva & Strachimirov, 1960), Slovenia (Mikuž, 2009); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Davoli, 1990).

Athleta rarispina (Lamarck, 1811)

Plate 32, fig. 3; Plate 68, fig. 2; Plate 80, fig. 4

- *1811 Voluta rarispina Lamarck, p. 79.
- 1825 Voluta rarispina Lam. de Basterot, p. 43, pl. 2, fig. 1.
- 1832 Voluta rarispina Deshayes, p. 1146, pl. 384, fig. 2a, b.
- 1838 Voluta rarispina Lamk. Bronn, p. 1107, pl. 42, fig. 40.
- 1840 Voluta Rarispina var. Dertonensis Bell. et Micht., Bellardi & Michelotti, pl. 168, pl. 7, figs 2, 3.
- 1845 Voluta rari-spina Lam. Grateloup, pl. 38, figs 1, 3, 7-9, 12, 13, 18, 19.
- 1852 Voluta rarispina Lam. Hörnes, p. 91, pl. 9, figs 6-10.
- 1853 Voluta rarispina Lamk. Deshayes, p. 74, pl. 122, figs 9, 10.
- 1866 Voluta rarispina Lamarck Fischer, p. 244.
- 1890a Volutolithes (Athleta) rarispina (Lamck.) Sacco,p. 18, pl. 1, fig. 22.
- 1899 Athleta rarispina Lamk. Cossmann, p. 142, pl. 4, fig. 24.
- 1914 Volutolithes rarispina Lam. Telegdi-Roth, p. 26, pl. 2, figs 1-3, 5, 12.
- 1916 Volutolithes rarispina (Lamck.) Stefanini, p. 67, pl. 2, figs 2, 3.
- 1928 Volutolithes (Athleta) ficulina Lamarck var. rarispina Lamarck – Peyrot, p. 155, no. 1087, pl. 11, figs 18-22.
- 1937 Volutolithes Telegdyi Gaál, p. 9, text-fig. 3.
- 1940 Volutolithes (Athleta) rarispina Lk. Roman, p. 363, pl. 2, fig. 19.
- 1954 Voluta (Athleta) ficulina rarispina Lk. Strausz, p. 79, text-fig. 3.
- 1954 Volutolithes (Athleta) ficulina rarispina Lam. Csepreghy-Meznerics, p. 49, pl. 7, figs 3, 5.
- 1958 Athleta telegdyi Gaál Seneš, p. 160, pl. 22, figs

288-293.

- 1958 Athleta ficulina rarispina (Lam.) Seneš, p. 160, pl. 22, figs 294-303.
- 1958 Volutolithes (Athleta) ficulina var. rarispina (Lamarck) – Erünal-Erentöz, p. 85, pl. 13, figs 3, 4.
- 1960 Athleta (Athleta) ficulina var. rarispina (Lamarck 1811) Kojumdgieva & Strachimirov, p. 154, pl. 41, figs 4-6.
- 1962 Athleta ficulina aff. rarispina (Lamarck 1811) Hölzl, p. 184, pl. 10, fig. 4.
- 1964 Volutolithes (Athleta) ficulina (Lamarck) Râileanu & Negulescu, p. 178, pl. 15, fig. 1 (non figs 2, 3 = Athleta ficulina).
- 1966 Voluta (Athleta) ficulina rarispina Lamarck, 1811
 Strausz, p. 373 (pars), pl. 64, figs 12, 14, pl. 65, figs 1-3, 5-7; pl. 66, figs 1, 2 (non pl. 65, figs 4, 8, 9 = Athleta ficulina)
- 1968 Athleta (Athleta) ficulina rarispina (Lamarck, 1811) Hinculov, p. 146, pl. 36, figs 10a-c.
- 1971a Athleta ficulina rarispina (Lamarck) Eremija, p. 75, pl. 6, fig. 11.
- 1972 Volutolithes (Athleta) ficulina rarispina Lam. Csepreghy-Meznerics, p. 31, pl. 14, figs 16, 18, 20.
- 1973 Athleta rarispina (Lamarck, 1811) Báldi, p. 306, pl. 42, figs 6, 7.
- 1973 Athleta (A.) rarispina (Lamarck) 1811 Bohn-Havas, p. 1061, pl. 6, figs 3, 4.
- 1975 Athleta rarispina Lamarck, 1811 Báldi & Steininger, p. 346, pl. 6, figs 1, 2.
- 1985 *Athleta (Athleta) ficulina rarispina* (Lamarck, 1811) Atanackovič, p. 163, pl. 36, figs 16, 17.
- 1990 Athleta (Athleta) rarispina (Lamarck, 1811) Davoli, p. 78, pl. 4, fig. 14.
- 1997 Athleta (Athleta) rarispina (Lamarck, 1811) Bałuk, p. 41, pl. 13, figs 10, 11.
- 1998 Athleta (Athleta) ficulina rarispina (Lamarck) Schultz, p. 70, pl. 28, fig. 10.
- 2003 Athleta (Athleta) rarispina (Lamarck 1811) İslamoğlu & Taner, p. 57, pl. 5, fig. 3.
- 2004 Athleta (Athleta) rarispina (Lamarck 1811) İslamoğlu, p. 159, pl. 4, fig. 2.

Dimensions and material – Maximum height 60.8 mm. Localities 2 & 3: JvdV/45, RGM 783 921/4, YI 6/13; locality 6: NHMW 1847/0058/1491/15, RGM 783 857/9; localities 7 & 8: NHMW 1847/0058/0337-1847/0058/0340/4, JvdV/5, RGM 783 905/1; locality 9: RGM 783 825/3; locality 10: YI 8/3; locality 13: JvdV/4; locality 17: NHMW 1847/0058/0325-1847/0058/0336/12, JvdV/50+, RGM 777 876/1 (ex JvdV coll.), RGM 784 030/3, RGM 783 788, 783 796-783 799/50+, MTA 2013/048/25, YI 7/50+. Exact locality unknown AÜ-LE-K-228/2.

Discussion – Athleta rarispina (Lamarck, 1811) is extremely common in the sandy deposits of Seyithasan. The size of adult shells varies considerably, with dwarf specimens found together with relatively large ones. Despite these size differences, the shells are relatively constant in shape and sculpture, with no shells approaching *A. ficulina*, which is restricted to the clayey deposits in the Karaman Basin. For further discussion, see under *Athleta ficulina* (Lamarck, 1811).

Volutolithes (Athleta) pygmaea Bellardi *in* Sacco, 1890, from the Italian Oligocene is comparable in shape and is possibly related to *A. rarispina*. It differs mainly in its smaller size and narrow aperture. *Volutolithes telegdyi* Gaál, 1937 was described from the late Egerian (= latest Chattian or early Aquitanian) of Slovakia (Seneš, 1958). It co-occurs with *A. rarispina* and seems to be only a very stout and ovoid morphotype of *A. rarispina* with reduced sculpture and a prominent callus.

Distribution - Late Oligocene or earliest Miocene: Paratethys: Hungary (Telegdi-Roth, 1914; Báldi, 1973). Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Peyrot, 1928); Paratethys (Aquitanian): Germany (Hölzl, 1962); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1890a), Turkey (late Burdigalian): Kasaba Basin (İslamoğlu, 2004). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Grateloup, 1845, Peyrot, 1928), (Serravallian): Portugal (NHMW coll.); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1880; Schultz, 1998), Poland (Friedberg, 1912; Bałuk, 1997), Hungary (Strausz, 1962, 1966; Csepreghy-Meznerics, 1954, 1972; Bohn-Havas, 1973), Bulgaria (Kojumdgieva & Strachimirov, 1960); Bosnia (Eremija, 1971a; Atanackovič, 1985), Romania (Hinculov, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Fischer, 1866; Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Davoli, 1990), Turkey (early Tortonian): Antalya Basin (İslamoğlu & Taner, 2003).

Family Harpidae Bronn, 1849 Subfamily Moruminae Hughes & Emerson, 1987 Genus *Oniscidia* Mörch, 1852

Type species – Oniscia cancellata Sowerby, 1825, by monotypy. Recent, Indo-West Pacific.

Note – Vokes (1998) summarised the use of the generic name Oniscidia Mörch, 1852, and whilst highlighting the clear shell differences between Oniscidia, which has cancellate shell sculpture, and Morum Röding, 1798 (type species Strombus oniscus Linné, 1767), which has tuberculate shell sculpture, she considered Onicidia to be a subgenus of Morum. This decision was based on marked similarities in anatomical characters between the two groups (Hughes & Emerson, 1987). The Oniscidia group is older, being present since the Eocene (MacNeil in MacNeil & Dockery, 1984, p. 113), whereas Morum is much younger geologically, being known only from late Miocene and younger beds of the New World (Vokes, 1998). It is unlikely that the cosmopolitan tropical genus Oniscidia is monophyletic with the New World genus Morum, and in keeping with the more restricted use of genera adopted here, we consider the two taxa distinct at full generic rank.

Oniscidia cythara (Brocchi, 1814)

Plate 32, fig. 4; Plate 80, fig. 5

- *1814 *Buccinum cythara* nob., Brocchi, p. 330, pl. 5, fig. 5a, b.
- 1825 Oniscia cithara Br. Sowerby, G.B. I, pl. 24, fig. 5.
- 1827 Cassidaria Harpaeformis Grateloup, p. 18.
- 1837 Oniscia Cythara var. polonica m., Pusch, p. 126, pl. 11, fig. 19.
- 1845 *Cassidaria harpaeformis* Grat., Grateloup, pl. 34, fig. 8.
- 1845 Cassidaria cythara Brocc. Grateloup, pl. 34, fig.7, 9, 18.
- 1847 Oniscia cythara Brocchi Michelotti, p. 219, pl. 12, figs 3, 4.
- 1852 Oniscia cithara Sow. Hörnes, p. 171, pl. 14, fig.
 2.
- 1867 *Oniscia cithara* Sow. Pereira da Costa, p. 125, pl. 16, fig.5.
- 1884 Oniscia cithara Brocc. Hoernes & Auinger, p. 154, pl. 17, figs 1-6.
- 1890b *Oniscia cithara* (Brocch.) Sacco, p. 76, pl. 2, figs 34-36.
- 1890b Oniscia cithara subv. acuticosta Sacc., Sacco, p. 77.
- 1890b Oniscia cithara subv. rotundicosta Sacc., Sacco, p. 77.
- 1890b *Oniscia cithara* subv. *subverrucosa* Sacc., Sacco, p. 77.
- 1890b *Oniscia cithara* var. *postapenninica* Sacc., Sacco, p. 78, pl. 2, fig. 37.
- 1890b Oniscia cithara var. pleuricostata Sacc., Sacco, p. 78, pl. 2, fig. 39.
- 1890b Oniscia postcythara Sacc., Sacco, p. 79, pl. 2, fig. 41.
- 1903 Oniscia (Oniscidia) cithara Br. Cossmann, p. 135, pl. 5, fig. 19.
- 1904 *Oniscia cithara* subv. *acuticosta* Sacc., Sacco, p. 100, pl. 21, fig. 23.
- 1904 Oniscia cithara subv. rotundicosta Sacc., Sacco, p. 100, pl. 21, fig. 24.
- 1912 Oniscia cithara Brocc. Friedberg, p. 116, pl. 6, fig. 5.
- 1924 Oniscia (Oniscidia) harpaeformis Grateloup Cossmann & Peyrot, p. 428, no. 721, pl. 12, figs 18-20.
- 1954 Lambidium cytharum (Brocchi) Csepreghy-Meznerics, p. 33, pl. 4, figs 1-3.
- 1955 *Morum (Oniscidia) cytharum* (Brocchi) 1814 Rossi Ronchetti, p. 166, fig. 86.
- 1956 *Lambidium cytharum* Brocchi Csepreghy-Meznerics, p. 433, pl. 4, figs 15-16.
- Morum cytharum (Brocchi 1814) Kojumdgieva & Strachimirov, p. 135, pl. 61, fig. 9.
- 1962 Morum (Oniscidia) cythara Brocchi Strausz, p. 137, pl. 64, figs 8, 9.
- 1966 Morum (Oniscidia) cythara Brocchi, 1814 Strausz, p. 242, pl. 64, figs 8, 9.
- 1968 *Morum cytharum* (Brocchi 1814) Zelinskaya *et al.*, p. 182, pl. 43, figs 7, 8.

- 1985 Morum (Oniscidia) cythara (Brocchi, 1814) Atanackovič, p. 135, pl. 30, figs 13, 14.
- 1997 *Morum (Oniscidia) cythara* (Brocchi, 1814) Bałuk, p. 201, pl. 16, figs 7, 8.
- Morum (Oniscidia) cythara (Brocchi) Schultz, p. 60, pl. 23, fig. 11.
- 2001a *Morum (Oniscidia) harpaeforme* (Grateloup, 1827) Lozouet *et al.*, p. 64.

Dimensions and material – Maximum height 50.9 mm. Localities 2 & 3: JvdV/1), YI 10/1; localities 7 & 8: NHMW 1847/0058/0346/2; locality 17: NHMW 1847/0058/0344/1, 1847/0058/0345/44, JvdV/13, RGM 777 877/1 (ex JvdV coll.), RGM 783 754/4, MTA 2013/049/4, YI 9/14.

Discussion - Lozouet et al. (2001a, p. 64) listed, but did not illustrate Morum (Oniscidia) harpaeforme (Grateloup, 1827) from the early Miocene Aquitanian of France. Their synonymy is somewhat confusing, as d'Orbigny's (1852, no. 1663, p. 89) citation of Oniscia cithara Sowerby is included in their synonymy, despite Sowerby (1825) referring to Brocchi's (1814) publication of this name. They also included in their synonymy the citation by Cossmann & Peyrot (1924), who in their discussion clearly considered the French, Italian and Paratethyan shells to be a single species, Oniscia (Oniscidia) harpaeformis Grateloup. It is therefore unclear whether Lozouet et al. (2001a) considered the French, Italian and Paratethyan shells to be conspecific or not, and if so, why the younger name was chosen, as the only possible earlier homonym, Buccinum cithara Solander (= Lightfoot, 1786) is a nomen nudum. As for the trivial name, Sowerby's (1825) emendation of cythara to cithara was considered to be unjustified by Petit (2009).

In the present authors' opinion two species of Oniscidia Mörch, 1852 were present in the European Miocene: Oniscidia variolosum (Grateloup, 1834) (= Oniscia verrucosa Michelotti, 1840) and Oniscidia cythara Brocchi, 1814 (= Cassidaria harpaeformis Grateloup, 1827). We have not seen any specimens of O. variolosum, but it is said to differ from O. cythara in the form of its sculpture, which is composed of more numerous axial ribs, which are deeply incised by the spiral cords forming tubercular surface sculpture, in having columellar folds (the number of which is not clear from the description) and a stronger columellar callus (Cossmann & Peyrot, 1924). Unfortunately, all the illustrations we have seen of O. variolosum show rather abraded specimens. Both species were present in the northeastern Atlantic and Tethyan Aquitanian-Burdigalian, but only O. cythara survived into the Serravallian, and is present in the northeastern Atlantic, Proto-Mediterranean Sea and Paratethys, and disappeared at the end of the Tortonian. We here record O. cythara for the first time from the late Burdigalian-Langhian of the North Sea Basin, represented by a single well-preserved adult specimen from Winterswijk-Miste, Netherlands, in the JvdV collection.

Oniscidia cythara is not uncommon in the sandy facies

of the Karaman assemblages. The Turkish specimens are lighter-shelled, tend to have slightly more numerous and weaker axial ribs, and the columellar callus is thinner with more pustules and irregular folds than many of the specimens we have seen from the Paratethys. Moreover, most of the Paratethyan shells have weak labral denticles and a prominent thickening in the mid-portion of the outer lip, whereas the outer lip is thinner and the denticles are more strongly developed in the Karaman shells. One might be tempted to consider them distinct at some taxonomic level, but the number of ribs overlap between the Paratethyan and Turkish shells. A colour pattern is enhanced under UV light in the Karaman shells, consisting of two narrow spiral lines on the last whorl and a distinct colour along the tops of the axial ribs on the spire (Pl. 80, fig. 5). This is a common colour pattern in living Onisicidia species.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Grateloup, 1827, 1845, Cossmann & Peyrot, 1924; Lozouet et al., 2001a); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Brocchi, 1814; Borson, 1820; Michelotti, 1847; Sacco, 1890b). Early-Middle **Miocene:** North Sea Basin (late Burdigalian-Langhian): Netherlands (JvdV coll.). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1924), (Serravallian): Portugal (NHMW coll.); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1884; Schultz, 1998), Poland (Pusch, 1837; Bałuk, 1995), Hungary (Strausz, 1962, 1966; Csepreghy-Meznerics, 1954, 1956), Bosnia (Atanackovič, 1985), Bulgaria (Kojumdgieva & Strachimirov, 1960), Romania (Hoernes & Auinger, 1884), Ukraine (Friedberg, 1912; Zelinskava et al., 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1890b, 1904).

Family Marginellidae Fleming, 1828 Subfamily Marginellinae Fleming, 1828 Tribe Prunini Coovert & Coovert, 1995 Genus *Volvarina* Hinds, 1844

Type species – Marginella nitida Hinds, 1844 [= *Mar-ginella (Volvarina) nitida* Hinds, 1844, = *Voluta mitrella* Risso, 1826), by subsequent designation (Redfield, 1871)]. Recent, eastern Atlantic and Mediterranean.

Volvarina mitrella (Risso, 1826)

Plate 32, Figs 11-13

- *1826 Voluta mitrella Risso, p. 250, pl. 10, fig. 143.
- 1989 Volvarina mitrella (Risso, 1826) Gofas, p. 162, figs 2-7.
- 2002 Volvarina cozziniana Chirli, p. 27, pl. 14, figs 5-12.

- 2003 Volvarina mitrella (Risso, 1826) Giannuzzi-Savelli et al., p. 270, figs 684-690.
- 2006c *Volvarina mitrella* (Risso, 1826) Landau *et al.*, p. 35, pl. 9, figs 1-8.

Dimensions and material – Maximum height 12.7 mm. Localities 7 & 8: NHMW 1847/0058/0358-1847/-0058/0360/3, NHMW 1847/0058/0361/3; locality 17: NHMW 1847/0058/0362/3, JvdV/2, YI 114/6.

Discussion - Marginellids are poorly represented in the Turkish assemblages, and Volvarina mitrella (Risso, 1826) is the largest species found in the Karaman Miocene. It is characterised by its relatively elevated spire and the absence of an external labial varix. The Recent populations show a wide range of variability (Gofas, 1992; Giannuzzi-Savelli et al., 2003). Some smaller, narrower specimens are similar to Marginella nitida Hinds, 1844, whereas broader shells with a strongly inflected outer lip correspond to Marginella inflexa G.B. Sowerby, II, 1846. Both these names were treated as synonyms of Volvarina mitrella by Gofas (1989). This same range of variability can be seen in the Karaman material. Landau et al. (2006c) also considered Volvarina cozziniana Chirli, 2002, described from the early Pliocene of Italy, to be a junior subjective synonym. For further discussion see Landau et al. (2006c, p. 36).

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Landau *et al.*, 2006c); central Mediterranean, Italy (Chirli, 2002). Pleistocene: central Mediterranean, Cyprus (NHMW collection). Recent: Mediterranean, 40-80 m depth. The geographical range stops West of Gibraltar, where it does not occur (Gofas, 1989).

Volvarina oblongata (Sacco, 1890, *ex* Bellardi ms) Plate 32, figs 14, 15

- *1890a Marginella (Volvarina) oblongata Bell. in Sacco, p. 28, pl. 2, fig. 13.
- 1899 Marginella (Volvarina) oblongata Bon. Cossmann, p. 93, pl. 4, fig. 21.
- 1968 Hyalina (Volvarina) oblongata (Bellardi, 1890) Robba, p. 568, pl. 43, fig. 7.
- Marginella (Volvarina) oblongata Bellardi in Sacco, 1890 – Ferrero Mortara *et al.*, p. 177, pl. 54, fig. 5.

Dimensions and material – Maximum height 6.9 mm. Locality 17: NHMW 1847/0058/0363/1, 1847/0058/0364/1, NHMW 1847/0058/0365/3, JvdV/24, RGM 783 983/3 + 9 fragments, YI 18/13.

Discussion – The very elevated spire makes *Volvarina oblongata* (Sacco, 1890, *ex* Bellardi ms) quite distinct from any of its European fossil or living congeners.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1890; Cossmann, 1899; Robba, 1968).

Family Cystiscidae Stimpson, 1865 Subfamily Persiculinae Coovert & Coovert, 1995 Genus *Gibberula* Swainson, 1840

Type species – Gibberula zonata Swainson, 1840 (= *Volvaria oryza* Lamarck, 1822), by monotypy. Recent, Eastern Atlantic.

Gibberula conoidea (Sacco, 1890, *ex* Bellardi ms) Plate 32, fig. 16; Plate 68, fig. 5

- *1890a *Marginella (Persicula) conoidea* Bell. *in* Sacco, p. 29, pl. 2, fig. 17.
 - Marginella (Persicula) conoidea Bellardi in Sacco, 1890 – Ferrero Mortara et al., p. 178, pl. 54, fig.9.

Dimensions and material – Maximum height 2.5 mm. Localities 2 & 3: JvdV/23; locality 6: JvdV/50+, RGM 783 996/2, YI 20/1; localities 7 & 8: NHMW 1847/0058/0368/30, JvdV/50+, RGM 783 959/2; locality 13: JvdV/50+, YI 19/1; locality 17: NHMW 1847/0058/0366/1, NHMW 1847/0058/0367/9, JvdV/50+, RGM 784 042/2, RGM 783978/50+, YI 115/13.

Discussion - Gibberula conoidea (Sacco, 1890, ex Bellardi ms) belongs to a group of tiny conical European Neogene Gibberula species, which did not leave any living representatives. The group consists of G. conoidea, originally described from the late Miocene Tortonian of the Po Basin, Italy, G. pilarae Muñiz Solís, 1996 from the western Mediterranean early Pliocene Estepona Basin, Spain, and G. 'sabatica' of Chirli (2002) (non Sacco, 1890, ex Bellardi ms) from the early Pliocene of Italy. All these species have a maximum height of just over 2.5 mm. Gibberula pilarae is the broadest of the three species, with a prominent high-placed shoulder and a strongly thickened and rounded outer lip. Gibberula 'sabatica' and G. conoidea are similar in shape, but the outer lip in G. 'sabatica' becomes thinner abapically and the aperture is dilated in the anterior portion, whereas this is not the case in G. conoidea, in which the aperture is roughly of equal width along its entire length.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1890).

Gibberula sp.

Plate 68, fig. 6

Dimensions and material – Height 3.9 mm. Locality 6: RGM 784 070/1.

Discussion – A single shell from the Lale forest deposits represents a second Gibberula species, easily separated from Gibberula conoidea (Sacco, 1890, ex Bellardi ms), with which it co-occurs, by its larger size and quite different shell shape. The shell is somewhat abraded and the dorsum is damaged. Nevertheless, it is characterised by its stocky ovate profile, low spire, bevelled outer lip bearing coarse teeth on its inner edge, six columellar folds of which the anterior two are far stronger than the others, although the second abapical fold does not extend far over the columella, and rather short anterior end, which is well delimited by a clear constriction at the base. Gibberula sabatica (Sacco, 1890, ex Bellardi ms) described from the early Pliocene of Italy is closely similar, with the anterior columellar folds similarly developed, but differs in having a more cylindrical profile, the basal constriction is less evident and the teeth within the outer lip are finer. Gibberula jriae (Sacco, 1890, ex Bellardi ms), also from the early Pliocene of Italy, is also quite similar, but the outer lip ascends adapically higher and joins the last whorl at a wider angle. The teeth within the outer lip are much finer than in the Turkish shell. We note that G. jriae of Chirli (2002, p. 19, pl. 10, figs 1-12) corresponds to G. sabatica, whereas G. sabatica of Chirli (2002, p. 20, pl. 10, figs 13-16, pl. 11, figs 1-8) is a very distinct, probably undescribed species, similar to Gibberula pilarae Muñiz Solís, 1996 (see Landau et al., 2006c). Gibberula brevis (Bellardi, 1890) from the late Miocene Tortonian of Italy has a far more cylindrical shape and very fine outer lip denticles. Gibberula proxima Landau, La Perna & Marquet (2006c) from the early Pliocene western Mediterranean of Spain differs again in having finer outer lip teeth and the two anterior columellar folds extend from the columellar margin over the venter. The same differences separate the Recent Mediterranean species Gibberula recondita Monterosato, 1884. The Paratethyan species reported as Gibberula philippii (Monterosato, 1878) by Bałuk (1997, pl. 18, figs 1-3) is quite different, with a more cylindrical shell and a much taller spire.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Mitridae Swainson, 1829 Subfamily Mitrinae Swainson, 1829 Genus *Episcomitra* Monterosato, 1917

Note – The genus *Mitra* Lamarck, 1798 has been used widely in both Recent and fossil faunas. It is unlikely that all these '*Mitra*'s' form one global monophyletic group and following the more restricted use of genera adopted in this work, we believe the genus *Mitra* should be used only for Indo-Pacific shells with a barbed or crenulated outer lip (see Landau *et al.*, 2011). *Fusimitra* Conrad, 1855

is the genus group containing the tropical American species of the *Mitra swainsoni* group (Landau *et al.*, 2010). The European Neogene '*Mitra*'-species of the *M. fusiformis* group and Recent Mediterranean species should be placed in *Episcomitra* Monterosato, 1917, type species *Mitra zonata* Marryat, 1818. Apart from the non-barbed outer lip the European species tend to have spiral sculpture restricted to the base, whereas many of the Pacific *Mitra* species have a totally spirally striate teleoconch.

Episcomitra brevis (Bellardi, 1887)

Plate 33, fig. 1

*1887a *Mitra brevis* Bell., Bellardi, p. 12, pl. 3, fig. 28
1981 *Mitra brevis* Bellardi, 1887 – Ferrero Mortara *et al.*, p. 147, pl. 40, fig. 7.

Dimensions and material – Maximum height 13.6 mm. Locality 17: RGM 794 082/1 (ex JvdV collection).

Discussion – We have provisionally identified this single, incomplete specimen as *Episcomitra brevis* (Bellardi, 1887). It is characterised by its small size and squat oval shape, which is unusual for the genus.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1887a; Davoli, 2000).

Episcomitra fusiformis (Brocchi, 1814) Plate 33, fig. 2

- *1814 Voluta fusiformis nob., Brocchi, p. 315.
- 1852 *Mitra fusiformis* Brocc. Hörnes, p. 98 (*partim*, pl. 10, fig. 4 only).
- 1872 Mitra fusiformis Brocchi Wood, p. 8, pl. 5, fig. 3.
- 1880 Mitra fusiformis Brocc. Hoernes & Auinger, p. 75 (partim, pl. 8, fig. 25 only).
- 1880 Mitra venayssiana Fontannes, p. 79, pl. 6, fig. 1.
- 1887a Mitra fusiformis Brocch. Bellardi, p. 23, pl. 1, fig. 21.
- Mitra fusiformis var. parvobrevis Sacc., Sacco, p. 81, pl. 18, fig. 14.
- Mitra fusiformis var. subangulosa Sacc., Sacco, p. 81, pl. 18, figs 15, 16.
- 1911 Mitra fusiformis Br. Cerulli-Irelli, p. 235, pl. 38, fig. 19.
- 1911 *Mitra fusiformis* var. *angulifera* Cerulli-Irelli, p. 235, pl. 38, fig. 20.
- 1911 *Mitra fusiformis* var. *mariana* Cerulli-Irelli, p. 235, pl. 38, fig. 21.
- 1955 *Mitra (Mitra) fusiformis* (Brocchi 1814) Rossi Ronchetti, p. 250, fig. 133.
- 1958 Mitra (Mitra) fusiformis (Brocchi) in Hoernes Erünal-Erentöz, p. 80, pl. 12, figs 13, 14.
- 1959 Mitra fusiformis desita Bellardi Ruggieri et al.,p. 85, pl. 18, figs 111, 113.

- 1974 *Mitra (Mitra) fusiformis* (Brocchi, 1814) Malatesta, p. 356, pl. 28, figs 10, 11, pl. 29, fig. 18.
- 1975 *Mitra fusiformis* var. *subangulosa* Sacco Fekih, p. 132, pl. 39, fig. 8.
- 1976 *Mitra fusiformis* (Brocchi, 1814) Caprotti, p. 11, pl. 16, fig. 26.
- 1976 *Mitra fusiformis* subsp. *fusiformis* Cernohorsky, p. 367, pl. 320, figs 1, 2.
- 1978 Voluta fusiformis Brocchi, 1814 Pinna & Spezia,
 p. 168, pl. 53, fig. 3.
- ?2000 Mitra aff. fusiformis Brocchi, 1814 Davoli, p. 176, pl. 2, figs 14-16.
- 2002 *Mitra fusiformis* (Brocchi, 1814) Chirli, p. 33, pl. 17, figs 1-5.
- 2003 *Mitra (Mitra) fusiformis* (Brocchi 1814) İslamoğlu & Taner, p. 56, pl. 4, fig. 11, pl. 5, fig. 1.
- 2011 Episcomitra fusiformis (Brocchi, 1814) Landau et al., p. 29, pl. 15, fig. 2.
- non 1833b Mitra fusiformis Brocchi Grateloup, p. 292, no. 555 [= Episcomitra dufresnei (Basterot, 1825)].
- non 1852 Mitra fusiformis Brocc. Hörnes, p. 98 (partim, pl. 10, fig. 5 only) [= Episcomitra repleta (Bellardi, 1887)].
- non 1852 Mitra fusiformis Brocc. Hörnes, p. 98 (partim, pl. 10, fig. 6 only) [= Episcomitra friedbergi (Cossmann, 1912)].
- *Mitra fusiformis* Brocc. Pereira da Costa, p. 66,
 pl. 12, figs 8-11 [= *Episcomitra pereirai* (Brébion, 1957)].
- non 1880 Mitra fusiformis Brocc. Hoernes & Auinger, p. 75 (partim, pl. 8, fig. 26 only) [= Episcomitra hoernesi (Mayer, 1864)].
- non 1880 Mitra fusiformis Broce. Hoernes & Auinger, p. 75 (partim, pl. 8, figs 27-29 only) [= Episcomitra friedbergi (Cossmann, 1912)].
- non 1954 Mitra fusiformis Br. –Strausz, p. 75, pl. 4, fig. 83 [= Episcomitra hoernesi (Mayer, 1864)].

Dimensions and material – Maximum height 69.8 mm. Locality 12: RGM 783 623/6; locality 13: NHMW 1847/0058/0369/1, NHMW 1847/0058/0370/14, JvdV/32, RGM 783 693/12, MTA 2013/056/2, YI 203/8. Exact locality unknown: AÜ LE-K-226/2.

Discussion – As discussed by Cernohorsky (1976, p. 374), the European Mitridae are in need of revision. Many of the species described by Bellardi (1887a, b; 1888) are probably juveniles or variants of a small number of previously described and well-known species. A revision of these forms is beyond the scope of this work, but our Turkish specimens are fairly typical of *Episcomitra fusiformis* (Brocchi, 1814).

Episcomitra fusiformis does not seem to have been present in the Atlantic Miocene of France. Records of *Mitra fusiformis* by Grateloup (1833, 1845) refer to *Episcomitra dufresnei* (de Basterot, 1825), which is similar in shape to *E. fusiformis*, but differs in having a wider siphonal canal and a longer and more twisted siphonal fasciole. The French species is highly variable in shell width (see Peyrot, 1928; Cernohorsky, 1976), with the slender forms closest in shape to *E. fusiformis*, but the difference in siphonal canal and fasciole are constant. There is also no undisputed record of this species from the early-mid-dle Miocene Proto-Mediterranean Sea, although some of Bellardi's 'species' probably represent *E. fusiformis* (Cernohorsky, 1976). The shells illustrated by Pereira da Costa (1866, pl. 12, figs 8-11) as *M. fusiformis* were considered to be a distinct species by Brébion (1957), differing from *M. fusiformis* in being smaller, distinctly shouldered just below the suture, and in having four columellar folds instead of five as in *E. fusiformis*.

Distribution - Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1852; Hoernes & Auinger, 1880); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Davoli, 2000), (early Tortonian): Antalya Basin, Turkey (İslamoğlu & Taner, 2003). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011), western Mediterranean, Estepona Basin, Spain (NHMW collection), Roussillon Basin, France (Fontannes, 1880); central Mediterranean, Italy (Chirli, 2002); Tunisia (Fekih, 1975). Early-late Pliocene: North Sea Basin, England (Wood, 1872); central Mediterranean, Italy (Bellardi, 1887; Sacco, 1904; Ruggieri et al., 1959; Malatesta, 1974). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1911).

Episcomitra oblongula (Bellardi, 1887) Plate 33, fig. 3

- *1887a *Mitra oblongula* Bell., Bellardi, p. 36, pl. 3, fig. 13 (as *oblongata* on plate caption).
- 1981 *Mitra oblongula* Bellardi, 1887 Ferrero Mortara *et al.*, p. 152, pl. 44, fig. 4.

Dimensions and material – Maximum height 30.8 mm. Locality 17: JvdV/1, RGM 794 561/1 (ex JvdV collection), YI 226/1; locality 17a: NHMW 1847/0058/1598/1.

Discussion – Episcomitra oblongula (Bellardi, 1887) is characterised by its slender, smooth shell, straight-sided whorls, stepped suture and relatively short aperture in relation to total height. Under UV light a clear colour pattern of fine spiral lines is visible. Bellardi (1887a, b) described numerous mitrids from the Italian Neogene deposits, some of which, such as *Mitra polygyrata* Bellardi, 1887 (see Ferrero Mortara *et al.*, pl. 46, fig. 4), are possibly synonyms of *E. oblongula*.

Distribution – **Early Miocene**: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1887a). **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subfamily Imbricariinae Troschel, 1867 Genus *Cancilla* Swainson, 1840 *Type species – Tiara isabella* Swainson, 1831, by subsequent designation (Hermannsen, 1846). Recent, Pacific.

Cancilla planicostata (Bellardi, 1887)

Plate 33, figs 4-8; Plate 80, fig. 7

- 1852 Mitra scrobiculata Brocc. Hörnes, p. 102 (partim, pl. 10, fig. 17 only) (non Brocchi, 1814).
- Mitra (Nebularia) scrobiculata Brocc. Hoernes & Auinger, p. 80 (partim, pl. 9, fig. 17 only) (non Brocchi, 1814).
- 1887a *Mitra exarata* Bell., Bellardi, p. 84, pl. 4, fig. 53 (*non* A. Adams, 1853).
- *1887b Mitra planicostata Bell., Bellardi, p. 5, pl. 2, fig. 9.
- 1904 *Cancilla planicostata* var. *bifidocostata* Sacc., Sacco, p. 84, pl. 18, fig. 54.
- 1904 Cancilla planicostata var. lingusticocontorta Sacc., Sacco, p. 84, pl. 18, fig. 55.
- 1958 Mitra (Cancilla) grateloupi (d'Orbigny) Erünal-Erentöz, p. 81, pl. 12, fig. 17 (non d'Orbigny, 1852).
- 1958 Mitra (Cancilla) scrobiculata var. karamanensis Erünal-Erentöz, p. 82, pl. 12, fig. 18.
- Mitra (Tiara) grateloupi d'Orbigny 1852 –
 Kojumdgieva & Strachimirov, p. 157, pl. 42, fig. 1.
- 1962 Mitra (Nebularia) scrobiculata Brocchi Strausz,
 p. 77, (partim, pl. 26, figs 6, 7 only) (non Brocchi, 1814).
- Mitra (Nebularia) scrobiculata Brocchi, 1814 Strausz, p. 365 (partim, pl. 26, figs 6, 7 only) (non Brocchi, 1814).
- 1981 Mitra exarata Bellardi, 1887 Ferrero Mortara et al., p. 162, pl. 50, fig. 1.
- 1981 *Mitra planicostata* Bellardi, 1887 Ferrero Mortara *et al.*, p. 162, pl. 50, fig. 2.
- 2000 *Cancilla planicostata* (Bellardi, 1887) Davoli, p. 187, pl. 4, figs 6, 7.
- 2002 Cancilla planicostata (Bellardi, 1887) Chirli, p. 45, pl. 22, figs 10, 11.
- 2008 *Cancilla planicostata* (Bellardi, 1887) Chirli & Richard, p. 52, pl. 10, fig. 1.

Dimensions and material – Maximum height 40.3 mm. Localities 2 & 3: JvdV/19; localities 7 & 8: NHMW 1847/0058/0377/16, JvdV/23, RGM 777 879/1 (ex JvdV collection), RGM 783 912/4, MTA 2013/057/6, YI 220/15; locality 9: JvdV/1, RGM 783 830/4; locality 12: JvdV/17, RGM 783 625/1; locality 13: NHMW 1847/0058/0371-1847/0058/0375/5, 1847/0058/0371/1, 1847/0058/0376/15, JvdV/50+, RGM 783 695/50+, YI 223/50+; locality 17: NHMW 1847/0058/0378/10, JvdV/17, RGM 783 800/1, YI 221/30.

Discussion – Several closely similar mitrid species from the late Miocene of Italy were described by Bellardi (1887b), characterised by having slender shells with evenly convex or weakly shouldered whorls and narrow spiral cords. The differences between the various species described by Bellardi (1887b) depended primarily on the width of the cords relative to their interspaces, so that Mitra exarata Bellardi, 1887 (non A. Adams, 1853) and Mitra planicostata Bellardi, 1887 were said to have relatively broad spiral cords, separated by narrow groove-like interspaces, M. exarata differing from *M. planicostata* by having weakly shouldered whorls. The interspaces in the broad-corded group are so narrow that the axial threads give them a pitted appearance. On the other hand, Mitra elegantissima Bellardi, 1887 and M. exornata Bellardi, 1887 were said to have relatively narrow, sharp spiral cords separated by interspaces crossed by numerous axial threads, giving the interspaces a cancellate appearance. Mitra exornata differs from M. elegantisima by having a more elongate shell with more convex spire whorls and more widely spaced spiral cords, five on the penultimate whorl and 16 on the last whorl in the holotype (Ferrero Mortara et al., 1981, pl. 50, fig. 4), with secondary spiral threads in some of the interspaces.

In the Turkish deposits a mitrid of this group is very common in the clayey deposits. The shells are somewhat variable in shape. Some specimens are very slender (Pl. 33, fig. 6), whilst other are somewhat broader with the whorls distinctly shouldered (Pl. 33, fig. 5) and represent the form described by Bellardi (1887b) as *Mitra exarata*. The ribs are distinctly rounded, and are separated by narrow pitted grooves in most specimens (Pl. 33, fig. 5), which in some specimens are somewhat wider (Pl. 33, fig. 8). In a few specimens the ribs are sharp as in *Cancilla elegantissima* (Pl. 33, fig. 4), but not as numerous as in the Italian species. A colour pattern of broad vertical flammules is preserved and is enhanced under UV light in most specimens representing all these forms (Pl. 80, fig. 7).

Therefore, based on the large number of shells found in the Karaman assemblages we suggest that these forms represent extremes of a single species. The name *Cancilla planicostata* is chosen for this species as first revisers, as it represents the most common form and *Mitra exarata* Bellardi 1887 is a primary homonym of the Recent Pacific species *M. exarata* A. Adams, 1853. We do not place *C. elegantissima* in synonymy as it seems to have more numerous spiral cords, nor *Cancilla exornata*, which has secondary sculpture in the interspaces between the primary cords.

Cancilla pulcherrima (Bellardi, 1887) is another 'cancellate' Italian late Miocene species, with sculpture similar to the narrow-corded forms, but it has a different shell profile with a somewhat opistocyrt spire, the last adult whorl is more inflated, and the siphonal canal is longer.

Numerous closely similar species occur in the European Neogene, some of which may well be further synonyms of *Cancilla planicostata*. *Cancilla bronni* (Michelotti, 1847) from the late Miocene of the Po Basin, Italy, is illustrated in the literature by consistently poor or incomplete specimens (Pelosio, 1967; Robba, 1968; Davoli, 2000) and is difficult to compare, but seems to have more strongly pitted grooves, which on early whorls give the shells a somewhat cancellate appearance. *Cancilla* transiens (Bellardi, 1887) is closely similar, although the spiral cords seem to be flatter and subobsolete on the last whorl, whereas in the Karaman specimens the cords remain distinct throughout. Cancilla grateloupi (d'Orbigny, 1852) from the North Sea Basin (Glibert, 1952b; A.W. Janssen, 1984b) and northeastern Atlantic Miocene (Peyrot, 1928) is also similar, but has flattened cords and a slightly shorter last whorl. Cancilla scrobiculata (Brocchi, 1814), widespread in the Mediterranean Pliocene, reaches a much larger adult size, is relatively broader, the spiral sculpture weakens on later whorls and is often subobsolete on the last whorl, and the siphonal fasciole is more strongly developed. The Miocene forms recorded in the literature as M. scrobiculata represent a distinct species, Cancilla praescrobiculata (Toldo, 1889), which differs from the Pliocene species in sculptural details (see Davoli, 2000). Cancilla suballigata (Bellardi, 1887) and C. alligata (Defrance, 1824) both differ in having flattened spiral cords.

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1887a). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1852), Bulgaria (Kojumdgieva & Strachimirov, 1960), Romania (Hoernes & Auinger, 1880), Hungary (Strausz, 1962, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Davoli, 2000). Early Pliocene: western Mediterranean, Roussillon Basin, France (Chirli & Richard, 2008); central Mediterranean, Italy (Bellardi, 1887a; Sacco, 1904; Chirli, 2002).

Cancilla praescrobiculata (Toldo, 1889)

Plate 33, figs 9-11

- 1852 Mitra scrobiculata Brocc. Hörnes, p. 102 (partim, pl. 10, fig. 14 only) [non Cancilla scrobiculata (Brocchi, 1814)].
- 1880 Mitra (Nebularia) scobiculata Brocc. Hoernes & Auinger, p. 80 (partim, pl. 9, fig. 18 only) [non Cancilla scrobiculata (Brocchi, 1814)].
- *1889 *Mitra praescrobiculata* Toldo, p. 146, pl. 3, figs 1, 2.
- 1959 *Mitra scrobiculata* Brocc. Eremija, pl. 1, fig. 4 [non Cancilla scrobiculata (Brocchi, 1814)].
- ?1960 Mitra (Tiara) colligens Bellardi 1887 Kojumdgieva & Strachimirov, p. 158, pl. 42, fig. 4.
- ?1997 Mitra (Tiara) scrobiculata (Brocchi, 1814) Bałuk, p. 28, pl. 7, fig. 9 [non Cancilla scrobiculata (Brocchi, 1814)].
- 2000 *Cancilla praescrobiculata* (Toldo, 1889) Davoli, p. 188, pl. 5, figs 1, 2, 16, 18.

Dimensions and material – Maximum height 83.7 mm. Locality 9: RGM 783 831/2; locality 12: RGM 783 624/2; locality 13: NHMW 1847/0058/0379-1847/0058/0380/2, 1847/0058/0381/4, JvdV/11, RGM 794 083/1 (ex JvdV collection), RGM 783 694/2, YI 224/5. Discussion - The 'Mitra scrobiculata' lineage has been present in European assemblages since the middle Miocene, and continues today in West African waters. However, the specific assignment of the various forms has been controversial. Some authors considered all the fossil forms to be a single species (Strausz, 1966; Bałuk, 1997), and the Recent West African taxon a subspecies of the fossil form (Cernohorsky, 1991), whereas others separated the Miocene and Pliocene forms (Toldo, 1889; Davoli, 2000). Those who separate the Miocene forms under the name Cancilla praescrobiculata (Toldo, 1889) consider the Miocene form to differ from C. scrobiculata (Brocchi, 1814) in the character of the intermediate whorls. In the Miocene shells the 5-6 spiral cords are irregular, separated by interspaces which are widest adapically, narrowing abapically, whereas in the Pliocene shells the cords are more regularly spaced, separated by narrow grooves of equal width. Moreover, in the Pliocene form the spiral sculpture becomes attenuated on the last adult whorl, whereas it is consistently stronger in the Miocene form. Also, in C. praescrobiculata the adapical four columellar folds are strong and unequally developed, with a weaker fifth fold abapically, whereas in C. scrobiculata only the adapical two folds are strongly developed. Lastly the siphonal fasciole is twisted to the left in the Miocene form but not in the Pliocene one. Although some of these differences, such as the attenuation of the sculpture on the last whorl, may have been overstated (see Pelosio, 1967, pl. 42, figs 10, 12 for specimens of C. scrobiculata with strong spiral sculpture throughout) the sculptural differences on the intermediate whorls are relatively constant. The specimens from the Karaman assemblages clearly illustrate the type of sculpture typical of the Miocene forms. We therefore follow Toldo (1899) and Davoli (2000) in separating the Miocene forms as C. praescrobiculata, but with some hesitation, as the shell illustrated by Bałuk (1997, pl. 7, fig. 9) has spiral sculpture more reminiscent of the Pliocene form, but the twisted siphonal canal of the Miocene form.

The Recent species *Cancilla crosnieri* Cernohorsky, 1991 from West Africa differs in having denser spiral sculpture on the penultimate and last whorls. It was originally described a as subspecies of *C. scrobiculata*, however, we prefer to elevate it to full specific rank.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1852; Hoernes & Auinger, 1880), ?Poland (Bałuk 1997), Bosnia (Eremija, 1959), Bulgaria (Kojumdgieva & Strachimirov, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Toldo, 1889; Davoli, 2000).

Cancilla suballigata (Bellardi, 1887)

Plate 33, figs 12, 13; Plate 80, fig. 8

*1887a *Mitra suballigata* Bell., Bellardi, p. 71, pl. 4, fig. 15.

- 1887a Mitra praecedens Bell., Bellardi, p. 75, pl. 4, fig. 17.
- 1904 Mitra suballigata var. transversesulcata Sacc., Sacco, p. 82, pl. 18, fig. 41.
- 1981 *Mitra suballigata* Bellardi, 1887 Ferrero Mortara *et al.*, p. 159, pl. 48, fig. 12.
- 1981 *Mitra praecedens* Bellardi, 1887 Ferrero Mortara *et al.*, p. 160, pl. 48, fig. 13.
- 2000 *Cancilla suballigata* (Bellardi, 1887) Davoli, p. 191, pl. 5, figs 3-6.

Dimensions and material – Maximum height 38.1 mm. Localities 2 & 3: JvdV/4, YI 219/2; localities 7 & 8: NHMW 1847/0058/0384/6, JvdV/3; locality 12: JvdV/15; locality 13: NHMW 1847/0058/0382-1847/0058/0383/2, 1847/0058/0384/34, RGM 777 880/1 (ex JvdV collection), RGM 783 696/13, YI 205/43; locality 17: NHMW 1847/0058/0385/25, JvdV/22, MTA 2013/058/8, YI 204/20.

Discussion – The shells from the Karaman Basin are identical to the syntype illustrated by Ferrero Mortara *et al.* (1981, pl. 48, fig. 12). The number and spacing of the spiral grooves is variable, with some specimens having close-set threads as seen in *Mitra praecedens* Bellardi, 1887, which is here included in the synonymy of *C. suballigata*. As first revisers we choose the name *Cancilla suballigata* (Bellardi, 1887) as the valid name for this species. Most of the Turkish shells preserve their colour pattern, which consists of fairly widely spaced narrow orange spiral stripes and narrow vertical flammules (Pl. 33, fig. 13; Pl. 80, fig. 8). The protoconch is damaged in all specimens, but is mammillate, consisting of about three whorls.

Cancilla suballigata (Bellardi, 1887) is similar to the Pliocene Mediterranean species *C. alligata* (Defrance, 1824), but differs in having a wider shell and a proportionally shorter spire.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1887a; Sacco, 1904; Davoli, 2000).

Genus Ziba H. Adams & A. Adams, 1853

Type species – Mitra carinata Swainson, 1824, by subsequent designation (Wenz, 1843). Recent, West Africa.

Ziba goniophora (Bellardi, 1850)

Plate 34, figs 1, 2; Plate 68, fig. 7; Plate 80, fig. 9

- 1847 Mitra bacillum Lamk. Michelotti, p. 318, pl. 76, figs 1, 2 [non Ziba bacillum (Lamarck, 1811)].
- *1850 *Mitra goniophora* Bell., Bellardi, p. 12, pl. 1, fig. 20.
- 1880 Mitra goniophora Bell. Hoernes & Auinger, p. 78 (partim, pl. 9, fig. 12 only).
- 1887 *Mitra goniophora* Bell. Bellardi, p. 68, pl. 4, fig.8.

- 1928 Mitra goniophora Bellardi Peyrot, no. 1052, pl.9, figs 9-24
- Mitraria (Mitraria) goniophora var. austriaca (Meznerics 1950) – Kojumdgieva & Strachimirov, p. 159, pl. 42, fig. 8.
- 1962 *Mitra goniophora* Bellardi Strausz, p. 102 (*partim*, text-fig. 114, pl. 41, figs 20-23 only).
- 1966 *Mitra goniophora* Bellardi, 1850 Strausz, p. 364 (*partim*, text-fig. 159, pl. 41, figs 20-23 only).
- 1969 Mitra goniophora Bellardi 1850 Bohn-Havas, p. 1059, pl. 6, figs 1, 2.
- 1969 Mitra goniophora transsylvanica Meznerics 1954
 Bohn-Havas, p. 1059, pl. 5, figs 19, 20, pl. 9, fig. 8.
- 1981 *Mitra goniophora* Bellardi, 1850 Ferrero Mortara *et al.*, p. 158, pl. 48, fig. 11.
- 1991 *Ziba goniophora* (Bellardi, 1850) Cernohorsky, p. 84, pl. 76, figs 1, 2.
- 1997 *Mitraria (Mitraria) goniophora* (Bellardi, 1850) Bałuk, p. 30, pl. 8, figs 3, 4.
- 2000 *Cancilla (Ziba) goniophora* (Bellardi, 1850) Davoli, p. 194, pl. 3, figs 3, 5, 12-14, 17.
- non 1880 Mitra goniophora Bell. Hoernes & Auinger, p. 78 (partim, pl. 7, fig. 9 only) [? = Cancilla suballigata (Bellardi, 1887)].
- non 1880 Mitra goniophora Bell. Hoernes & Auinger, p. 78 (partim, pl. 9, fig. 14 only) [= Ziba subcarinata (Bellardi, 1887) or Ziba austriaca (Csepreghy-Meznerics (1950)].
- ?non 1928 Mitra goniophora var. perangulata Peyrot, no. 1053, pl. 9, fig. 25 [= Ziba subcarinata (Bellardi, 1887)].
- non 1962 Mitra goniophora Bellardi Strausz, p. 103 (partim, pl. 41, figs 24, 25 only) [= Ziba subcarinata (Bellardi, 1887 or Ziba austriaca (Csepreghy-Meznerics (1950)].
- non 1966 Mitra goniophora Bellardi, 1850 Strausz, p. 364 (partim, pl. 41, figs 24, 25 only) [= Ziba subcarinata (Bellardi, 1887 or Ziba austriaca (Csepreghy-Meznerics (1950)].
- non 2002 Mitraria goniophora (Bellardi, 1850) s. l. Harzhauser, p. 108, pl. 8, fig. 20.

Dimensions and material – Maximum height 24.0 mm. Localities 2 & 3: JvdV/1; locality 11: JvdV/2; locality 13: YI 235/2; locality 17: NHMW 1847/0058/0387/1, 1847/0058/0388/1, 1847/0058/0389/47, JvdV/42, RGM 777 882/1 (ex JvdV collection), RGM 784 059/1, 783 801/3, 783 988/17, MTA 2013/059/5, YI 227/43.

Discussion – Placement within the genus *Ziba* H. Adams & A. Adams, 1853 seems most appropriate. The type species, *Ziba carinata* (Swainson, 1824) from the Recent waters off West Africa, from the Cape Verde Islands to Senegal and Angola, is quite similar to *Z. goniophora*, with a similar, strongly angular shoulder on the last whorl. The protoconch of *Z. goniophora* is paucispiral, consisting of about 1.25 smooth whorls with a medium-sized nucleus (Pl. 68, fig. 7). Cernohorsky (1991)

described the protoconch of modern *Ziba* species as being multispiral. However, protoconch type is an unreliable generic character.

A colour pattern is preserved in many of the shells from the Karaman Basin (Pl. 34, figs 1, 2) and is strongly enhanced under UV light (Pl. 80, fig. 9), consisting of spiral rows of squarish dots, with a row of larger dots at the shoulder of the last whorl, similar to the pattern illustrated by Bohn-Havas (1969, pl. 9, fig. 8) for Miocene Hungarian specimens. For comparison with other European fossil *Ziba* species see Davoli (2000).

The Paratethyan representatives of this group are in need of revision. The specimens illustrated by Hörnes (1852) as Mitra goniophora were described as Mitra goniophora austriaca by Csepreghy-Meznerics (1950) and were later elevated to species rank by Bałuk (1997). The definition of this species by Csepreghy-Meznerics (1950) was unfortunate as she referred to figs 8, 9 and 10 of Hörnes (1852, pl. 10). His fig. 10, however, is clearly not conspecific with the other two shells. The shells illustrated by Hoernes & Auinger (1880, pl. 9, fig. 14) and Friedberg (1911, pl. 1, fig. 8; pl. 37, fig. 24) have also been identified Mitra austriaca by Csepreghy-Meznerics (1950) and Bałuk (1997). The less angulated shell illustrated as fig. 13 by Hoernes & Auinger (1880, pl. 9) was selected as the holotype of Mitraria mathiasi by Bałuk (1997). His Polish shell, however, which he considers to be conspecific with Mitraria mathiasi, differs considerably in its stout shape and coalescing spire and the slightly angulated shoulder, whereas M. mathiasi has bulgy shoulders, incised sutures and subparallel flanks of the spire whorls. The small, stout shell illustrated as fig. 11 by Hoernes & Auinger (1880, pl. 9) was selected as the holotype of Mitraria rudolfi by Bałuk (1997). Again the Polish shell treated as Mitraria rudolfi by Bałuk (1997) seems to differ from the type as it lacks the barrel-shaped last whorl and has a more conical spire. Hence, only the specimen illustrated as fig. 12 in Hoernes & Auinger (1880, pl. 9) has been accepted by most authors as representing Ziba goniophora (Bellardi, 1850), displaying also the slight concavity below the shoulder angulation. Herein we restrict the synonymy of Paratethyan occurrences to references illustrating specimens with this morphotype.

Distribution – Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Peyrot, 1928); Paratethys (Langhian-Serravallian): Hungary (Strausz, 1962, 1966; Bohn-Havas, 1969), Bulgaria (Kojumdgieva & Strachimirov, 1960), Romania (Hoernes & Auinger, 1880); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Davoli, 2000).

Family Costellariidae MacDonald, 1860 Genus *Pusia* Swainson, 1840

Type species – Mitra microzonias Lamarck, 1811, by monotypy. Recent, Indo- Pacific.

Note – Although most modern workers include the rather squat-shelled Recent European costellariids such as *Mitra ebenus* Lamarck, 1811 and *Mitra savignyi* Pay-raudeau, 1826 in the genus *Vexillum* Röding, 1798 (*i.e.* Chirli, 2002; Rolán, 2005; Sosso & dell'Angelo, 2010; CLEMAM, 2013), we prefer to place them in *Pusia* Swainson, 1840. This genus is comprised of rather small species with a squat shell, coarse axial ribs and reduced or absent spiral sculpture, whereas most *Vexillum* species have more elongate, turrited shells, many with cancellate sculpture.

Pusia baluki nov. sp.

Plate 34, figs 3-6; Plate 68, fig. 8; Plate 80, fig. 10

Material and dimensions – Holotype NHMW 1847/-0058/0390, height 14.8 mm; paratype 1 RGM 783 973, height 13.1 mm; paratype 2 RGM 783 974, height 13.6 mm; paratype 3 RGM 783 975, height 12.2 mm; paratype 4 NHMW 1847/0058/0391, height 16.9 mm; paratype 5 NHMW 1847/0058/0392, height 16.0 mm; paratype 6 RGM 784 044, height 8.8 mm; paratype 7 RGM 777 881 (ex JvdV collection), height 16.3 mm; furthermore three specimens in YI 435, height 13.7 mm,YI 436, height 14.1 mm and YI 437, height 16.9 mm.

Dimensions and other material: Maximum height 19.7 mm. Localities 2 & 3: YI 218/2; locality 13: JvdV/40, YI 233/3; locality 17: NHMW 1847/0058/0393/48, JvdV/50+, RGM 783 976/11 juveniles and fragments, MTA 2013/060/4, YI 217/34; locality 17a: NHMW 1847/0058/1589/3.

Etymology – For Wacław Bałuk in recognition of his contribution to the knowledge of the Miocene Paratethyan assemblages of Poland.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A medium-sized *Vexillum* species with a mammillate protoconch of 2.45 whorls, axial sculpture of broad ribs, spiral sculpture restricted to the siphonal fasciole, four columellar folds, with the abapical fold very weak and a colour pattern of a central white spiral band.

Description – Shell medium-sized, fusiform-biconic. Protoconch multispiral, mammillate, of 2.45 whorls, with a medium sized nucleus (dp= 550 μ m, hp = 480 μ m, dpl = 320 μ m, dn = 200 μ m; Pl. 68, fig. 8), boundary sharply delimited by prosocline scar. Teleoconch of seven weakly convex whorls with periphery at abapical suture, whorl profile slightly bulging below adapical suture. Suture impressed, undulating. Sculpture of eight low, broad, rounded, weakly opisthocline axial ribs, in some specimens weakening and broadening further on late whorls, becoming subobsolete on last whorl. Spiral sculpture absent. Last whorl about 65% of total height, elongate, weakly constricted at base. Aperture narrow, elongate, 40% of total height. Anal canal represented by narrow, deep groove. Siphonal canal of short to medium length, open. Columella straight, bearing four oblique folds weakening abapically. Columellar callus not expanded, sharply delimited. Siphonal fasciole flattened, bearing coarse spiral cords.

Variability – There is some variability in the width of the shell, some specimens being relatively elongate, whilst other quite squat in profile. The number of axial ribs is constant, although they almost disappear on the last whorls in some specimens, but in others remain strong throughout. Spiral sculpture is absent, except over the siphonal canal, which bears strong spiral cords in some specimens. A couple of weak cords are also present above the fasciole on the base of the last whorl in some specimens. Specimens with subobsolete axial ribs on the last whorl tend not to have well-developed spiral sculpture on the siphonal canal or base. The columellar folds weaken rapidly abapically and the fourth fold is hardly developed in some specimens.

Discussion – The arguments given by Glibert (1952a, p. 361) for considering the Pliocene to Recent species Pusia ebenus (Lamarck, 1811) distinct from the Miocene species Pusia leucozona (Andrzejowski, 1830) were based on teleoconch characters. Pusia ebenus differs in having four columellar folds as opposed to three in P. leucozona, and the colour pattern, which is often preserved in both species, consists of a single narrow white spiral band on the last whorl in P. ebenus, whereas P. leucozona has two broader white spiral bands. However, the specimens figured by Friedberg (1911, pl. 1, figs 10, 11) from the middle Miocene Paratethys of Ukraine clearly have four folds. Several specimens from the Vienna Basin, in the NHMW collection, also display four folds of which the anterior one is very weak. The specimens from Karaman have four folds (Pl. 34, fig. 6a), although the abapical fold is only weakly developed and the narrow white spiral band more typical of P. ebenus is clearly visible in the Turkish specimens (Pl. 34, figs 4b, 6b), and can be enhanced under UV light (Pl. 80, fig. 10). However, the Karaman specimens have a mammillate protoconch, consisting of about three whorls with a medium-sized nucleus, whereas the protoconch of *P. ebenus* is paucispiral (della Bella & Tabanelli, 1995, p. 294, fig. B).

Pusia baluki nov. sp. is strongly reminiscent of the middle Miocene Paratethyan species *Pusia leucozona* (Andrzejowski, 1830). Comparable to the shells from Karaman, it develops three columellar folds which are accompanied by a weak anterior one in many specimens. The shape differs from the Karaman species slightly in its ovoid biconical outline and it lacks the straight-sided to even somewhat concave part of the last adult whorl seen in the Karaman shells. The sutures of the Karaman shells are strongly wavy and the last whorl forms a bulge along the upper suture. These characters are rarely developed in the middle Miocene Paratethyan shells. The protoconch of the Paratethyan species *Pusia leucozona* is only known from a single juvenile specimen and uncertainties remain about the specific identification. This juvenile specimen we ascribe to *P. leucozona* has a conical paucispiral protoconch differing strongly from the Karaman shells. Davoli (2000) recorded *P. leucozona* from the late Miocene Tortonian of Italy and describes the shell as having a paucispiral protoconch. None of his figures show the protoconch, and the specimens are severely worn.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Pusia pyramidella (Brocchi, 1814)

Plate 34, figs 7-9; Plate 68, fig. 9

- *1814 Voluta pyramidella nob., Brocchi, p. 318, pl. 4, fig.5.
- 1814 *Voluta plicatula* nob., Brocchi, p. 318, pl. 4, fig.7.
- 1887b Uromitra pyramidella (Brocc.) Bellardi, p. 46, pl. 5, fig. 51.
- 1887b Uromitra plicatula (Brocc.) Bellardi, p. 49, pl. 5, figs 54-56.
- 1904 Uromitra pyramidella var. miostriata Sacc., Sacco, p. 85, pl. 19, fig. 13.
- 1911 Mitra (Uromitra) pyramidella Br. Cerulli-Irelli, p. 287, pl. 38, fig. 23.
- 1911 Mitra (Uromitra) plicatula Br. Cerulli-Irelli, p. 287, pl. 38, fig. 24-29.
- 1955 Pusia (Pusia) (Pusia) ebenus var. pyramidella (Brocchi 1814) – Rossi Ronchetti, p. 239, fig. 127.
- 1955 *Pusia (Pusia) (Pusia) ebenus* var. *plicatula* (Brocchi 1814) – Rossi Ronchetti, p. 241, fig. 128.
- 1958 Vexillum (Vexillum) plicatula (Brocchi) Erünal-Erentöz, p. 78, pl. 12, figs 6-12.
- 1959 Pusia (Pusia) pyramidella (Brocchi) Ruggieri et al., p. 79, pl. 19, fig. 116.
- 1959 Pusia (Pusia) plicatula (Brocchi) Ruggieri et al., p. 80, pl. 17, fig. 106.
- 1964 Vexillum (Uromitra) plicatulum (Brocchi 1814) Anderson, p. 262, pl. 26, fig. 200.
- 1967 Pusia (Pusia) plicatula (Brocchi) Pelosio, p. 45, pl. 42, figs 4-6.
- 1974 Pusia (Pusia) plicatula (Brocchi) Caprotti, p. 30, pl. 3, fig. 11.
- 1974 Vexillum (Ebenomitra) pyramidella (Brocchi 1814) – Malatesta, p. 366, pl. 29, fig. 1.
- 1974 Vexillum (Ebenomitra) ebenus plicatula (Brocchi 1814) – Malatesta, p. 366, pl. 29, fig. 2.
- 1976 Pusia pyramidella (Brocchi, 1814) Caprotti, p. 11, pl. 16, fig. 18.
- 1978 Voluta pyramidella Brocchi, 1814 Pinna & Spezia, p. 170, pl. 65, fig. 2.
- 1978 Voluta plicatula Brocchi, 1814 Pinna & Spezia,
 p. 170, pl. 67, fig. 2.
- 1984a Vexillum (Uromitra) plicatulum (Brocchi, 1814) A.W. Janssen, p. 267, pl. 67, fig. 9.

- 1992 Vexillum (Pusia) ebenus (Lamarck, 1811) Cavallo & Repetto, p. 120, fig. 307.
- 1995 Voluta pyramidella Br. della Bella & Tabanelli, p. 293, fig A.
- 2000 *Vexillum (Uromitra)* aff. *V. (U.) plicatulum* (Brocchi, 1814) – Davoli, p. 206, pl. 6, figs 1-6.
- 2002 Vexillum pyramidellum (Brocchi, 1814) Chirli, p. 53, pl. 27, figs 10-12, pl. 27, figs 1-8.
- 2007 Vexillum (Uromitra) plicatulum (Brocchi, 1814) –
 Wienrich, p. 654, pl. 137, fig. 2.
- 2010 Vexillum ebenus pyramidella (Brocchi, 1814) Sosso & dell'Angelo, p. 42, p. 59 unnumbered figure centre middle row.
- non 1852 Mitra pyramidella Brocc. Hörnes, p. 107, pl. 10, fig. 28 [= Vexillum badensis (Hoernes & Auinger, 1880)].

Dimensions and material – Maximum height 21.0 mm. Localities 2 & 3: JvdV/10, RGM 783 938/2, MTA 2013/061/10, YI 228/38 + 1 juvenile; localities 7 & 8: NHMW 1847/0058/0395/1, 1847/0058/0396/50+, JvdV/37, RGM 783 891/22; locality 10: YI 230/2; locality 12: JvdV/12; locality 13: NHMW 1847/0058/0397/1, 1847/0058/0398/50+, JvdV/6, RGM 784 043/1, 783 697/4, MTA 2013/062/10, YI 229/42. Exact locality unknown: AÜ LE-K-225/6.

Discussion - Della Bella & Tabanelli (1995) concluded that Voluta pyramidella Brocchi, 1814 and Voluta plicatula Brocchi, 1814 were different forms of a single species, the name Pusia pyramidella having priority. This species is similar to Pusia ebenus (Lamarck, 1811), but differs in having a multispiral protoconch, whereas P. ebenus has a paucispiral protoconch. Pusia pyramidella is extremely variable in shape and ornament as seen in the series illustrated (Pl. 34, figs 7-9). Strongly ribbed and almost completely smooth forms coexist in the Karaman assemblages. In most specimens the ribs are present on the early teleoconch whorls, and tend to weaken abapically. The height of the spire and width of the shell are also very variable. The protoconch of the Turkish shells is multispiral, consisting of just over three whorls (dp = 540 μ m, hp = 675 μ m, dp/hp = 0.8, dp1 = 290 μ m, dn = 180 μ m; Pl. 68, fig. 9), similar to that figured by della Bella & Tabanelli (1995, p. 294, fig. A) for specimens from the early Pleistocene of Italy.

Hörnes (1852) identified several shells from the middle Miocene of the Vienna Basin as *Mitra pyramidella* Brocc., treating *Voluta plicatula* Brocchi, 1814 as a synonym. The specimen illustrated by Hörnes (1852, pl. 10, fig. 28) was later separated by Hoernes & Auinger (1880) as *Mitra* (*Costellaria*) badensis based on the slender shell and the characteristic narrow, sharp-crested axial ribs. These authors, however, considered Hörnes's (1852, pl. 10, fig. 29) to represent *Mitra* (*Costellaria*) plicatula. The shells in the collection of the NHMW, described by Hoernes & Auinger (1880), represent a strongly sculptured morphotype with prominent, densely spaced ribs atypical of *P. pyramidella*. Therefore, we tentatively exclude these Paratethyan shells from the synonymy. A single specimen from the middle Miocene of Ukraine, described by Friedberg (1911) as *Turricula plicatula* Brocc., would be another potential record of this species in the Paratethys Sea. The illustration shows a small, slender shell with straight axial ribs and with spire whorls with flanks that are subparallel to the axis. Based on this illustration, a clear identification as *P. pyramidella* is not possible.

Distribution – Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Germany (Anderson, 1964; Wienrich, 2007), Netherlands (A.W. Janssen, 1984a); Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1887; Davoli, 2000). Early Pliocene: western Mediterranean, Estepona Basin, Spain (NHMW collection); central Mediterranean, Italy (Bellardi, 1887b; Pelosio, 1967; Chirli, 2002). Early-late Pliocene: Central Mediterranean, Italy (Bellardi, 1887; Ruggieri et al., 1959; Caprotti, 1974, 1976; Malatesta, 1974; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010). Early Pleistocene: Central Mediterranean, Italy (Cerulli-Irelli, 1911; della Bella & Tabanelli, 1995).

Pusia transsylvanica (Boettger, 1902)

Plate 34, figs 10-12

- 1880 Mitra (Costellaria) recticosta Bell. Hoernes & Auinger, p. 85, pl. 10, figs 5-8 (non Pusia recticosta Bellardi, 1850).
- *1902 *Mitra (Costellaria) recticosta* var. *transsylvanica* Boettger, p. 13, no. 37.
- 1906 Mitra (Costellaria) pseudorecticosta var. transsylvanica Bttgr. – Boettger, p. 10. no. 44.
- 1911 *Turricula vindobonensis* Friedb., Friedberg, p. 26, pl. 1, fig. 18.
- 1932/33 *Turricula (Uromitra) vindobonensis* Friedb. Meznerics, p. 343, pl. 14, fig. 7a.
- 1934 Vexillum (Costellaria) pseudorecticosta var. transsylvanica (Boettger) – Zilch, p. 258, pl. 17, fig. 15.
- 1997 Vexillum (Costellaria) pseudorecticosta (Boettger, 1901 [sic]) Bałuk, p. 36, pl. 10, figs 3-7.

Dimensions and material-Maximum height 12.3 mm. Locality 17: NHMW 1847/0058/0399/1, 1847/0058/0400/1, 1847/0058/0401/1, JvdV/35, RGM 783 990/5 + 7 fragments and juveniles, YI 231/21 + 2 juveniles.

Discussion – As discussed by Bałuk (1997), both Boettger (1906) and Friedberg (1911) concluded independently that the specimens identified by Hoernes & Auinger (1880) as *Mitra recticosta* Bellardi, 1850 were not conspecific with shells from the late Miocene of Italy, and renamed the Paratethyan shells. Bałuk (1997) recognised that Boettger's (1906) name *Mitra (Costellaria) pseudorecticosta* had priority over that of Friedberg (1911), although he dated the name as "1901". Boettger (1902) described a shell
from Kostej, Romania, as *Mitra (Costellaria) recticosta* var. *transsylvanica* (lectotype illustrated by Zilch, 1934, pl. 17, fig. 15), which we consider conspecific with the Austrian shells illustrated by Hoernes & Auinger (1880, pl. 10, figs 5-8). The earliest name for this species is *Pusia transsylvanica* (Boettger, 1902).

The shells from the Karaman Basin are relatively constant in shape, with 23-30 axial ribs on the penultimate whorl. The ribs tend to become subobsolete on the second half of the last whorl, similar to one of the specimens figured by Hoernes & Auinger (1880, fig. 5) from Austria. The protoconch is mammillate, consisting of 3.5-4 smooth whorls with a small nucleus, similar to that seen in specimens from the type locality (NHMW collection). Similar to specimens from the Vienna Basin described by Hoernes & Auinger (1880), the Turkish shells have densely-spaced axial ribs. The type specimen of *P. transsylvanica* (Boettger, 1902), illustrated in Zilch (1934, pl. 17, fig. 15), represents a comparatively rare form with fewer axial ribs.

Boettger (1902) described a second species, *Mitra* (*Costellaria*) *recticosta* var. *vexans*, from the same Romanian deposits. This species was also recorded by Bałuk (1997) from the Paratethys of Poland. *Vexillum vexans* differs from *P. transsylvanica* in being smaller, with a shorter shell, the sutures are slightly deeper and it has fewer axial ribs. This form has not been found in the Karaman deposits. *Pusia recticosta* differs in having a relatively wider, shorter shell, with the spire whorls almost straight-sided as opposed to distinctly convex in *P. transsylvanica*, and the axial ribs are straighter.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1852; Hoernes & Auinger, 1880; Meznerics, 1932/33), Romania (Boettger, 1902, 1906; Zilch, 1934), Poland (Bałuk, 1997), Ukraine (Friedberg, 1911); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Costellaria Swainson, 1840

Type species – Mitra rigida Swainson, 1821 (= *Mitra semifasciata* Lamarck, 1811), by monotypy. Recent, Indo-Pacific. *Uromitra* Bellardi, 1887, type species *Uromitra agressa* Bellardi, 1887, by subsequent designation, Miocene, Italy, was considered to be a synonym by Cernohorsky (1980).

Costellaria cupressina (Brocchi, 1814)

Plate 34, fig. 13

- *1814 Voluta cupressina nob., Brocchi, p. 319, pl. 4, fig.6.
- 1847 *Mitra elegans* mihi, Michelotti, p. 314, pl. 13, figs 12, 13.
- 1850 Mitra cupressina Brocc. Bellardi, p. 19, pl. 2, fig. 16.
- 1852 Mitra cupressina Brocc. Hörnes, p. 104, pl. 10, figs 25-27.

- 1880 Mitra (Callithea) cupressina Brocc. Hoernes & Auinger, p. 86, pl. 10, fig. 10.
- 1887b Uromitra cupressina Bell. [sic] Bellardi, p. 26, pl. 5, figs 25, 26.
- 1899 Uromitra Michelotti Hoern. Cossmann, p. 169, pl. 8, fig. 15.
- 1899 Uromitra cupressina Brocchi Cossmann, p. 169, pl. 8, fig. 32.
- 1928 Turricula cupressina Brocc. Friedberg, p. 580, pl. 37, fig. 29.
- 1955 Vexillum (Vexillum) cupressinum (Brocchi, 1814)– Rossi Ronchetti, p. 244, fig. 130.
- 1960 Vexillum (Uromitra) cupressinum (Brocchi 1814)
 Kojumdgieva & Strachimirov, p. 161, pl. 42, fig. 12.
- 1962 Mitra (Vexillum) cupressina Brocchi Strausz, p. 76, pl. 25, figs 4, 5.
- 1966 Mitra (Vexillum) cupressina Brocchi, 1814 Strausz, p. 369, pl. 25, figs 4, 5.
- 1967 Vexillum (Vexillum) cupressinum (Brocchi) Pelosio, p. 146, pl. 42, figs 7-9.
- 1969 Vexillum (Uromitra) cupressinum (Brocchi) Mastrorilli, p. 120, pl. 8, fig. 20.
- 1974 Uromitra cupressina (Brocchi, 1814) Malatesta, p. 367, pl. 29, fig. 4.
- 1974 Vexillum (Uromitra) cupressinum (Brocchi 1814) – Caprotti, p. 30, pl. 3, fig. 10.
- 1992 Vexillum (Costellaria) cupressinum (Brocchi, 1814) – Cavallo & Repetto, p. 120, fig. 306.
- 1997 Vexillum (Uromitra) pseudocupressinum nom.n., Bałuk, p. 37, pl. 11, fig. 3.
- 2000 Vexillum (Uromitra) cupressinum (Brocchi 1814) – Davoli, p. 203, pl. 6, figs 5, 15-18.
- 2002 Vexillum (Uromitra) cupressinum (Brocchi 1814) – Chirli, p. 55, pl. 27, figs 9-12, pl. 28, figs 1-4.
- 2008 Vexillum cupressinum (Brocchi, 1814) Chirli & Richard, p. 53, pl. 10, figs 5, 6.
- non 1960 Vexillum (Uromitra) cupressinum (Brocchi 1814) – Malatesta, p. 181, pl. 9, fig. 7 (? = turrid).

Dimensions and material – Maximum height 22.3 mm. Locality 12: RGM 794 084/1 (ex JvdV collection).

Discussion - The reasons given by Bałuk (1997) for separating the middle Miocene Paratethyan forms usually referred to as Mitra cupressina Brocchi, 1814 from those found in the Miocene to Pliocene Proto-Mediterranean are not convincing. Bałuk (1997) stressed the denser sculpture in the Paratethyan forms compared to the holotype figured by Pinna & Spezia (1978, pl. 61, fig. 4). However, a late Miocene Tortonian specimen illustrated by Davoli (2000, pl. 6, fig. 5) has even denser sculpture. Moreover, this character is very variable as seen in the late Miocene series figured by Davoli (2000, pl. 6, figs 5, 15-18) and the early Pliocene series figured by Pelosio (1967, pl. 42, figs 7-9) and Chirli (2002, pl. 27, figs 9-12, pl. 28, figs 1-4). The second reason given by Bałuk (1997), the spiral furrows being deeper in the Italian specimens, seems a trivial difference. Having said this, Vienna Basin specimens in the NHMW collection are quite large (around 35 mm high) compared with the Italian shells illustrated by Chirli (2002; 16-20 mm in height) and have dense axial sculpture with distinctly weaker spiral cords. Moreover, some of the shells have a fifth columellar fold. We provisionally consider the Paratethyan and Mediterranean forms to be conspecific pending further revision.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1852; Hoernes & Auinger, 1880), Poland (Friedberg, 1928; Bałuk, 1997), Hungary (Strausz, 1962, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1887b; Davoli, 2000). Early Pliocene: western Mediterranean, Estepona Basin, Spain (NHMW collection), Roussillon Basin, France (Chirli & Richard, 2008); central Mediterranean, Italy (Bellardi, 1887; Chirli, 2002). Early-late Pliocene: central Mediterranean, Italy (Malatesta, 1974; Cavallo & Repetto, 1992).

Costellaria nov. sp.?

Plate 34, fig. 14

Dimensions and material – Maximum height 29.2 mm. Locality 9: RGM 794 056/1 (ex JvdV collection).

Discussion - This shell is reminiscent of Costellaria cupressina (Brocchi, 1814), from which it differs mainly in its larger size, the presence of five columellar folds, the slightly more gradate spire whorls, and the tall, elongate last whorl. The transition from base into siphonal canal is distinctly less concave than in C. cupressina. The large size, however, might be insufficient to base a clear separation as many offshore specimens of C. cupressina in the middle Miocene of the Vienna Basin attain a height around 35 mm. None of these specimens agree in sculpture with C. cupressina and they never develop such a nearly quadratic-reticulate sculpture but are characterised by predominant axial ribbing. The same problem arises with the number of columellar folds, which may rise to 5 in the Viennese shells as well. Hence, the sculpture and the gradate spire along with the elongate last adult whorl remain distinctive characters. Therefore, this Turkish specimen possibly represents a new, as yet unnamed species. We await further material to formally describe this species.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Thala H. Adams & A. Adams, 1853

Type species – Mitra mirifica Reeve, 1845, by subsequent designation (Cossmann, 1899). Recent, Indo-West Pacific.

Thala obsoleta (Brocchi, 1814)

Plate 34, figs 18, 19; Plate 69, fig. 3

- *1814 *Voluta obsoleta* nob., Brocchi, p. 646, pl. 15, fig. 30.
- 1830 Mitra striata Eichwald, p. 221.
- 1850 *Mitra obsoleta* Brocch. Bellardi, p. 28, pl. 2, fig. 29.
- 1852 Mitra obsoleta Bronn [sic] Hörnes, p. 110, pl.
 10, fig. 32.
- 1880 Mitra obsoleta Brocchi Fontannes, p. 87, pl. 6, fig. 9.
- 1888 Micromitra pusilla Bell., Bellardi, p. 8, pl. 6, fig. 48.
- 1888 Micromitra obsoleta (Brocch.) Bellardi, p. 9, pl. 6, fig. 49.
- 1888 Micromitra mangeliaeformis Bell., Bellardi, p. 9, pl. 6, fig. 50.
- 1904 *Thala obsoleta* var. *elatocostata* Sacc., Sacco, p. 88, pl. 19, fig. 24.
- 1904 Thala obsoleta var. angustolonga Sacc., Sacco, p. 88, pl. 19, fig. 25.
- 1955 *Pusia (Pusia) (Pusia) obsoleta* (Brocchi, 1814) Rossi Ronchetti, p. 243, fig. 129.
- 1978 Voluta obsoleta Brocchi, 1814 Pinna & Spezia,
 p. 169, pl. 68, fig. 2.
- 1981 *Micromitra mangeliaeformis* Bellardi, 1888 Ferrero Mortara *et al.*, p. 172, pl. 54, fig. 3.
- 1981 *Micromitra pusilla* Bellardi, 1888 Ferrero Mortara *et al.*, p. 172, pl. 54, fig. 6.
- 1983 *Thala obsoleta* (Brocchi, 1814) Giannuzzi-Savelli & Reina, p. 233, text-fig. 2.
- 2000 *Thala obsoleta* (Brocchi, 1814) Davoli, p. 210, pl. 7, fig. 10, pl. 8, figs 1, 2.
- 2002 *Thala obsoleta* (Brocchi, 1814) Chirli, p. 56, pl. 28, figs 5-12.
- 2011 *Thala obsoleta* (Brocchi, 1814) Landau *et al.*, p. 29, pl. 15, fig. 6.
- non 1997 Thala obsoleta (Brocchi, 1814) Bałuk, p. 39, pl. 11, fig. 2.

Dimensions and material – Maximum height 6.8 mm. Locality 17: NHMW 1847/0058/0408/1, 1847/0058/0409/1, 1847/0058/0410/13, JvdV/19, RGM 784 008/1, RGM 783 989/7, 8 fragments and juveniles, YI 232/6.

Discussion – Thala species tend to have highly variable sculpture, as is clearly illustrated by any series of specimens illustrated [*i.e.* Glibert, 1952a for *Thala pupa* (Dujardin, 1837) and Chirli, 2002 for *T. obsoleta* (Brocchi, 1814)]. In our opinion, *Thala mangeliaeformis* (Bellardi, 1888) was based on a specimen of *T. obsoleta* with fewer, stronger axial ribs, as the spiral sculpture is the same and the syntype illustrated by Ferrero Mortara *et al.* (1981, pl. 54, fig 3) shows the same type of tall mammillate protoconch as seen on the Turkish (Pl. 69, fig. 3), Austrian and Italian specimens. We have not included the Italian early Miocene species described by Bellardi (1888; *i.e. Micromitra taurinia, M. propinqua, M. granosa, M. abbreviata*,

Giannuzzi-Savelli & Reina (1983) reviewed the European Neogene Thala species and recognised the following taxa: in the Atlantic early Miocene Aquitanian and Burdigalian of the Aquitaine Basin Thala burdigalensis Peyrot, 1928 is distinguished by having coarser reticulate sculpture than T. obsoleta, with fewer but stronger spiral cords. From the middle Miocene Aquitaine Basin T. minutecancellata (Degrange-Touzin, 1894) is similar in sculpture to T. burdigalensis, but has a squatter last whorl that is less constricted at the base. From the Atlantic middle Miocene Loire Basin, T. pupa is clearly different, with the spiral sculpture becoming predominant on later teleoconch whorls. Thala pupa has a paucispiral protoconch consisting of two whorls, with a large bulbous nucleus. Unfortunately, the protoconch was not preserved in most of the French shells examined. One specimen examined from the North Sea Basin Miocene Edegem Sand Member, Berchem Formation of Belgium, identified as Thala cf. burdigalensis (NHMW collection) has a tall conical protoconch consisting of 4.5 whorls with a very small nucleus, similar to that illustrated by A.W. Janssen (1984a, pl. 10, fig. 8) for Thala cf. burdigalensis from the Miocene of Winterwijk-Miste, The Netherlands, and quite different from the mammillate protoconch of T. obsoleta.

In the Paratethys, Thala sturi (Hoernes & Auinger, 1880) has a squatter shell than T. obsoleta with very coarse sculpture, T. lapugyensis (Hoernes & Auinger, 1880) has similar sculpture as T. obsoleta, but is squatter, with a relatively broader last whorl and shorter spire, and T. laubei (Hoernes & Auinger, 1880) has a finer sculpture than any of the preceding species, and is more slender with a relatively long siphonal canal. Thala partschi (Hörnes, 1852), from the middle Miocene of the Paratethys, might turn out to be a synonym of T. obsoleta, with which it frequently occurs syntopically. The numerous specimens in the collection of the NHMW are characterised by a rather slender and slightly smaller shell and the spire is higher compared with the more bulky T. obsoleta. A further difference is the more conical paucispiral protoconch of Thala partschi. Therefore, we prefer to exclude T. partschi from the synonymy.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1852; Hoernes & Auinger, 1880); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1888; Davoli, 2000). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Landau *et al.*, 2011); western Mediterranean, Estepona Basin, Spain (NHMW collection), northeastern Spain (NHMW collection), Roussillon Basin, France (Fontannes, 1880); central Mediterranean, Italy (Bellardi, 1888; Chirli, 2002). Family Volutomitridae Gray, 1854 Genus *Conomitra* Conrad, 1865

Type species – Mitra fusoides Lea, 1833, by subsequent designation (Fischer, 1884). Eocene, USA.

Conomitra karamanensis nov. sp.

Plate 34, figs 15-17; Plate 69, figs 1, 2

Material and dimensions – Holotype NHMW 1847/-0058/0402, height 6.0 mm; paratype 1 NHMW 1847/0058/0403, height 6.0 mm; paratype 2 NHMW 1847/0058/0404, height 5.4 mm; paratype 3 RGM 784 054, height 5.7 mm; paratype 4 RGM 784 055, height 5.6 mm; paratype 5 RGM 784 056, height 5.5 mm; furthermore two specimens in YI 484, height 6.0 mm, and YI 485 height: 5.9 mm.

Dimensions and additional material – Maximum height 6.0 mm. Localities 2 & 3: YI 215/5; locality 6: JvdV/5; localities 7 & 8: NHMW 1847/0058/0406/10; locality 10: YI 217/1; locality 13: NHMW 1847/0058/0406/50+, RGM 784 057/3, YI 216/42; locality 17: NHMW 1847/0058/0407/8, YI 346/7.

Etymology – Named after the type locality, the Karaman Basin.

Locus typicus – Pınarlar Yaylası, Akpınar, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Conomitra* species, with a low paucispiral protoconch, a short spire composed of weakly convex whorls, sculpture reduced to a single infrasutural cord and spiral cords on the base, a narrow, internally lirate aperture and five columellar folds.

Description - Shell small, globular, biconic. Protoconch low, paucispiral, of 1.5 smooth whorls, with a large nucleus (dp = 910 μ m, hp = 550 μ m, dp/hp = 1.65, dp1 = 750 μ m, dn = 580 μ m; Pl. 69, figs 1, 2), transition to teleoconch delimited by beginning of spiral sculpture. Teleoconch of four low, weakly convex whorls, with periphery at abapical suture. Suture impressed, linear. Sculpture restricted to one infrasutural spiral cord and poorly developed weak axial folds on first two teleoconch whorls. Last adult whorl 72% of total height, rounded at shoulder, weakly constricted at base, bearing a few faint spiral cords on base. Aperture 50% of total height, narrow, elongate. Anal canal poorly developed. Siphonal canal short, wide, open. Outer lip simple, deeply lirate within. Columella bearing five folds, increasingly oblique and weakening abapically. Columellar callus narrow.

Discussion – This small costellariid is remarkably similar to the antipodean species *Peculator hedleyi* (Murdoch,

1905). No generic description of *Peculator* Iredale, 1924 was given by the author (type species *P. verconis* Iredale, 1924), but all *Peculator* species we have seen have four columellar folds, whereas *C. karamanensis* has five. Indeed, if *C. cognatella* were antipodean it would certainly be placed in *Peculator*. Most of the small Eocene European species placed in the genus *Conomitra* Conrad, 1865 have the second columellar fold more strongly developed, but this is not so obvious in the American species. We are therefore uncertain of the relationship of these small volutomitrids, and provisionally place them in *Conomitra*.

Conomitra karamanensis nov. sp. is characterised by its bioconic globular shape and very reduced sculpture. There is very little intraspecific variability, although some specimens are slightly more slender than others.

These small volutomitirids seem to be quite widespread in the European Miocene, but are seldom reported in the literature. Hoernes & Auinger (1890) described Tubinella (Leucozonia) badensis from the middle Miocene Paratethys of Austria, which differs from the Turkish shell in having a more globose shape, the last adult whorl more constricted at the base and in having spiral sculpture over the entire whorl surface. This species probably belongs within the same group of Conomitra species. A second species from the middle Miocene Paratethys of Romania described by the same authors, Tubinella (Leucozonia) cossmanni is superficially similar, but has stronger sculpture and lacks any columellar folds, and therefore not a volutomitrid. We are unsure of the familial and generic placement of this species. One further European Neogene taxon is Conomitra cognatella (Toldo, 1889) from the late Miocene Tortonian of Italy [see Davoli (2000, pl. 8, figs 10, 11), who wrongly placed it in Vexillum (Uromi*tra*], is very similar to *C*. *karamanensis* in size and shape, also having a paucispiral protoconch, but differs in having broad rounded ribs on the early teleoconch whorls and only four folds on the columella, whereas C. karamanensis has five columellar folds.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Superfamily Olivoidea Latreille, 1825 Family Olividae Latreille, 1825 Genus *Anazola* Gray, 1853

Type species – Oliva acuminata Lamarck, 1811, by subsequent designation (Cossmann, 1899). West Africa.

Anazola vindobonensis (Csepreghy-Meznerics, 1954) Plate 32, figs 5, 6

- 1852 Oliva clavula Lam. Hörnes, p. 49, pl. 7, fig. 1 [non Anazola clavula (Lamarck, 1810)].
- 1952a Olivancillaria clavula Lamarck, 1810 Glibert, p. 356, pl. 11, fig. 6 [non Anazola clavula (Lamarck, 1810)].

- *1954 Olivella (Lamprodroma) clavula vindobonensis Csepreghy-Meznerics, p. 44, pl. 6, figs 3, 9.
- 1966 Olivella (Lamprodroma) clavula vindobonensis Csepreghy-Meznerics, 1954 – Strausz, p. 360, pl. 72, fig. 6.
- 1966 *Olivella (Lamprodroma) clavula vindobonensis* Mezn. – Kókay, pl. 9, fig. 3 (no description).
- 1971 Olivella (Lamprodroma) clavula vindobonensis
 Csepr.-Mezn. Csepreghy-Meznerics, p. 30, pl. 14, fig. 4.
- 1973 Olivella (Lamprodroma) clavula vindobonensis
 Csepreghy-Meznerics, 1954 Báldí, p. 301, pl. 44, figs 7, 8.
- 1975 Olivella clavula vindobonensis Csepreghy-Meznerics, 1954 – Báldi & Steininger, p. 346, pl. 10, figs 2, 3.
- 1997 *Agaronia? vindobonensis* (Csepreghy-Meznerics, 1954) Bałuk, p. 23, pl. 7, figs 3, 4.
- non 1959 Oliva clavula Lam. Eremija, pl. 2, figs 9, 9a (no description) [= Ancillarina subcanalifera (d'Orbig-ny, 1852)].
- ?non 1973 Olivella (Lamprodroma) clavula vindobonensis Meznerics 1954 – Bohn-Havas, p. 1058, pl. 5, figs 14, 15, pl. 9, fig. 4.

Dimensions and material – Maximum height 34.4 mm. Localities 2 & 3: JvdV/2; locality 11: JvdV/4; locality 13: JvdV/1; locality 17: NHMW 1847/0058/0344-1847/0058/ 0349/3, JvdV/4; locality 17a: NHMW/1847/0058/1585/29, MTA 2013/050/3, YI 353/26.

Discussion – There is some confusion about this species and a solution possiby requires a deeper revision. This species usually has been considered to be a subspecies or synonym of Anazola clavula (Lamarck, 1810) (e.g. Davoli, 1989). Anazola clavula is typically found in the early Miocene deposits of France (Peyrot, 1928; Lozouet et al., 2001a), but appeared already during the late Oligocene in the Paratethys (Báldi & Steininger, 1975; described as Olivella clavula vindobonensis Csepreghy-Meznerics, 1954). Typical representatives of this species, as described by Peyrot (1928) and as stored in the collections of the NHMW (from Dax, France), are slender bulletshaped shells with a high spire and narrow apical angle. A second morphology is represented by the moderately slender, high spired shells from the Burdigalian of Italy with a conspicuous barrel-shaped last adult whorl (see Davoli, 1989). Although treated as A. clavula by most Italian authors, these shells might rather represent a separate species for which one of the varietal names proposed by Sacco (1904) would be available. During the middle Miocene, a third shell morphology became predominant. This comprises comparatively stout shells with a broad last whorl and a low spire. Already Peyrot (1928) recognised the difference between the early Miocene French specimens and those from the middle Miocene of the Vienna Basin illustrated by Hörnes (1852). Consequently, Csepreghy-Meznerics (1954) proposed a separation at the subspecies level and introduced the name Olivella

There are no 'clavula-morphs' in the Badenian of the Paratethys and therefore the form *Anazola vindobonensis* can be treated only as either a chronosubspecies within an anagenetic lineage or as a full species. Since the various early Miocene representatives are still not fully understood – *e.g. A. vindobonensis* might be closer to the Italian Burdigalian species – we propose treating the middle Miocene *Anazola* as a distinct species. A further species might be represented by the broad-cylindrical and high-spired Hungarian middle Miocene species with a narrow suture referred to as *Olivella clavula vindobonensis* by Bohn-Havas (1973).

Outside the Paratethys, *Anazola vindobonensis* is also known from the middle Miocene of the Loire Basin (Glibert, 1952a as *Olivancillaria clavula*) and the Serravallian of the Karaman Basin. In the Turkish deposits *A. vindobonensis* is rare in the fully marine assemblages and found most often in the brackish deposits at localities 11 and 17a.

Distribution – Anazola clavula (Lamarck, 1810): Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Peyrot, 1928; Davoli, 1989; Lozouet *et al.*, 2001a); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1882; Sacco, 1904; Davoli, 1989); Paratethys (late Egerian; = Chattian or Aquitanian): Hungary (Báldi, 1973).

Anazola vindobonensis (Csepreghy-Meznerics, 1954): Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852), Poland (Bałuk, 1997), Hungary (Csepreghy-Meznerics, 1954; Strausz, 1962, 1966; Kókay, 1966; Bohn-Havas, 1973); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Strephona Mørch, 1852

Type species – Oliva flammulata Lamarck, 1811, subsequent designation; Recent, Eastern Atlantic.

Strephona dufresnei (de Basterot, 1825)

Plate 32, figs 7, 8; Plate 68, fig. 3

- *1825 Oliva Dufresnei Nob., de Basterot, p. 42, pl. 2, fig. 10.
- 1845 Oliva Dufresnei Bast. Nyst, p. 601, pl. 45, fig. 11.
- 1845 Oliva Dufresnei Bast. Grateloup, pl. 42, figs 23, 24.
- 1853 Oliva Dufresnei Bast. Beyrich, p. 303, pl. 2, figs7a, b, 8.
- 1866 Oliva flammulata Lam. Pereira da Costa, p. 35, pl. 10, figs 1, 2.
- 1882 Porphyria Dufresnei (Bast.) Bellardi, p. 207, pl. 12, fig. 26.
- 1882 Porphyria malthata Bell., Bellardi, p. 209.
- 1899 Neocylindrus Dufresnei Bast. Cossmann, p. 46,

pl. 2, figs 30, 31.

- 1904 Neocylindrus Dufresnei var. mamillospira Sacc., Sacco, p. 76, pl. 17, fig. 34.
- 1904 Neocylindrus Dufresnei var. parvispira Sacc., Sacco, p. 76, pl. 17, fig. 35.
- 1925 Oliva (Neocylindrus) Dufresnei var. procera Kautsky, p. 134, pl. 9, fig. 16.
- 1925 Oliva (Neocylindrus) Dufresnei var. brevispira Kautsky, p. 134, pl. 9, fig. 17.
- 1925 Olivella (Lamprodroma) cimbrica Kautsky, p. 134, pl. 9, fig. 18.
- 1928 Oliva (Neocylindrus) Dufresnei Basterot Peyrot, p. 174, no. 1097, pl. 11, figs 45-48.
- 1952a Oliva (Neocylindrus) dufresnei Basterot, 1825 Glibert, p. 358, pl. 11, fig. 8.
- 1952b Oliva (Neocylindrus) dufresnei Basterot, 1825 Glibert, p. 114, pl. 8, fig. 15.
- 1958 Oliva minutissima (Kautsky) Sorgenfrei, p. 237, pl. 49, fig 161 (non Kautsky, 1925)
- 1958 Oliva (Strephona) flammulata Lamarck Erünal-Erentöz, p. 77, pl. 12, fig. 5.
- 1964 Oliva (Strephona) dufresnei Basterot 1825 Anderson, p. 267, pl. 28, fig. 207.
- 1968 Oliva (Strephona) flammulata Lam. Stancu & Andreescu, p. 468, pl. 6, fig. 64.
- 1969 Oliva (Neocylindrus) dufresnei Bast. Csepreghy-Meznerics, p. 91, pl. 5, figs 22, 28.
- 1979 Oliva (Strephona) dufresnei De Basterot, 1825 R. Janssen, p. 302.
- 1981 *Porphyria malthata* Bellardi, 1882 Ferrero Mortara *et al.*, p. 133, pl. 34, fig. 8.
- 1984a *Oliva (Strephona) dufresnei* De Basterot, 1825 A.W. Janssen, p. 247, pl. 10, fig. 5, pl. 64, fig. 10.
- 1989 *Oliva (Strephona) dufresnei* Basterot, 1825 Davoli, p. 128, pl. 5, figs 8-10, 15, 17, 19-21.
- 1997 Oliva (Neocylindrus) dufresnei Basterot, 1825 Bałuk, p. 22, pl. 7, figs 1, 2.
- 2001 *Oliva (Strephona) dufresnei* Basterot, 1825 Wienrich, p. 507, pl. 81, fig. 3, pl. 104, fig. 5.
- 2009 *Oliva dufresnei* (Basterot, 1825) Zunino & Pavia, p. 358, pl. 1, fig. 18.
- 2010 *Oliva (Strephona) dufresnei* Basterot, 1825 Moths *et al.*, p. 59, text-fig. 35a, b, pl. 18, figs 6, 7, pl. 40, fig. 7.

Dimensions and material – Maximum height 22.5 mm. Localities 2 & 3: JvdV/2, YI 12/1; localities 7 & 8: RGM 784 027/1; locality 11: JvdV/4; locality 13: JvdV/1; locality 17: NHMW 1847/0058/0350 and NHMW 1847/0058/0351/5, JvdV/3, RGM 794565/1 (ex JvdV coll.), MTA 2013/051/1; locality 17a: NHMW/1847/0058/1584/14, YI 11/9.

Discussion – Davoli (1989) discussed the European Neogene Olividae, and recognised three species within the subgenus Strephona. Strephona bellardii (Cossmann, 1899) (= Porphyria inflata Bellardi, 1882, non Lamarck, 1810) is easily distinguished by its rather broad, squat shell, with a roundly shouldered last whorl. Strephona cylindracea (Borson, 1820) differs from Strephona dufresnei (de Basterot, 1825) in having an ovate-cylindrical profile, as opposed to the more cylindrical profile of S. dufresnei, in having a less deeply canaliculate suture, and in having a less thickened outer lip. Both species have a deep siphonal canal, but it is more oblique in S. dufresnei. Davoli (1989, tab. 3 and p. 129) described the protoconch of S. dufresnei as paucispiral, but did not illustrate it. The protoconch is low-domed, consisting of about 2.25 whorls (dp = 670 μ m, dp1 = 210 μ m, dn = 115 μ m; Pl. 68, fig. 3). A similar protoconch description for S. dufresnei was given by A.W. Janssen (1984a, pl. 10, fig. 5) and Wienrich (2001, pl. 81, fig. 3). The protoconch of S. cylindracea is also multispiral (Davoli, 1989, pl. 6, fig. 7), but higher domed than that of S. dufresnei. In the Turkish deposits S. dufresnei is rare in the fully marine assemblages and found most often in the brackish deposits at localities 11 and 17a.

Distribution - Late Oligocene: North Sea Basin (Chattian): Germany (R. Janssen, 1979). Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Peyrot, 1928; Davoli, 1989; Lozouet et al., 2001a); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1882; Sacco, 1904; Davoli, 1989; Zunino & Pavia, 2009). Paratethys (Karpatian) (Harzhauser, 2004). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Denmark (Sorgenfrei, 1958), Netherlands (A.W. Janssen, 1984a), Belgium (Nyst, 1843; Glibert, 1952b), Germany (Beyrich, 1853; Kautsky, 1925; Anderson, 1964; Wienrich, 2001; Moths et al., 2010). Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Peyrot, 1928), (Langhian): Loire Basin, France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Poland (Bałuk, 1997), Hungary (Csepreghy-Meznerics, 1969), Romania (Stancu & Andreescu, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Davoli, 1989).

Subfamily Ancillariinae Swainson, 1840 Genus *Amalda* H. Adams & A. Adams, 1853

Type species – Ancillaria tankervillii Swainson, 1825, by subsequent designation (H. E. Vokes, 1939).

Amalda glandiformis (Lamarck, 1810)

Plate 32, figs 9, 10; Plate 68, fig. 4; Plate 80, fig. 6

- *1810 Ancillaria glandiformis Lamarck, p. 305.
- 1816 Ancillaria glandiformis Lamarck, pl. 393, fig. 7.
- 1820 Ancilla inflata nobis, Borson, p. 204, pl. 1, fig. 7.
- 1823 Anolax inflata Borson Brongniart, p. 63, pl. 4, fig. 12.
- 1833 Ancillaria Conus Andrzejowski, p. 437, pl. 11, fig. 1.
- 1837 Ancillaria coniformis m., Pusch, p. 116, pl. 11, fig. 1.
- 1845 Ancillaria glandiformis Lam. Grateloup, pl. 42, figs 6-10.

- 1852 Ancillaria glandiformis Lam. Hörnes, p. 57, pl. 6, figs 6-13, pl. 7, fig. 2.
- 1853 Ancillaria glandiformis Lam. Beyrich, p. 315, pl. 2, fig. 5.
- 1853 Ancillaria glandiformis Lamk. Deshayes, p. 75, pl. 123, fig. 17.
- 1866 Ancillaria glandiformis Lam. Pereira da Costa, p. 38, pl. 10, figs 3-9.
- 1866 Ancillaria glandiformis Lamarck Fischer, p. 240.
- 1880 Ancillaria glandiformis Lamk. Hoernes & Auinger, p. 55, pl. 7, figs 1, 2.
- 1882 Ancillaria glandiformis Lamck. Bellardi, p. 227, pl. 12, figs 41, 42.
- 1899 Baryspira glandiformis Lamk. Cossmann, p. 65, pl. 3, figs 1-4.
- 1904 Baryspira glandiformis var. dertorugulosa Sacc., Sacco, p. 80, pl. 17, fig. 65.
- 1904 Baryspira glandiformis var. dertoacuta Sacc., Sacco, p. 80, pl. 17, fig. 66.
- 1904 Baryspira glandiformis var. taurolonga Sacc., Sacco, p. 80, pl. 17, figs 67, 68.
- 1904 Baryspira glandiformis var. perplicata Sacc., Sacco, p. 80, pl. 17, fig. 69.
- Baryspira glandiformis var. anguloseinflata Sacc., Sacco, p. 80, pl. 17, fig. 70.
- 1904 Baryspira glandiformis var. dertocallosa Sacc., Sacco, p. 80, pl. 17, figs 71-73.
- 1904 Baryspira glandiformis var. dertocrassissima Sacc., Sacco, p. 80, pl. 17, figs 74, 75.
- 1904 Baryspira glandiformis var. pseudoconus Sacc., Sacco, p. 80, pl. 17, fig. 76.
- 1911 Ancilla glandiformis Lam. Friedberg, p. 108, pl. 6, fig. 1, text-fig. 30.
- 1912 Ancillaria (Baryspira) glandiformis var. dertocallosa Sacco – Schaffer, p. 137, pl. 49, figs 22-24.
- 1916 Ancilla glandiformis (Lamck.) Stefanini, p. 66, pl. 1, figs 29-31.
- 1928 Ancilla (Baryspira) glandiformis Lamarck Peyrot, p. 187, no. 1105, pl. 12, figs 21-25.
- 1928 Ancilla (Baryspira) glandiformis var. conoidea Deshayes – Peyrot, p. 189, no. 1106, pl. 12, figs 11, 12.
- 1936 Ancilla (Baryspira) glandiformis Lamarck Bogsch, p. 78, pl. 2, figs 14-17.
- 1940 Ancilla (Sparella) glandiformis Lk. Roman, p. 390, pl. 4, figs 10, 13.
- 1942 Ancilla (Baryspira) glandiformis (Lamarck) Wenz, p. 210, pl. 1, fig. 7.
- 1946 Ancilla glandiformis Lamarck Stchepinsky, p. 145, pl. 36, figs 3-7.
- 1952a Ancilla (Baryspira) glandiformis Lamarck, 1810 Glibert, p. 351, pl. 11, fig. 4.
- 1954 Ancilla (Baryspira) glandiformis Lk. Strausz, p.
 78, pl. 7, figs 147a-e.
- 1954 Ancilla (Baryspira) glandiformis conoidea Desh. – Strausz, p. 78, pl. 7, figs 148a-c
- 1956 Ancilla (Baryspira) glandiformis Lam. Csepreghy-Meznerics, p. 434, pl. 8, figs 18, 19.
- 1956 Ancilla (Baryspira) glandiformis conoidea Desh.
 Csepreghy-Meznerics, p. 411, pl. 8, figs 20, 21.

- 1958 Ancilla (Baryspira) glandiformis Lk. Mongin, p. 232, pl. 1, figs 1-2, 4-7.
- 1958 Ancilla (Baryspira) glandiformis Lamarck Erünal-Erentöz, p. 75, pl. 12, figs 1-3.
- 1958 Ancilla (Baryspira) glandiformis Lamarck Hölzl, p. 249, pl. 21, fig. 6.
- 1958 *Ancilaria* [*sic*] *glandiformis* Broce. Jovanovíc & Dolić, p. 96, pl. 1, fig. 5.
- 1959 Ancilla glandiformis Lam. Eremija, pl. 1, figs 12, 12a (no description).
- 1959 Ancilla glandiformis Lam. Stevanović & Miloševic, p. 93, pl. 3, figs 1a, b.
- Ancilla (Baryspira) glandiformis var. conoidea (Deshayes, 1832) – Kojumdgieva & Strachimirov, p. 168, pl. 43, fig. 5.
- 1960 Ancilla (Baryspira) glandiformis var. elongata (Deshayes, 1832) – Kojumdgieva & Strachimirov, p. 168, pl. 43, fig. 7.
- 1966 Ancilla (Baryspira) glandiformis var. conoidea Desh. – Symeonidis, p. 284, pl. 59, fig. 7.
- Ancilla (Baryspira) glandiformis Lamarck, 1810 –
 Strausz, p. 357, pl. 40, figs 16-23, pl. 41, figs 1, 2, pl. 73, figs 13, 14, pl. 74, figs 1, 2.
- 1966 Ancilla (Baryspira) glandiformis conoidea Deshayes, 1832 Strausz, p. 358, pl. 73, figs 6-12.
- 1968 Ancilla glandiformis (Lamarck, 1810) Zelinskaya et al., p. 209, pl. 48, figs 29, 30.
- 1968 Ancilla (Baryspira) glandiformis (Lamarck, 1810)– Hinculov, p. 146, pl. 36, figs 6, 7.
- 1968 Ancilla (Baryspira) glandiformis elongata (Desh.)– Stancu & Andreescu, pl. 6, fig. 61.
- 1969 Ancilla (Baryspira) glandiformis (Lamarck) Atanacković, p. 208, pl. 11, figs 9, 10.
- 1971 Ancilla (Baryspira) glandiformis dertocallosa (Sacco, 1904) – Steininger, p. 403, pl. 10, fig. 11.
- 1971a Ancilla glandiformis elongata (Deshayes) Eremija, p. 75, pl. 5, fig. 2.
- 1972 *Ancilla (Baryspira) glandiformis* Lamarck Nicorici, pl. 16, figs 7, 8 (no description).
- 1972 Ancilla (Ancilla) glandiformis conoideus Br. Csepreghy-Meznerics, p. 30, pl. 13, fig. 21, 24.
- 1973 Ancilla (Baryspira) glandiformis (Lamarck) 1810
 Bohn-Havas, p. 1059, pl. 5, fig. 17.
- 1975 *Ancilla (Baryspira) glandiformis* Lamarck Pilot *et al.*, pl. 1, fig. 8 (not seen).
- 1981 Ancilla glandiformis (Lamarck, 1822 [sic]) Meco, p. 607, pl. 1, figs 1-12.
- 1985 Ancilla glandiformis (Lamarck) Brigantini, pl. 1, fig. 28 (not seen).
- 1985 Ancilla (Baryspira) glandiformis (Lamarck, 1810)
 Atanacković, p. 159, pl. 35, figs 13-17.
- 1985 Ancilla (Baryspira) glandiformis conoidea (Deshayes, 1832) Atanacković, p. 160, pl. 35, figs 18-20.
- 1989 Ancilla (Baryspira) glandiformis (Lamarck, 1810)
 Davoli, p. 114, pl. 1, figs 8, 9, 11, 12, pl. 2, figs 1-10, pl. 3, fig. 11, pl. 6, figs 1, 3, 8, 11.
- 1990 Ancilla (Baryspira) glandiformis (Lamarck, 1810)
 Davoli, p. 74, pl. 10, fig. 3.
- 1997 Amalda (Baryspira) glandiformis (Lamarck,

1810) - Bałuk, p. 24, pl. 6, figs 1-11.

- 1998 Ancilla (Baryspira) glandiformis (Lamarck) Schultz, p. 70, pl. 28, fig. 2.
- 2002 *Amalda (Baryspira) glandiformis* (Lamarck, 1810) Harzhauser, p. 109, pl. 8, fig. 19.
- 2004 Ancilla (Baryspira) glandiformis Lamarck, 1810– İslamoğlu, p. 157, pl. 3, figs 7, 8.
- 2006 Amalda glandiformis (Lamarck, 1810) morphotype elongata – Landau & Silva, p. 6, pl. 1, figs 1-8 (with additional synonyms).
- 2006 Amalda glandiformis (Lamarck, 1810) Landau & Silva, text-figure 4, figs 2, 3.
- 2007 *Ancilla glandiformis* (Lamarck) Főzy & Szente, p. 298, fig. 12 (not seen).
- 2009 *Amalda (Baryspira) glandiformis* (Lamarck, 1810) Mikuž, p. 25, pl. 7, figs 94-99.
- 2009 Amalda glandiformis (Lamarck, 1810) Zunino & Pavia, p. 358, pl. 1, fig. 20.
- 2011 *Amalda glandiformis* (Lamarck, 1810) Harzhauser *et al.*, p. 216, fig. 4.1.
- 2011 Amalda glandiformis (Lamarck, 1810) morphotype elongata – Landau et al., p. 30, pl. 15, fig. 7.

Dimensions and material – Maximum height 60.5 mm. Localities 2 & 33 lot NHMW 1847/0058/0356/3, JvdV/50+, RGM 783 920/9, MTA 2013/052/15, YI 15/50+; locality 6: JvdV/4, RGM 784 061/2, RGM 783 855/11; localities 7 & 8: JvdV/50+, RGM 783 885/50+; locality 9: JvdV/6, RGM 783 824/33; locality 11: JvdV/9; locality 12: JvdV/50+; locality 13: NHMW 1847/0058/0352-0353/2, 1847/0058/0354/25+, JvdV/50+, RGM 777878/1 (ex JvdV coll.), RGM 783 692/50+, MTA 2013/053/20, YI 14/50+; locality 15: NHMW 1847/0058/0357/2; locality 17: NHMW 1847/0058/0355/18, JvdV/50+, RGM 783 789/50+, MTA 2013/054/67, YI 13/39; locality 18: JvdV/18. Exact locality unknown AÜ-LE-K-223/1.

Discussion - According to Glibert (1952a), Amalda glan*diformis* (Lamarck, 1810) is a very variable species, with three main morphotypes; forma typica Deshayes (Glibert 1952a, pl. 11, fig. 4a), regularly fusiform, with rounded ends; forma conoidea Deshayes (Glibert 1952a, pl. 11, fig. 4d) with a broad, depressed spire and heavy parietal callus, and forma elongata Deshayes, with a tall, narrow spire and thin callus. According to Glibert, intermediates exist between these well-defined forms in the Miocene. In the Turkish assemblages both the *typica* and *conoidea* morphotypes can be found, and numerous intermediates. It is common in both the clayev and sandy facies of the Karaman deposits. The taxonomic difficulties surrounding this species, especially in the Pliocene assemblages where only the *elongata* form occurs, were discussed in length by Landau & Silva (2006), and will not be repeated here. Under UV light there is a striking difference in colour between the callus and the rest of the shell surface (Pl. 80, fig. 6), as in most other species of Ancillariinae. R. Janssen (1979) separated the late Oligocene North Sea Basin specimens under the name Amalda anomala (Schlotheim, 1820), differing from the Miocene spe-

cies A. glandiformis in having a poorly developed spire

callus, a columella pillar with numerous small folds and in lacking spiral ridges on the parietal wall. After a more detailed study of Oligocene material from several localities, Lozouet (1992), concluded that although the Oligocene shells have a less well-developed spire callus, they could not be separated. Lozouet (1992) went on to note that *A. glandiformis* from the Miocene usually has only two folds on the columella pillar and concluded that the presence of numerous folds on the pillar was an ancestral character, so he separated the Oligocene shells as the subspecies *A. glandiformis anomala*. For further discussion see Landau & Silva (2006).

Distribution - Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Grateloup, 1845; Peyrot, 1928; Mongin, 1958); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Borson, 1820; Bellardi, 1882; Sacco, 1904; Brigantini, 1985; Zunino & Pavia, 2009), Proto-Mediterranean Sea (late Burdigalian): Kasaba Basin, Turkey (İslamoğlu, 2004); Paratethys (Aquitanian-Burdigalian): Austria, (Schaffer, 1912; Steininger, 1971; Harzhauser, 2002), Slovakia (Harzhauser et al., 2011). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Grateloup, 1845; Peyrot, 1928), (Langhian): Loire Basin, France (Glibert, 1952a; Mongin, 1958); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1852; Hoernes & Auinger, 1880; Mongin, 1958; Schultz, 1998), Poland (Andrzejowski, 1833; Pusch, 1837; Friedberg, 1911; Bogsch, 1936; Bałuk, 1997), Hungary (Bogsch, 1936; Strausz, 1962, 1966; Csepreghy-Meznerics, 1956, 1972; Bohn-Havas, 1973), Bulgaria (Kojumdgieva & Strachimirov, 1960), Romania (Hoernes & Auinger, 1880), Bosnia (Eremija, 1959, 1971a; Atanackovič, 1985), Serbia (Jovanovíc & Dolić, 1958; Stevanović & Miloševic, 1959), Slovenia (Mikuž, 2009), Ukraine (Zelinskaya et al., 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Fischer, 1866; Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867), southwestern Spain (Wenz, 1942), Canary Islands (Meco, 1981); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1882; Sacco, 1904; Davoli, 1989, 1990). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González-Delgado, 1992; Landau et al., 2011), Bou Regreg Basin, NW Morocco (Glibert, 1960a); Western Mediterranean, Estepona Basin, Spain (Landau & Silva, 2006). Early-late Pliocene: northeastern Atlantic: Mondego Basin, Portugal (Cox, 1941; Zbyszewski, 1959; Brébion, 1971; Silva, 2001, 2002).

Superfamily Cancellarioidea Forbes & Hanley, 1851 Family Cancellariidae Forbes & Hanley, 1851 Subfamily Cancellariinae Forbes & Hanley, 1851 Genus *Aneurystoma* Cossmann, 1899

Type species – Cancellaria dufourii Grateloup, 1832, by original designation. Early Miocene, France.

Aneurystoma afenestrata (Sacco, 1894) Plate 35, figs 1, 2; Plate 69, fig. 4

- *1894b Aphera bronni var. afenestrata Sacc., Sacco, p. 67 (nom. nov. pro Cancellaria Dufouri [sic] Grat. in Hörnes, 1854, non Cancellaria Dufourii Grateloup, 1832).
- 2012 Aneurystoma afenestrata (Sacco, 1894) Harzhauser & Landau, p. 17, figs 3G, 4J1–J3 (with additional synonyms).

Dimensions and material – Maximum height 23.4 mm. Locality 13: RGM 794 089/1 (ex JvdV collection); locality 17: NHMW 1847/0058/0410/1, YI 354/1 incomplete specimen.

Discussion – Originally described from the Miocene Paratethys, where it is extremely rare, this very distinctive cancellariid is also very uncommon in the Turkish assemblages. The two specimens illustrated herein show some variation in the height of the spire and strength of spiral sculpture. They agree fairly closely with the syntype, but differ slightly in having two secondary spirals intercalated in the interspace of the primary ribs at the periphery of the last whorl. The protoconch is naticoid, paucispiral, consisting of about two whorls with a large nucleus (Pl. 69, fig. 4). For further discussion see Harzhauser & Landau (2012, p. 18).

Distribution – **Early Miocene**: Paratethys (late Burdigalian): Austria (Harzhauser & Landau, 2012). **Middle Miocene**: Paratethys (Langhian): Austria (Hörnes, 1854; Hoernes & Auinger, 1890; Sieber, 1936; Harzhauser & Landau, 2012), Poland (Bałuk, 1997); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus *Bivetiella* Wenz, 1943 (= *Bivetia* Jousseaume, 1887b, *non* 1887a)

Type species – Bivetia bivet Jousseaume, 1887 (*Cancellaria similis* Sowerby, 1833), by original designation of *Bivetia* Jousseaume, 1887b. Recent, northwestern Africa.

Bivetiella dertonensis (Bellardi, 1841)

Plate 35, fig. 3; Plate 80, fig. 11

- *1841 *Cancellaria cancellata* Lamarck var. *Dertonensis* Bellardi, p. 28, pl. 3, figs 13, 14.
- 1942 *Cancellaria (Cancellaria) cancellata* (Linné) Wenz, p. 211, pl. 1, fig. 9 [*non Bivetiella cancellata* (Linné, 1767)].
- 2012 *Bivetiella dertonensis* (Bellardi, 1841) Harzhauser & Landau, p. 18, figs 3H, 5B1–B3, 5C1–C3, 5D1–D3 (with additional synonyms).

Dimensions and material – Maximum height 28.1 mm. Localities 2 & 3: JvdV/1, RGM 794 545/1 (ex JvdV collection); locality 12: JvdV/3, RGM 777 883/1 (ex JvdV collection); locality 13: NHMW 1847/0058/0411/2, JvdV/2, RGM 783 698/1, YI 40/1; locality 17: NHMW 1847/0058/0412/2.

Discussion - The Pliocene-Recent species Bivetiella cancellata (Linné, 1767) is closely similar to the Miocene species Bivetiella dertonensis (Bellardi, 1841) (synonym C. subcancellata d'Orbigny, 1852), which differs in being smaller with a more depressed spire, a more canaliculate suture, and thicker, closer, irregularly spaced and more numerous axial ribs. The colour pattern in the Turkish shell, enhanced under UV light, consists of a broad adapical band on the spire whorls and at the periphery on the last adult whorl, with a second narrower band delimiting the base (Pl. 80, fig. 11), forming a pattern identical to that of the Recent species B. cancellata. Landau et al. (2006a) examined the protoconch of specimens of B. dertonensis from the Sallomacian of Moulin Débat, Gironde department, France, and the middle Miocene, Badenian of Austria (NHMW collection). The number of protoconch whorls is similar in the two species, but the diameter varies in both species from 1.2 to 1.42 mm and the nucleus from 80 to 155 μ m. None of the specimens examined showed any trace of protoconch sculpture. Although some authors have synonymised the two forms (Malatesta, 1974; Vera-Peláez & Muñiz Solís, 1995) we agree with Davoli (1995) that the differences are constant and of stratigraphic value. Several varieties of B. dertonensis were reported by Sacco (1894b, pl. 2, figs 66-70) from the early Miocene of Italy. However, it is difficult to interpret these specimens from the poor illustrations given, and the types have not been reillustrated. We therefore include them in the synonymy with some reservation. Confirmed specimens of *B. dertonensis* appear in the middle Miocene and disappear at the end of the Miocene, to be replaced by B. cancellata. The two possibly form an evolutionary lineage and could then be considered to be subspecies, although we prefer to give them full species rank. The species-group name *dertonensis* was used by Bellardi (1841) as a varietal name for both Cancellaria cancellata and C. bonellii. Davoli (1982, p. 21) treated Bivetiella dertonensis (Bellardi, 1841), originally named as a variety of C. cancellata Linné, as a valid species and at the same time (p. 64) placed C. bonellii dertonensis Bellardi, 1841 in the synonymy of Bonellitia serrata (Bronn). Davoli effectively acted as first reviser by accepting one usage of *dertonensis* and rejecting the other.

Landau *et al.* (2006a) separated the Miocene North Sea Basin species or subspecies, *Bivetiella cancellata praecedens* (Beyrich, 1856), which is smaller, higher-spired and with considerably finer sculpture than the Pliocene to Recent species. The North Sea Basin form has secondary and even tertiary spiral cords, which are not seen in any specimens of *B. cancellata*. This form is also close to *B. dertonensis*, some specimens of which from Austria and Italy have secondary spiral cords. The North Sea Basin records are the oldest of this lineage (from the Bolderberg Formation, Belgium) (Glibert, 1952b). The

Bolderberg Formation is a Pleistocene derived deposit, probably containing early Miocene material. The species, however, also occurs in the Edegem Sand Member of the Berchem Formation, which is *in situ*, and is of late Burdigalian or possibly Langhian age. Bivetiella praecedens possibly was ancestral to the B. cancellata lineage, which consequently seems to have appeared in the North Sea Basin, migrated into the Paratethys and reached the Mediterranean and the Aquitaine basins. However, another species of the same genus, Bivetiella neuvillei (Peyrot, 1928) is known from the Burdigalian of the Aquitaine Basin as well as from the Bolderberg Formation (Glibert, 1952b). No European Oligocene records of the subgenus are known, so the group possibly migrated into Europe at the end of this period, possibly from the Caribbean.

Bałuk (1997, pl. 14, fig. 7) identified a single Polish specimen as *C. (Bivetiella) neuvillei* on the basis of the shell having secondary spiral sculpture, which according to Bałuk is absent in *B. subcancellata* (d'Orbigny, 1852). As discussed above, some specimens of *B. dertonensis* from Austria, Italy and our specimens from Turkey have some secondary spiral sculpture, and we consider the Polish shell to be conspecific with *B. dertonensis*, albeit with unusually strong secondary spiral sculpture. Cahuzac *et al.* (2004) considered the French Atlantic Burdigalian form to be a distinct species, *Bivetiella stromboides* (Grateloup, 1832), which they suggested was ancestral to the other members of the *B. cancellata* group. For further discussion see Harzhauser & Landau (2012, p. 19).

Distribution – ? Early Miocene: Several taxa have been introduced as variety names by Sacco (1894b) for shells from the Burdigalian of the Colli Torinesi in Italy. These may represent the earliest records of this species but their identifications need revision. Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Peyrot, 1928; Cahuzac et al., 2004); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854; Sieber, 1936; Schultz, 1998, Harzhauser & Landau, 2012), Czech Republic (Harzhauser & Landau, 2012); Hungary (Strausz, 1966; Csepreghy-Meznerics, 1956, 1969a), Poland (Friedberg, 1914; Bałuk, 1997), Romania (Harzhauser & Landau, 2012); western Proto-Mediterranean (Serravallian): Montjuic Basin, northern Spain (Almera & Bofill, 1884); eastern Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867), southern Spain (Wenz, 1942); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1894b; Davoli, 1982, 1990); Proto-Mediterranean Sea (Messinian): Po Basin, Italy (Davoli, 1995).

Genus Contortia Sacco, 1894

Type species – Cancellaria contorta de Basterot, 1825, by original designation. Neogene, France.

Contortia bellardii (Michelotti, 1847)

Plate 35, fig. 4; Plate 69, fig. 5

- 1841 Cancellaria evulsa var. Taurinia Bell., Bellardi, p. 25, pl. 2, figs 17, 18 (nomen nudum).
- *1847 *Cancellaria Bellardii* mihi, Michelotti, p. 225. (*nom. nov. pro Cancellaria evulsa* var. *Taurinia* Bellardi, 1841).
- 1894b Cancellaria evulsa var. taurinia Bell. Sacco, p. 45, pl. 3, fig. 12.
- non 1854 Cancellaria Bellardii Micht. Hörnes, p. 314, pl. 34, fig. 17 [= Contortia saccoi (Hoernes & Auinger, 1890)].
- non 1969b Cancellaria (Bonellitia) evulsa taurinia Sacco Csepreghy-Meznerics, p. 93, pl. 5, figs 35, 36 [= Contortia saccoi (Hoernes & Auinger, 1890)].

Dimensions and material – Height 21.3 mm. Locality 13: NHMW 1847/0058/0413/13.

Discussion – In the last few years the rather confusing taxonomy surrounding European Neogene members of the genus *Contortia* Sacco, 1894 has been clarified, following publications on the Pliocene Italian species by Brunetti *et al.* (2008) and the middle Miocene Parate-thyan species by Harzhauser & Landau (2012). *Contortia bellardii* (Michelotti, 1847) is characterised by its very inflated whorls, the adult whorl has little sign of a shoulder, and its cancellate sculpture is relatively regular, with the axial and spiral elements of roughly equal strength and the interspaces square. The protoconch is low, consisting of just over two smooth whorls with a medium-sized nucleus (Pl. 69, fig. 5).

Contortia bellardii is most similar to the middle Miocene Paratethyan species *Contortia saccoi* (Hoernes & Auinger, 1890) and *Contortia tortoniana* (Sacco, 1894), but differs from both of these in having more convex whorls and the sculpture is more regularly cancellate, rather than horizontally oblong as in the Paratethyan species. *Contortia callosa* (Hörnes, 1854) and *C. contorta* (de Basterot, 1825), both of which are also found in the Akpınar deposits, differ in having fewer, broader axial ribs. Similarly, all the Italian Pliocene congeners differ from *C. bellardii* in having stronger spiral sculpture.

Distribution – **Early Miocene**: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1894b). **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Contortia callosa (Hörnes, 1854)

Plate 35, figs 5, 6; Plate 69, fig. 6; Plate 80, fig. 12

- *1854 *Cancellaria callosa* Partsch, Hörnes, p. 314, pl. 34, figs 14-16.
- 2012 *Contortia callosa* (Hörnes, 1854) Harzhauser & Landau, p. 21, figs 3J, 5E1–E3, 5F1–F3, 5G1–G3 (with additional synonyms).

Dimensions and material – Maximum height 35.6 mm. Localities 7 & 8: NHMW 1847/0058/0414/2, RGM 783 875/1; locality 12: JvdV/1; locality 13: NHMW 1847/0058/0414/1, 1847/0058/0416/3, RGM 777 884/1 (ex JvdV collection), YI 41/1.

Discussion – This species is characterised by its inflated, solid shell and globose last whorl. The sculpture consists of 10-12 rounded axial ribs, which are crossed by numerous spiral threads and a few broader primary spirals. These are formed by 2-3 closely-spaced spiral threads that amalgamate into a single band. The absence of a sutural ramp, the convex whorls, the weak to absent umbilicus, the predominant axial sculpture and the presence of three columellar folds are characteristic of the genus *Contortia* Sacco, 1894 as defined by Cahuzac *et al.* (2004) and Landau *et al.* (2006).

The protoconch in the Turkish shells is low, consisting of just over two smooth whorls with a medium-sized nucleus (Pl. 69, fig. 6). This is slightly different from that illustrated by Harzhauser & Landau (2012, fig. 3J), which shows a more dome-shaped protoconch of 2.5 whorls, however, the Paratethyan shell is somewhat worn and the teleoconch of the Turkish shells is absolutely characteristic of the species. A colour pattern is enhanced under UV light on the last whorl consisting of a narrow subsutural band and a second broader band mid-whorl (Pl. 80, fig. 12).

The early Miocene Burdigalian shells from the Colli Torinesi in Italy, treated by Sacco (1894b) as *Contortia callosa taurolaevior* and *C. c. tauroturrita*, differ strongly from the type in their sculpture. They lack the characteristic spiral cords and have broader and more poorly defined axial ribs. For further discussion see Harzhauser & Landau (2012, p. 21).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854; Hoernes & Auinger, 1890; Sieber, 1936; Harzhauser & Landau, 2012), Poland (Bałuk, 2006); Romania (Harzhauser & Landau, 2012); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Contortia contorta (de Basterot, 1825)

Plate 35, fig. 7, 8; Plate 69, fig. 7

- *1825 *Cancellaria contorta* Nob., de Basterot, p. 47, pl. 2, fig. 3.
 - 1832 Cancellaria deshayesiana Grateloup, p. 338, no. 362.
- 1832 *Cancellaria contorta* De Bast. Grateloup, p. 338, no. 363.
- 1832 *Cancellaria volutella* Lam. Varietas B. *Columbella triplicata* Nob., Grateloup, p. 340, no. 368.
- 1832 Cancellaria buccinula De Bast. Grateloup, p. 341, no. 369 (non Cancellaria buccinula Lamarck, 1822).
- 1845 C. Buccinula Lam. Grateloup, pl. 25, fig. 9.
- 1845 C. Deshayesiana Var. A Grateloup, pl. 25, fig. 13.

- 1845 C. contorta De Bast. Grateloup, pl. 25, fig. 19.
- 1845 *C. volutella* Lam. Var B. Grateloup, pl. 25, fig. 22.
- 1858 Cancellaria Beyrichi Mayer, p. 391, pl. 11, fig. 8.
- 1867 Cancellaria contorta Bast. Pereira da Costa, p. 197, pl. 24, fig. 6.
- 1894b Cancellaria Michelinii var. ovatoventricosa Sacco, p. 15 (nom. nov. pro Cancellaria Deshayesiana var. A in Grateloup, 1845).
- 1894b Contortia contorta (Bast.) Sacco, p. 49, pl. 3, fig. 24.
- 1894b Contortia contorta var. taurinia Bell. Sacco, p. 49, pl. 3, fig. 25.
- 1894b *Contortia dertocontorta* Sacc., Sacco, p. 49, pl. 3, fig. 27.
- 1894b Contortia dertocontorta var. eximbricata Sacc., Sacco, p. 50, pl. 3, fig. 28.
- 1894b Contortia dertocontorta var. rotundulina Sacc., Sacco, p. 50, pl. 3, fig. 29.
- 1925 Merica contorta Bast. Kautsky, p. 137, pl. 10, fig. 2.
- 1928 Merica contorta (Basterot) Peyrot, p. 206, pl. 12, figs 30-34, 41.
- ?1928 Merica sallomacensis nov. sp., Peyrot, p. 210, pl. 13, figs 13, 14.
- 1928 Merica Beyrichi (Mayer) Peyrot, p. 211, pl. 12, figs 15, 16.
- 1928 Merica varicosula nov. sp., Peyrot, p. 212, pl. 12, figs 42, 43.
- 1952a *Cancellaria (Merica) contorta* forma *basteroti* Deshayes, 1830 – Glibert, p. 366, pl. 11, fig. 11.
- 1958 Cancellaria (Merica) contorta Basterot Hölzl, p. 260, pl. 21, fig. 14.
- 1972 Cancellaria (Merica) contorta contorta Basterot, 1825 – A.W. Janssen, p. 37, pl. 8, fig. 1.
- 1982 Cancellaria (Merica) contorta Basterot, 1823 Davoli, p. 25, pl. 2, figs 1-4, 12.
- 1995 Cancellaria (Merica) contorta Basterot, 1823 Davoli, p. 227, pl. 1, fig. 5.
- 2004 *Cancellaria buccinula* Grateloup, 1832 Cahuzac *et al.*, p. 228, figs 8L-N.
- 2004 Cancellaria deshayesiana Grateloup, 1832 Cahuzac et al., p. 230, figs 80-R.
- 2004 *Cancellaria contorta* Basterot, 1825 Cahuzac *et al.*, p. 236.
- 2004 Cancellaria volutella Lam. var. B. Cahuzac et al., p. 237, figs 8S-U.
- 2006a Contortia contorta (Basterot, 1825) Landau et al., pl. 2, fig. 4.
- 2008 Contortia contorta (Basterot, 1825) Brunetti et al., figs 7A-L.
- 2010 Contortia sp. Moths et al., p. 75, text-fig. 43.
- non 1854 Cancellaria contorta Bast. Hörnes, p. 311, pl. 34, figs 7, 8 [= Contortia fenestrata (Eichwald, 1830)].
- non 1964 Cancellaria (Merica) contorta Basterot, 1825 Anderson, p. 270, pl. 29, fig. 210 [= Cancellaria (Bivetiella) praecedens Kautsky, 1925].

Dimensions and material - Maximum height 25.3 mm.

Localities 2 & 3: JvdV/4, YI 42/1; localities 7 & 8: NHMW 1847/0058/0463/1, NHMW 1847/0058/0977/1, NHMW 1847/0058/0464/10, RGM 784 020/1; locality 13: RGM 783 699/1; locality 17: JvdV/1.

Discussion – Landau *et al.* (2006a) discussed the relationship between the Miocene *Contortia contorta* (de Basterot, 1825) and the Pliocene *Contortia italica* (d'Ancona, 1872), and concluded that these were distinct species differing in small details of their teleoconch morphology, but most importantly by the character of the protoconch, which is dome-shaped and consisting of about 2.5 whorls in *C. contorta*, but only of 1.25 strongly convex whorls, with a slightly involute nucleus in *C. italica*.

The Turkish specimens are interesting, as their teleoconch characters are more similar to the Pliocene *C*. *italica* in having less convex whorls and a more scalate spire. However, their protoconch (Pl. 69, fig. 7) consists of 2.2 whorls with a relatively small nucleus, and therefore is of the *C*. *contorta* type.

Davoli (1982, 1995) suggested that C. italica [as Cancellaria (Merica) altavillae (Libassi, 1859)] was the Pliocene descendent of C. contorta, passing through the late Miocene form *dertocontorta* Sacco, 1894, which he synonymised with C. contorta, and Davoli (1995) showed a small difference in height/length between the Tortonian (C. dertocontorta) and Pliocene (C. italica) forms. Unfortunately, in neither of these publications is there any mention of protoconch type. The Tortonian shells illustrated by Davoli (1982, 1995) from Italy certainly have more scalate spires than the early Miocene Aquitanian-Burdigalian specimens from France. It seems therefore that the teleoconch morphotype of C. *italica* was already present during the late Serravallian-early Tortonian in at least some populations and that the two species can only be reliably separated by their protoconch morphology. We can infer from their protoconch types that at some point at the end of the Miocene the species changed from a planktotrophic (C. contorta) to non-planktotrophic development (C. italica).

Exactly how many Contortia species occur in the European Neogene is complex and beyond the scope of this work. However, the following observations can be made. Brunetti et al. (2008) separated the Mediterranean Pliocene forms into two species, C. italica and C. strictoturrita (Sacco, 1894), the latter differing from C. italica in being larger and thicker-shelled, with a narrower apical angle, with fewer axial ribs but more numerous spiral cords, a less nearly circular aperture and minor differences in the abapical columellar fold. The authors went on to point out a difference in protoconch size, which judging from their figures is about 20% in the width, although only one protoconch of each form was illustrated. Brunetti et al. (2008) placed Admetula malacitana Vera-Peláez & Muñiz-Solis, 1995 from the early Pliocene Estepona Basin, Spain, which was synonymised with C. contorta by Landau et al. (2006a), in the synonymy of C. strictoturrita. These Spanish specimens are thin-shelled and with an apical angle similar to that of C. contorta. Moreover, the protoconch of the Estepona shell is identical to that of *C. italica.* The modest difference in protoconch size must be interpreted with caution, as protoconch size can vary intraspecifically with depth (Robertson, 1994) and the 20% difference reported by the authors may well be within the natural distribution of protoconch size for the species. In muricid species with a direct mode of development, such as *Vokesimurex purdyae* (Radwin & d'Attilio, 1976) amongst other, Houart (1991) showed a huge variability in protoconch size and shape. Indeed both of these authors cautioned against the use of protoconch size alone to distinguish between species. We therefore remain sceptical of this separation. The Paratethyan *Contortia* species were recently revised by Harzhauser & Landau (2012).

Distribution - Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Peyrot, 1928; A.W. Janssen, 1972; Cahuzac et al., 2004; Brunetti et al., 2008); Paratethys (Burdigalian): Austria (Hölzl, 1958); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1894b; Brunetti et al., 2008). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Germany (Kautsky, 1925; Moths et al., 2010). Middle Miocene: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Peyrot, 1928; Cahuzac et al., 2004), (Langhian): Loire Basin, France (Glibert, 1952a); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1894b; Davoli, 1982), (Messinian): Po Basin, Italy (Davoli, 1995).

Genus Sveltia Jousseaume, 1887b

Type species – Voluta varricosa Brocchi, 1814 (current accepted spelling *varicosa*), by original designation. Pliocene, Italy.

Sveltia dertovaricosa (Sacco, 1894)

Plate 35, fig. 9; Plate 69, fig. 8

- *1894b *Cancellaria* (*Sveltia*) *dertovaricosa* Sacc., Sacco, p. 57, pl. 3, fig. 49.
- 2012 *Sveltia dertovaricosa* (Sacco, 1894) Harzhauser & Landau, p. 49, figs 3S, 9H1–H3 (with additional synonyms).

Dimensions and material – Maximum height 35.1 mm. Localities 2 & 3: NHMW 1847/0058/1438/9, JvdV/50+, RGM 783 934/6, MTA 2013/063/3, YI 46/14; locality 6: JvdV/7, RGM 783 851/1; localities 7 & 8: NHMW 1847/0058/0468/23, JvdV/6, RGM 783 873/1; locality 9: JvdV/4, RGM 783 822/5, YI 45/2; locality 10: YI 44/4; locality 12: JvdV/9; locality 13: NHMW 1847/0058/0467/33, JvdV/22, RGM 784 031/1, RGM 783 700/14, MTA 2013/064/10, YI 47/43; locality 17: NHMW 1847/0058/0465/1, NHMW 1847/0058/0466/27, JvdV/24, RGM 783 778/6, MTA 2013/065/8, YI 43/21. Exact locality unknown: AÜ LE-K-232/1.

Discussion - Landau et al. (2006a) discussed the relationship between the Miocene species Sveltia dertovaricosa Sacco, 1894 and the Pliocene species S. varicosa (Brocchi, 1814), and showed that there was a clear trend for the shells to become larger, with more angular whorls, a more inflated angular last whorl and, above all, to lose the abapical columellar fold. The Italian Tortonian shells are intermediate in shape between the middle Miocene S. dertovaricosa and S. varicosa, but with a weakly developed third columellar fold present, and therefore is still considered to be S. dertovaricosa. The Serravallian specimens from Turkey are typical of S. dertovaricosa, with rather elongate shells and the adult whorl not strongly inflated. The third columellar fold is strongly developed (Pl. 39, fig. 9). The protoconch of the Turkish specimens (Pl. 69, fig. 8) is indistinguishable from that of S. varicosa (see Landau et al., 2006a, pl. 6, fig. 4). Although *Voluta varricosa* was the original spelling, we note that this Pliocene species was subsequently spelled varicosa by most authors after Brocchi (1814). This spelling is now considered to be the correct spelling under either Article 33.2.3.1 or Article 33.3.1 of the ICZN (1999, see Petit & Harasewych, 2005, p. 110).

We have provisionally excluded Sveltia burdigalensis Peyrot, 1928, from the early Miocene of the Aquitaine Basin in France from the synonymy. It is very similar to S. dertovaricosa, also with three columellar folds, but the shell is small, with a somewhat more inflated last whorl and narrower but more prominent axial sculpture. The protoconchs of specimens examined from Martillac, Gironde department, France (NHMW collection) are identical to that of S. dertovaricosa from various localities (i.e., Turkey, Paratethys). We have also excluded Sveltia varicosa paucicostata Peyrot, 1928, originally described from the Serravallian of the Aquitaine Basin, France, but better known and widespread in the early and middle Miocene of the North Sea Basin (Belgium, Glibert, 1952b; The Netherlands, A.W. Janssen, 1984b; Germany, Wienrich, 2001). This form differs in its very elongate, slender shape and very deep sutures. This (sub)species evolved in the Pliocene North Sea Basin into Sveltia jonkairiana (Nyst, 1835). For further discussion see Harzhauser & Landau (2012, p. 50).

Distribution – **Middle Miocene**: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Peyrot, 1928); Paratethys (Langhian and Serravallian): Austria (Hörnes, 1854; Sieber, 1936; Schultz, 1998; Harzhauser & Landau, 2012), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Csepreghy-Meznerics, 1950; Strausz, 1962, 1966), Poland (Friedberg, 1914; Bałuk, 1997; Harzhauser & Landau, 2012), Romania (Harzhauser & Landau, 2012), Slovenia (Mikuž, 2003, 2009), Bosnia (Atanacković, 1969, 1985); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1894b, Davoli, 1982, 1995; Brunetti *et al.*, 2011).

Genus Calcarata Jousseaume, 1887b

Type species – Voluta calcarata Brocchi, 1814, by original designation. Pliocene, Italy.

Calcarata calcarata (Brocchi, 1814)

Plate 35, fig. 10; Plate 69, fig. 9

- *1814 Voluta calcarata nob., Brocchi, p. 309, pl. 3, fig. 7.
 1884 Cancellaria calcarata Brocchi var. Almera & Bofill, p. 41, pl. C, figs 15, 16.
- 1958 Sveltia (Calcarata) calcarata (Brocchi, 1814) Erünal-Erentöz, p. 86, pl. 13, figs 9, 10.
- 2006a Calcarata calcarata (Brocchi, 1814) Landau et al., p. 71 (partim, pl. 5, fig 1 only) [non pl. 5, fig. 2 = Calcarata vindobonensis (Hilber, 1892)] (with additional synonyms, excluding Paratethyan references).
- 2011 *Calcarata calcarata* (Brocchi, 1814) Landau *et al.*, p. 31, pl. 16, fig. 3.
- 2011 Calcarata calcarata (Brocchi, 1814) Brunetti et al., p. 100, fig. 8A-I, fig. 9A.
- non 1854 Cancellaria calcarata Brocc. var. Hörnes, p. 322, pl. 35, fig. 5 [= Calcarata vindobonensis (Hilber, 1892)].
- non 1936 Cancellaria (Calcarata) calcarata Brocchi Sieber, p. 98, pl. 3, fig. 9 [= Calcarata vindobonensis (Hilber, 1892)].
- non 1956 Cancellaria (Calcarata) calcarata Brocchi Csepreghy-Meznerics, p. 417, pl. 9, figs 36-39 [= Calcarata vindobonensis (Hilber, 1892)].
- non 1960 Sveltia (Calcarata) calcarata (Brocchi) Kojumdgieva & Strachimirov, p. 164, pl. 42, fig. 17 [= Calcarata vindobonensis (Hilber, 1892)].
- non 1966 Cancellaria (Calcarata) calcarata Brocchi Strausz, p. 381, pl. 43, figs 16-18 [= Calcarata vindobonensis (Hilber, 1892)].
- non 1968 Narona (Calcarata) calcarata (Brocc.) Stancu & Andreescu, pl. 5, fig. 55 [= Calcarata vindobonensis (Hilber, 1892)].
- non 1969 Narona (Calcarata) calcarata (Brocchi) Atanacković, p. 209, pl. 11, figs 15, 16 [= Calcarata vindobonensis (Hilber, 1892)].
- non 1985 Narona (Calcarata) calcarata (Brocchi, 1814) Atanacković, p. 165, pl. 37, figs 6-9 [= Calcarata vindobonensis (Hilber, 1892)].
- non 1997 Narona (Calcarata) calcarata (Brocchi, 1814) Bałuk, p. 50, pl. 16, fig. 1, pl. 17, fig. 7 [= Calcarata vindobonensis (Hilber, 1892)].
- non 2006a Calcarata calcarata (Brocchi, 1814) Landau et al., p. 71 (partim; Paratethyan references and pl. 5, fig. 2 only) [= Calcarata vindobonensis (Hilber, 1892)].
- non 2009 Narona (Sveltia) calcarata (Brocchi, 1814) Mikuž, p. 28, pl. 9, figs 122, 123 [= Calcarata vindobonensis (Hilber, 1892)].

Dimensions and material - Maximum height 29.1 mm.

Localities 2 & 3: NHMW 1847/0058/1437/27, RGM 783 935/1, MTA 2013/066/4, YI 48/9; locality 6: NHMW 1847/0058/1502/17, JvdV/5, RGM 783 852/1; localities 7 & 8: NHMW 1847/0058/047/12, JvdV/9, RGM 783 874/1; locality 9: JvdV/9, RGM 783 821/8; locality 12: JvdV/1; locality 13: NHMW 1847/0058/0469/1, 1847/0058/0470/43, RGM 784 019/1, 783 701/9, MTA 2013/067/7, YI 49/20; locality 17: YI 50/1. Exact locality unknown: AU LE-K-231/2.

Discussion – Calcarata calcarata (Brocchi, 1814) is the only relatively common cancellariid present in the Karaman assemblages, but the Turkish specimens never reach the large size attained by some shells in Italian Pliocene assemblages. There is some variability in the development of the spines at the shoulder and in some specimens there is a second spiral cord below the abapical carina on the last whorl, but otherwise the shells are remarkably constant in shape.

Late Miocene and Pliocene specimens of *Calcarata calcarata* all lack spiral sculpture between the shoulder and the basal carina (Landau *et al.*, 2006a). Middle Miocene shells from the Paratethys usually assigned to this species bear distinct spiral sculpture on the last adult whorl and differ also in their squattier outline. These were shown to represent a distinct Paratethyan middle Miocene species, *Calcarata vindobonensis* (Hilber, 1892) by Harzhauser & Landau (2012). The protoconch of the Turkish shells (Pl. 69, fig. 9) is similar to that illustrated by Landau *et al.* (2006a, pl. 5, fig. 2) on a specimen of *C. vindobonensis* from the middle Miocene Paratethys of Kostej, Romania, rather than *C. calcarata*.

Reports of *Calcarata calcarata* from the Miocene of the North Sea Basin also require revision. Juvenile shells from the late Miocene of Germany and Denmark, described by Moth & Tüxen (2008) and Schnetler (2005), differ distinctly from Pliocene Italian specimens of *C. calcarata* in their low, but strongly convex protoconch, and in the angulation of early teleoconch whorls, which is much closer to the upper suture in the illustrated specimens than in *C. calcarata*. Others, such as the shells described by Anderson (1964) from the middle Miocene of northern Germany, might well represent *Calcarata calcarata*.

Distribution – Middle Miocene: western Proto-Mediterranean (Serravallian): Montjuic Basin, northern Spain (Almera & Bofill, 1884); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian), Cacela Basin, Portugal (BL collection); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1894b; Davoli, 1982, 1995). Early Pliocene: northeastern Atlantic (Guadalquivir Basin): Spain (Landau *et al.*, 2011); western Mediterranean Sea (Estepona Basin): Spain (Landau *et al.*, 2006a), northeastern Spain (Almera & Bofill, 1884), Roussillon Basin, France (Martinell & Domènech, 1986); central Mediterranean Sea, Italy (Malatesta, 1974; Chirli, 2002; Brunetti *et al.*, 2011). Late Pliocene: central Mediterranean Sea: Italy (Sacco, 1894b; Glibert, 1960; Caprotti & Vescovi, 1973; Chirli, 1988; Cavallo & Repetto, 1992).

Closely related species or chronosubspecies of *C. calcarata*:

Early-middle Miocene: ? North Sea Basin (late Burdigalian-early Langhian): Germany (Beyrich, 1856; Kautsky, 1925; Anderson, 1964; Moths, 1989; Wienrich, 2001, Moths & Tüxen, 2008; Moths *et al.*, 2010), Denmark (Sorgenfrei, 1958; Rasmussen, 1956, 1968; Schnetler, 2005).

Genus Solatia Jousseaume, 1887b

Type species – 'Solatia solat Adams (Piscatorum Chemn.)' (= Buccinum piscatorium Gmelin, 1791), by original designation. Recent, West Africa.

Solatia exwestiana (Sacco, 1894)

Plate 35, fig. 11

- *1894b Cancellaria (Gulia) exwestiana Sacc., Sacco, p. 24 [nom. nov. pro Cancellaria Westiana [sic] (Grat.) in Hörnes, pl. 35, figs 11-13, non Gulia acutangula «morph westziana» (Grateloup, 1845)].
- 2012 Solatia exwestiana (Sacco, 1894) Harzhauser & Landau, p. 47, figs 3R, 9F1–F3, 9G1–G3 (with additional synonyms).
- non 1963 Trigonostoma (Ventrilia) cfr. exwestianum (Sacco) – Venzo & Pelosio, p. 112, pl. 39, fig. 2.

Dimensions and material – Maximum height 27.8 mm. Locality 17: NHMW 1847/0058/0472/1, JvdV/1, RGM 794 077/1 (ex JvdV collection).

Discussion – Like most *Solatia* species, *S. exwestiana* (Sacco, 1894) has a highly variable shell, especially in regard to the height of the spire. Most specimens have a medium-height scalate spire, but some shells are much higher-spired, as is the case of the specimens from the Karaman assemblages.

The genus is represented by several other species in the European Neogene. In the Pliocene it is represented by the *Solatia piscatoria* (Gmelin, 1791)/*S. hirta* (Brocchi, 1814) species complex, which differs from *S. exwestiana* in having a more scalate spire, with a deeper canaliculate suture and in having more closely-spaced spiral sculpture, which develops stronger spines at the sculptural intersections. *Solatia exwestiana* also has spiral threads on the sutural ramp, a character common to all the Miocene species, but only very weakly developed or absent in the Pliocene-Recent representatives of the genus.

Solatia barjonae (Pereira da Costa, 1867, pl. 25, figs 10-13, not fig. 9), found in the Proto-Mediterranean and Atlantic late Miocene Tortonian faunas, differs from *S. exwestiana* in having a more oval shell, a less scalate spire, a more inflated adult whorl and more open cancellate sculpture, with more widly spaced axial and spiral elements and therefore less numerous spines. *Solatia doderleini* (Mayer, 1868), sympatric with *S. barjonae* in many European late Miocene, Tortonian deposits, differs from the latter in the height and shape of the spire, inclination of the sutural ramp and wider umbilicus, although as with the *S. piscatoria/S. hirta* complex, the two are not always easily distinguished (Landau *et al.*, 2006a; Davoli, 1982). For further discussion see Harzhauser & Landau (2012, p. 48).

Distribution – Early Miocene Paratethys (Burdigalian): Austria (Harzhauser & Landau, 2012), Switzerland (Harzhauser & Landau, 2012). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854; Sieber, 1936; Schultz, 1998); Czech Republic (Harzhauser & Landau, 2012), Hungary (Harzhauser & Landau, 2012), Romania (Harzhauser & Landau, 2012); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1894b).

Genus *Petitina* Harzhauser & Landau, 2012 [= *Inermia* Korobkov, 1955 (*non Inermia* Poey, 1860)]

Type species – Cancellaria inermis Pusch, 1837, by original designation. Tertiary, Poland.

Petitina inermis (Pusch, 1837)

Plate 35, figs 12, 13

- 1830 Buccinum mitraeforme Pusch, Pusch in Andrzejowski, p. 94, pl. 4, fig. 1.
- *1837 *Cancellaria inermis* m., Pusch, p. 129, pl. 11, fig. 22.
- 2012 Petitina inermis (Pusch, 1837) Harzhauser & Landau, p. 35, figs 3L, 7H1–H3, 7I1–I2, 7J1–J3 (with additional synonyms).

Dimensions and material – Maximum height 70.0 mm. Locality 6: JvdV/2; locality 13: JvdV/1; locality 17: NHMW 1847/0058/0473/1, NHMW 1847/0058/0474/11, JvdV/7, RGM 794 549/1 (ex JvdV collection), RGM 783 777/5, MTA 2013/068/1, YI 51/4. Exact locality unknown: AU LE-K-233/1.

Discussion – Buccinum mitraeforme Pusch in Andrzejowski, 1830 became a secondary homonym of *Voluta mitraeformis* Brocchi, 1814 in the first revision of this species by Pusch (1837). At that time both taxa were placed in *Cancellaria*. Therefore, Pusch (1837) introduced the replacement name *Cancellaria inermis*.

As highlighted by Bałuk (1997) and Harzhauser & Landau (2012), this species is extremely variable in almost every shell character, with squat and elongate forms coexisting, the whorls rounded to angular, and the axial ribs well developed to subobsolete. This same variability can be seen within the Karaman shells, some of which attain a large size. Peyrot (1928) separated the French Atlantic middle Miocene Serravallian forms under the name Sveltia inermis mut. gallica, and considered them to differ from the Paratethyan populations in having more globose spire whorls, with subobsolete axial sculpture and a last whorl lacking axial sculpture and strong nodules at the periphery. Peyrot (1928) thought the French populations were similar to the specimen illustrated by Pereira da Costa (1867) from the Atlantic middle Miocene Serravallian of Portugal. Bałuk (1995), whilst emphasising the variability of *Petitina inermis* (Pusch, 1837), stated that these Atlantic forms were distinctly different from those of the Paratethys, without further comment, and that they represented a distinct species. In our opinion, these minor differences are far from clear, and fall within the range of variability of *Petitina inermis* (Pusch, 1837). For further discussion see Harzhauser & Landau (2012, p. 36).

Distribution – Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Peyrot, 1928), Adiça, Portugal (Pereira da Costa, 1867); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854; Sieber, 1936; Schultz, 1998; Harzhauser & Landau, 2012), Czech Republic (Harzhauser & Landau, 2012), Hungary (Csepreghy-Meznerics, 1956; Strausz, 1962, 1966), Poland (Pusch, 1837; Friedberg, 1914; Bałuk, 1997), Romania (Harzhauser & Landau, 2012), Slovenia (Mikuž, 2009), Bosnia (Atanacković, 1969, 1985), Ukraine (Zelinskaya *et al.*, 1968); western Proto-Mediterranean (Serravallian): Montjuic Basin, northern Spain (Almera & Bofill, 1884); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Genus Trigonostoma Blainville, 1827

Type species – Delphinula trigonostoma Lamarck, 1822 (? = *Buccinum scalare* Gmelin, 1791), by monotypy. Recent, Indo-Pacific.

Trigonostoma exgeslini (Sacco, 1894)

Plate 36, figs 1, 2

- *1894b *Cancellaria (Gulia) Geslini* forma *exgeslini* Sacc., Sacco, p. 22. (*nom. nov. pro Cancellaria Geslini* Bast. *in* Hörnes, pl. 35, fig. 3, *non Gulia geslini* de Basterot, 1825).
- 2012 *Trigonostoma exgeslini* (Sacco, 1894) Harzhauser & Landau, p. 58, figs 3W, 11A1–A3, 11B1–B3 (with additional synonyms).

Dimensions and material – Maximum height 29.5 mm. Localities 7 & 8: NHMW 1847/0058/0475/1; locality 17: NHMW 1847/0058/0476, 1847/0058/0478/1, 1847/0058/0477/11, JvdV/1, RGM 783 776/1, YI 52/2.

Discussion – This is a very distinctive species with a moderately high, gradate spire, which starts with cancellate sculpture and regularly convex whorls and becomes strongly scalate abapically. The later teleoconch whorls are nearly straight-sided, with widely spaced axial ribs and narrower spiral cords. The growth of the last two

whorls is strongly allometric resulting in a rapidly widening sutural platform, crossed by widely spaced, elevated, prosocline axial ribs. The spiral cord at the sharply angulated shoulder is slightly raised and forms the outer rim of the sutural platform. The last whorl contracts rapidly below the shoulder, causing a subtrigonal outline to the aperture, and the umbilicus is wide and very deep. A weak, oblique third fold appears rarely below the two prominent columellar folds in some specimens. The lecithotrophic protoconch consists of about 2.25 whorls with a medium-sized nucleus. This morphology has little in common with the more elongate, less angulated and narrowly umbilicate species Gulia geslini (de Basterot, 1825), as described by Cahuzac et al. (2004). Thus, the separation from that French Burdigalian species as proposed by Sacco (1894) is fully justified.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854; Hoernes & Auinger, 1890; Sieber, 1936; Harzhauser & Landau, 2012), Poland (Friedberg, 1914; Bałuk, 1997), Hungary (Strausz, 1962, 1966; Csepreghy-Meznerics, 1950), Romania (Harzhauser & Landau, 2012). Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Ventrilia Jousseaume, 1887a

Type species – Ventrilia ventrilia Jousseaume, 1887 (= *Cancellaria tenera* Philippi, 1848), by monotypy. Recent, Caribbean.

Ventrilia imbricata (Hörnes, 1854) Plate 36, figs 3, 4

- *1854 *Cancellaria imbricata* Hörn., Hörnes, p. 327, pl. 35, fig. 16a-c.
- 2012 *Ventrilia imbricata* (Hörnes, 1854) Harzhauser & Landau, p. 61, figs 10 I1–I3 (with additional synonyms).

Dimensions and material – Maximum height 41.9 mm. Localities 2 & 3: JvdV/7; locality 6: RGM 783 853/1; locality 13: JvdV/1; locality 17: NHMW 1847/0058/0489/7, JvdV/3, RGM 794 547/1 (ex JvdV collection), RGM 794 548/1 (ex JvdV collection), RGM 783 775/1; locality 17a: NHMW 1847/0058/1590/2.

Discussion – Some gerontic specimens from Seyithasan are large (Pl. 36, fig. 4), with the spire whorls somewhat disjunct, making the umbilicus broader than in other specimens illustrated in the literature, but the sculpture and general shell shape of the smaller specimens (Pl. 36, fig. 3) are concordant with *Ventrilia imbricata* (Hörnes, 1854). This species is also found in the brackish levels of Seyithasan (locality 17a), where specimens are smaller and similar to the Paratethyan shells from the Vienna Basin. The poorly preserved single specimen from Estepona incorrectly identified as *Trigonostoma (Ventrilia) imbricatum* (Hörnes, 1854) by Landau *et al.* (2006c) is *Scalptia*

etrusca Brunetti *et al.*, 2008. For further discussion see Harzhauser & Landau (2012, p. 61).

Distribution - Early Miocene: Paratethys (Burdigalian, Karpatian): Korneuburg Basin, Austria (Harzhauser, 2002). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1854; Hoernes & Auinger, 1890; Sieber, 1936; Harzhauser & Landau, 2012), Czech Republic (Harzhauser & Landau, 2012), Poland (Friedberg, 1914; Bałuk, 1997), Romania (Harzhauser & Landau, 2012); western Proto-Mediterranean (Serravallian): Montjuic Basin, northern Spain (Almera & Bofill, 1884); eastern Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1894b; Davoli, 1982; Brunetti et al., 2008). Early Pliocene: northeastern Atlantic: Guadalquivir Basin, Spain (Landau et al., 2011).

Genus Ovilia Jousseaume, 1887b

Type species – Cancellaria doliolaris de Basterot, 1825, by original designation. Early Miocene, France.

Ovilia excassidea (Sacco, 1894)

Plate 36, fig. 9

- *1894b Cancellaria (Trigonostoma) cassideum forma excassidea Sacco, p. 8. (nom. nov. pro Cancellaria cassidea Brocc. in Hörnes, 1856, non Voluta cassidea Brocchi, 1814).
- 2012 *Ovilia excassidea* (Sacco, 1894) Harzhauser & Landau, p. 32, figs 7C1-C3 (with additional synonyms).

Dimensions and material – Maximum height 28.2 mm. Locality 17: NHMW 1847/0058/0479, 1847/0058/0480/2.

Discussion – The globose shape, the canaliculate suture, the wide but shallow umbilicus and the wide aperture with a strongly convex outer lip place this species in *Ovilia* Jousseaume, 1887 as defined by Cahuzac *et al.* (2004) and Landau *et al.* (2006).

Ovilia excassidea (Sacco, 1894) has conspicuous spiral sculpture composed of primary to tertiary cords, which cross broad axial ribs. The secondary and tertiary spiral sculpture in the 'window' between the primary spiral and axial elements is beaded.

The shells from the Tortonian of Montegibbio (Italy), described by Davoli (1982) as *Trigonostoma excassideum*, differ from the Viennese type specimen in their rather ovoid outline, the narrower and steeper sutural ramp and the much narrower umbilicus. Moreover, the spiral cords of the Italian shells are much less differentiated into primary and secondary cords than in *O. excassidea*. Their identity needs re-evaluation as they might rather belong to an *O. cassidea* species-group. *Trigonostoma dertocassideum* Sacco, 1894, which was treated as a likely synonym of *T. excassideum* by Davoli (1982), lacks the wide umbilicus and has a higher aperture and is clearly unrelated to this species.

In the Pliocene species *O. cassidea* (Brocchi, 1814) found throughout the Mediterranean and adjacent Atlantic differs significantly in having more regular, densely spaced spiral sculpture and a narrower umbilicus. *Ovilia andaluciensis* Landau, 1984, which is known only from the early Pliocene Atlantic Guadalquivir Basin of southwestern Spain, has almost no gutter adjacent to the suture, an even more inflated last whorl resulting in a very wide aperture, and very weak axial sculpture. For further discussion see Harzhauser & Landau (2012, p. 32).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Sieber, 1936; Harzhauser & Landau, 2012); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Scalptia Jousseaume, 1887b

Type species – Cancellaria obliquata Lamarck, 1822, by original designation. Recent, Indo-Pacific.

Scalptia dertocosticillata (Sacco, 1894) Plate 36, figs 6-7

- *1894b Cancellaria (Trigonostoma) imbricatum var. dertocosticillata Sacc., Sacco, p. 13, pl. 1, fig. 31.
- 2012 Scalptia dertocosticillata (Sacco, 1894) Harzhauser & Landau, p. 37 (with additional synonyms).

Dimensions and material – Maximum height 31.3 mm. Localities 2 & 3: NHMW 1847/0058/1439/3, JvdV/7, RGM 794 078/1 (ex JvdV collection), RGM 794 079/1 (ex JvdV collection); locality 17: NHMW 1847/0058/0481/3, MTA 2013/069/1, YI 53/2.

Discussion – As pointed out by Harzhauser & Landau (2012) this species frequently has been confused with *Scalptia polonica* (Pusch, 1837). Both species develop a comparable outline with a slight concavity below the shoulder and a somewhat inflated lower third of the last whorl. A marked shoulder angulation causes a gradate spire with deep cavities between the axial ribs on the narrow sutural ramp. The axial ribs are prominent on the spire whorls weakening slightly on the last whorl. The spiral cords cross the axial cords, and a secondary spiral cord is intercalated in the interspaces, giving the surface a slightly scaly appearance. For further discussion see Harzhauser & Landau (2012, p. 37).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Friedberg, 1914; Bałuk, 1997); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1894b).

Scalptia polonica (Pusch, 1837) Plate 36, fig. 5

- *1837 *Cancellaria acutangula* Fauj. var. *polonica* m., Pusch, p. 128, pl. 11, fig. 17a, b.
- 2012 *Scalptia polonica* (Pusch, 1837) Harzhauser & Landau, p. 39, figs 3M, 8D1–D3, 8E1–E3 (with additional synonyms).

Dimensions and material – Maximum height 35.3 mm. Localities 2 & 3: RGM 794 064/1 (ex JvdV collection); locality 17: NHMW 1847/0058/0482/5.

Discussion – This species is characterised by its stout and globular shell, relatively narrow sutural but deep sutural gutter, and prominent sculpture consisting of blunt axial ribs crossed by slightly weaker spirals cords. The deep interspaces are slightly spirally elongated rectangular and the intersections are somewhat spinose, especially at the shoulder. The umbilicus is moderately wide and delimited by a broad fasciole. Secondary spiral threads are developed in some specimens. For further discussion see Harzhauser & Landau (2012, p. 37).

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1887a). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854; Hoernes & Auinger, 1890; ?Sieber, 1936; Harzhauser & Landau, 2012), Poland (Pusch, 1837), Bulgaria (Harzhauser & Landau, 2012), Czech Republic (Harzhauser & Landau, 2012), Romania (Harzhauser & Landau, 2012), ?Bulgaria (Kojumdgieva & Strachimirov, 1960), Slovenia (Mikuž, 2009); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Scalptia scrobiculata (Hörnes, 1854)

Plate 36, fig. 8

- *1854 *Cancellaria scrobiculata* Hörnes, p. 318, pl. 35, fig. 1.
- 2012 *Scalptia scrobiculata* (Hörnes, 1854) Harzhauser & Landau, p. 46, 3Q, 9D1–D3 (with additional synonyms).

Dimensions and material – Maximum height 26.5 mm. Locality 17: NHMW 1847/0058/1555/1.

Discussion – The Karaman specimen has a more sloping sutural platform than the syntype illustrated by Harzhauser & Landau (2012, figs 9D1–D3) and the secondary spiral sculpture is weaker than in the Paratethyan shell. However, these differences are minor and we consider the Turkish shell to be conspecific with *Scalptia scrobiculata* (Hörnes, 1854).

This species is similar to *Scalptia gradata* (Hörnes, 1854), which differs in having fewer axial ribs, a more slender shape and a less convex last whorl. In *S. gradata* the ribs are blunt and varix-like whilst in *S. scrobiculata*

the ribs are relatively narrower and rounded. *Scalptia neugeboreni* (Hörnes, 1856) is also reminiscent of *S. scrobiculata* but has a wider umbilicus, much coarser spiral sculpture and a much deeper canaliculate sutural ramp. For further discussion see Harzhauser & Landau (2012, p. 47).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854; Hoernes & Auinger, 1890; Sieber, 1936; Harzhauser & Landau, 2012), Poland (Bałuk, 1837), Czech Republic (Harzhauser & Landau, 2012); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Scalptia spinosa (Grateloup, 1827) Plate 36, fig. 10

- *1827 Cancellaria Spinosa Grateloup, p. 21, no. 23.
- 2012 Scalptia spinosa (Grateloup, 1827) Harzhauser & Landau, p. 41, figs 3O, 8F1–F3, 8G1–G3, 8H1–H3 (with additional synonyms).

Dimensions and material – Maximum height 22.4 mm. Localities 7 & 8: RGM 783 876/1; locality 12: JvdV/4; locality 13: NHMW 1847/0058/0483-1847/0058/0485/3, YI 54/1.

Discussion – Scalptia spinosa (Grateloup, 1827) is characterised by having a strongly gradate spire, a wide sutural platform, a rather squat last whorl and a wide umbilicus. The axial sculpture is predominant, consisting of broad, prosocline ribs, which are spinose at the shoulder, crossed by narrow spiral cords of alternate strength. This very characteristic species is widespread in the European Miocene. The protoconch is multispiral dome-shaped, consisting of about three smooth whorls with a small nucleus, suggestive of a planktotrophic mode of development. For further discussion see Harzhauser & Landau (2012, p. 42).

Distribution – Early Miocene: northeastern Atlantic (late Burdigalian): Aquitaine Basin, France (Grateloup, 1827; Peyrot, 1928; Cahuzac et al., 2004); Proto-Mediterranean Sea: (Burdigalian): Colli Torinesi, Italy (Bellardi, 1841). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cahuzac et al., 2004); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854; Hoernes & Auinger, 1890; Sieber, 1936; Schultz, 1998; Harzhauser & Landau, 2012), Czech Republic (Harzhauser & Landau, 2012), Hungary (Csepreghy-Meznerics, 1972), Poland (Friedberg, 1914; Bałuk, 1997); Romania (Harzhauser & Landau, 2012); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1894b; Davoli, 1982). Early Pliocene: Central Mediterranean, Italy (d'Ancona, 1872).

Scalptia? *problematica* nov. sp. Plate 37, fig. 1

Dimensions and type material – Holotype NHMW 1847/0058/0488, height 17.9 mm, width 12.7.

Derivatio nominis – From Late Latin problematicus, from Ancient Greek προβληματικός (problēmatikos), reflecting the difficulty in placing this species within a recognised cancellariid genus.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Scalptia* (*s. lat.*) species, with a solid, globose shell, with the teleoconch consisting of 3.5 angular whorls, with cancellate scabrose sculpture, alternate axial ribs varicose on the last adult whorl, a subtrigonal aperture, lirate within, two narrow, non-bifid columellar folds and a moderate sized umbilicus.

Description – Shell small, solid, globose, relatively squat. Protoconch and early teleoconch whorls eroded. Teleoconch of 3.5 angular whorls, with shallow, relatively broad sutural ramp, weakly convex below, periphery at abapical suture. Axial sculpture of nine prosocline, rounded ribs, narrow on early teleoconch whorls, rapidly broadening on second half of penultimate whorl, broad, every second rib varicose on last whorl. Axial ribs cross sutural ramp, weakening towards adapical suture, interspaces between ribs somewhat depressed, concave. Spiral sculpture of three narrow primary cords, adapical cord at shoulder, delimiting sutural ramp. Fourth cord appearing abapically on penultimate whorl, eight on last whorl, with single secondary spiral thread in each interspace. Entire whorl surface covered with close-set, elevated growth lamellae, surface providing scabrose appearance. Last whorl globose, 84% of total height, convex below shoulder, somewhat constricted above siphonal fasciole. Aperture subtrigonal, 48% of total height, horizontal adapically, sharply angled at shoulder, convex below. Outer lip thickened by broad varix, prosocline in profile, bearing shallow stromboid notch abapically, deeply lirate within, with single abapical tooth bordering anal canal medially. Anal notch well developed, siphonal canal short, open, slightly recurved. Columella shallowly excavated, bearing two narrow oblique, non-bifid folds. Parietal callus thickened, closely appressed, well delimited, moderately expanded. Columellar callus strongly thickened, erect, forming medial border of umbilicus. Siphonal fasciole well-developed, rounded, bearing spiral cords, bordering small umbilicus laterally.

Discussion – Scalptia? problematica nov. sp. is represented in the Karaman assemblages by a single, well preserved shell. Despite the lack of material, the diagnostic characters are so unique as to warrant description. The systematic position of this unusual cancellariid is problematic. The

general shape and cancellate sculpture are reminiscent of Bivetiella Wenz, 1943 and Cancellaria Lamarck, 1799, but in these genera the folds are usually, but not always, heavier, with the upper fold bifurcated in Cancellaria and the lower folds in Bivetiella (Jung & Petit, 1990). In the varicose ribs it is similar to Bivetiella, but S.? problematica has more of its ribs varicose than in any Bivetiella species. The siphonal fasciole and umbilicus are far more strongly developed than in other Caribbean and European Neogene Cancellaria and Bivetiella species, and are similar to that of the Neogene to Recent Panamic Pacific species Cancellaria (s.lat.) corrosa Reeve, 1856. The shell shape is also similar to that of species in the American Caribbean genus Bivetopsia Jousseaume, 1887b, but species of *Bivetopsia* have three prominent columellar folds, the abapical largest, whereas the Turkish shell has only two narrow folds. The character of the sutural platform, with concave interspaces between the axial ribs, a subtrigonal aperture and columellar folds, suggests possible placement within Scalptia Jousseaume, 1887b. Scalptia (s. lat.) burdigalensis (Peyrot, 1928) is not unlike the new species, but is easily separated by its more fusiform shell, wider umbilicus and weaker siphonal fasciole. We tentatively place the new species within Scalptia (s. lat.).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subfamily Plesiotritoninae Beu & Maxwell, 1987 Genus *Tritonoharpa* Dall, 1908

Type species – Tritonoharpa vexillata Dall, 1908, by original designation. Recent, Galapagos Islands.

Tritonoharpa alanbeui nov. sp.

Plate 37, figs 2-4; Plate 69, fig. 10

Dimensions and type material – Holotype NHMW 1847/0058/0486, height 16.9 mm, width 5.6; paratype 1 YI 446, height 17.0 mm; paratype 2 NHMW 1847/0058/0487, height 23.9 mm (incomplete); paratype 3 NHMW 1847/0058/1342 (incomplete); paratype 4 RGM 794 061 (ex JvdV collection), height 11.5 mm (incomplete); furthermore one specimen in YI 453, height 15.0 mm (incomplete).

Other material – Localities 7 & 8: YI 447/1 (incomplete); locality 17: RGM 783 958/2 juveniles, 1 fragment.

Derivatio nominis – Named after Alan Beu, in recognition of his landmark monograph on the subfamily Plesiotritoninae.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis - A medium-sized Tritonoharpa species, with

a tall, slender shell, a multispiral protoconch of three whorls, finely and evenly reticulate teleoconch sculpture, a suture which is hardly coronate, a slightly angled penultimate whorl, a narrow aperture, a single weak columellar fold and a somewhat shield-like parietal callus.

Description - Shell medium-sized, very slender, tallspired. Protoconch of three smooth whorls, initially depressed, whorls rapidly increasing in height, nucleus small $(dp = 750 \,\mu\text{m}, hp 770 \,\mu\text{m}, dp1 = 120 \,\mu\text{m}, dn = 70 \,\mu\text{m}; Pl. 69,$ fig. 10). Teleoconch of six tall, weakly convex whorls. Penultimate whorl slightly angled in relation to vertical axis. Suture impressed, linear, very weakly coronated by tops of costae of succeeding whorl. Sculpture finely reticulate, with axial and spiral elements of roughly equal strength, penultimate whorl with 27-30 narrow, weakly opisthocline and flexuous axial ribs and eight narrow primary spiral cords, with a single secondary cord in each interspace, each about half width of one primary cord. Low, narrow varices present, placed regularly at each two-thirds of a whorl down entire teleoconch, raised over adapical suture. Last whorl elongate, slender, moderately constricted at base. Aperture narrow, elliptical, anal sinus shallow, siphonal canal of moderate length, narrow, open, dorsally recurved. Outer lip varix narrow, lip bearing numerous small denticles on inner edge, smooth within. Columella straight, bearing one very weak fold. Parietal callus moderately thickened and expanded, sharply delimited, closely appressed, columellar callus thickened, weakly erect. Siphonal fasciole convex.

Discussion – At the time of publication of Beu & Maxwell's (1987) landmark monograph on the subfamily Plesiotritoninae, the subfamily was almost unknown in European Neogene assemblages. It was represented by two records of poorly preserved shells from the early Miocene Burdigalian deposits of the Turin Hills, Italy: *Triton praetextum* Bellardi, 1873, which was placed with a question mark in the genus *Tritonoharpa* by Beu & Maxwell (1987) and seems to represent a very coarsely sculptured species that could also be placed in *Colubraria* Schumacher, 1817, and *Triton speciosum* Bellardi, 1873, which is extremely finely sculptured, and clearly represents a *Tritonoharpa* species, and is most nearly similar to the Recent western Australian species *T. ansonae* Beu & Maxwell, 1987.

Further to this, records of Tritonoharpa in European assemblages are extremely scarce. Bałuk (1997, pl. 17, figs 1, 2) illustrated the apex of a Tritonoharpa species too fragmentary to identify. Despite this implicit rarity, as well as these new records from the Miocene of Turkey, we (BL) have well preserved Tritonoharpa species from the early Miocene Aquitanian of France and the late Miocene Tortonian of southern Portugal, both of which represent undescribed species (Fig. 26). Tritonoharpa alanbeui nov. sp. is similar in shape to the French early Miocene species, but the latter has a deeper suture, the axial ribs are clearly predominant, sharper and more flexuous, the reticulate sculpture is horizontally elongated as opposed to squarely cancellate as in T. alanbeui and the penultimate whorl is not at an angle to the vertical axis. A revision of the French Oligocene-Miocene Plesiotritoninae, which will include this undescribed species, is in preparation (Alain Cluzaud pers. comm., 2012). The species from the Tortonian of Portugal is represented by three specimens and differs from both of the above species in being wider, with a more inflated last whorl. The axial sculpture is predominant, although more weakly so than in the French species and the sculptural elements slightly broader and more flattened than in either of the other two. The columellar callus is more strongly erect than in the other species, arching slightly over the base and siphonal fasciole. This species will be formally described as part of a revision of the gastropod assemblage from the Miocene of southern Portugal (BL). The protoconch is similar in all three species.



Figure 26. Tritonoharpa undescribed species 1 and 2.

- NHMW 2012/0197/0009 (ex BL collection), Saint Martin d'Oney, Falun de St. Avit, Landes, France, Aquitanian, early Miocene; height 16.6 mm.
- NHMW 2012/0197/0010 (ex BL collection), Cacela Velha, Algarve, Portugal, Tortonian, late Miocene; height 18.6 mm.

Compared to its living congeners, *Tritonoharpa alanbeui* nov. sp. is similar in shape to *Tritonoharpa beui* Verhecken, 1997 [= *T.* n. sp.? C of Beu & Maxwell (1987: 35 pl. 12, figs i-p)] from Indonesia, but differs in sculpture and in the character of the protoconch, which is paucispiral in the Recent species. *Tritonoharpa lanceolata* (Menke, 1828) from the Neogene and Recent Caribbean is again similar to *T. alanbeui* in shape and protoconch type, but differs in sculptural detail.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Superfamily Conoidea Fleming, 1822

Family Conidae Fleming, 1822 (= Conolithidae Tucker & Tenorio, 2009; Taranteconidae Tucker & Tenorio, 2009; Bouchet *et al.*, 2011)

Notes – More than 100 genus-group names have been proposed in the family Conidae (*e.g.* Emerson & Old, 1962; Kohn & Anderson, 1992). These classifications have been based on shell shape, sculpture, colour pattern, and radular tooth pattern, and vary widely in their results. These shell characters have not been used in a congruent fashion in previous genus-level classifications (Röckel *et al.*, 1995) and, until recently, modern authors recognised a single genus *Conus* (Woodring, 1970; Röckel *et al.*, 1995; Hendricks, 2008).

Tucker & Tenorio (2009) published a full classification of Recent and fossil Conidae, erecting numerous new genera. However, the relationships based upon molecular sequence data are probably premature. Only about 25% of extant species are analysed, and then their phylogenies are based on only one or two genes. Nevertheless, in many cases the authors have probably identified monophyletic groups. In this work we attempt to follow the generic classification suggested by Tucker & Tenorio (2009), although their family Conolithidae Tucker & Tenorio, 2009 was synonymised with Conidae Fleming, 1822 by Bouchet *et al.* (2011).

The shells of Conidae show a wide range of intraspecific variability in shape, sculpture and colour patterns, particularly in those species with a wide geographical range (Röckel *et al.*, 1995). For the fossil cones there is no consensus on which characters are the most useful for identifying species. Landau & Silva (2010) agreed with Hendricks' (2008) approach to fossil cone classification in adopting a conservative morphological species concept (*i.e.* one that accepts large amounts of intraspecific variation), and we have adopted the same methodology here, placing importance on the shell characters highlighted by Hendricks: the shape of the subsutural flexure (for terminology see Röckel *et al.*, 1995; Hendricks, 2008, text-fig. 2), and shell dimensions (for terminology see Hendricks, 2008, text-fig. 3):

- AH apertural height
- AL apertural length
- AW apertural width
- HMD height of maximum diameter
- LW length-width ratio (LW = SL/MD)
- MD maximum diameter
- PMD position of maximum diameter (PMD = HMD/AH)
- RD relative diameter (RD = MD/AH)
- RSH relative height of spire (RSH = [SL-AH]/SL)]
- SA spire angle
- SL shell length.

Furthermore, sculpture, including the presence or absence of tubercles on the spire whorls is noted, and the colour pattern seen under natural and ultraviolet light (see Hedegaard *et al.*, 2006) are used to distinguish species. The protoconch is preserved in some juvenile specimens, although this has not been used in the classification, as ascribing juvenile fossil cones to a particular species is far from simple. The European Neogene Conidae are in disarray, with most species represented by numerous synonyms. Hall's (1964) review of the Italian Miocene cones was a great contribution to the understanding of many of the synonymies and misidentifications, but a wider review is necessary taking into account conid records from all the Miocene basins. However, this is beyond the scope of the present work. We have included under each species a revised description, based on the Karaman material, summarising the shell characters on which the classification is based.

Genus Kalloconus da Motta, 1991

Type species – Conus pulcher Lightfoot, 1786, by original designation. Recent, West Africa.

Kalloconus berghausi (Michelotti, 1847)

Plate 37, figs 6-8; Plate 42, fig. 1; Pl. 81, fig. 1

- 1835 Conus figulinus Lam. Grateloup, p. 107 (non Linnaeus, 1758).
- 1835 *Conus maculosus* Nob., Grateloup, p. 110 (*non* Röding, 1798; *non* Sowerby, 1833).
- 1845 Conus maculosus Grat. Grateloup, pl. 44, fig. 17, pl. 45, figs 4, 5 (non Röding, 1798; non Sowerby, 1833).
- *1847 *Conus Berghausi* mihi, Michelotti, p. 342, pl. 13, figs 9, 9'.
- 1851 Conus Berghausi Micht. Hörnes, p. 19, pl. 1, fig.3.
- 1851 Conus Mercati Brocc. Hörnes, p. 23 (partim, pl. 2, fig. 2 only) (non Brocchi, 1814).
- 1852 Conus subfigulinus d'Orb., d'Orbigny, p. 11 (nom. nov. pro C. figulinus Grateloup, 1835, non Linnaeus, 1758).
- 1866 Conus Berghausi Micht. in Hörnes Pereira da Costa, p. 9, pl. 1, figs 2, 3, pl. 2, figs 3-6.
- 1866 Conus subraristriatus Costa, Pereira da Costa, p.
 9 (partim, pl. 4, figs 2-6 only) [non fig. 7 = Varioconus subraristriatus (Pereira da Costa, 1866)].
- ?1866 Conus Broteri Costa, Pereira da Costa, p. 30, pl. 9, figs 25-30.
- 1879 Conus (Dendroconus) Vaceki Hoernes & Auinger,p. 22 (nom. nov. pro C. berghausi in Hörnes, 1851).
- 1893a Conus (Dendroconus) Berghausi (Micht.) Sacco, p. 7, pl. 1, fig. 9.
- 1893a Conus (Dendroconus) Berghausi var. subaspira Sacc., Sacco, p. 8.
- 1893a Conus (Dendroconus) Berghausi var. propebetulinoides Sacc., Sacco, p. 8, pl. 1, fig. 10.
- 1893a Conus (Dendroconus) Berghausi var. bifasciolata Sacc., Sacco, p. 8, pl. 1, fig. 11.
- 1893a Conus (Dendroconus) Berghausi var. moravicoides Sacc., Sacco, p. 9, pl. 1, fig. 13.

- 1893a Conus (Dendroconus) Berghausi var. triangularis Sacc., Sacco, p. 9, pl. 1, fig. 14.
- 1893a Conus (Dendroconus) Berghausi var. planocylindrica Sacc., Sacco, p. 10, pl. 1, fig. 15.
- 1893a Conus (Dendroconus) Berghausi var. percommunis Sacc., Sacco, p. 10, pl. 1, fig. 16.
- 1893a Conus (Dendroconus) Berghausi var. glandiformis Sacc., Sacco, p. 10, pl. 1, fig. 17.
- 1893a Conus (Dendroconus) Berghausi var. conotriangula Sacc., Sacco, p. 11, pl. 1, fig. 18.
- 1893a Conus (Dendroconus) Berghausi var. semisulcatula Sacc., Sacco, p. 11, pl. 1, fig. 19.
- 1893a Conus (Dendroconus) Berghausi var. conicospira Sacc., Sacco, p. 11, pl. 1, fig. 20.
- 1893a Conus (Dendroconus) Berghausi var. permucronata Sacc., Sacco, p. 11, pl. 1, fig. 21.
- 1911 Conus Berghausi Micht. var. Vaceki R. Hoern. I Auing. – Friedberg, p. 62, pl. 3, fig. 5.
- 1911 Conus ventricosus Bronn Friedberg, p. 60, textfig. 14 (non Gmelin, 1791, non Bronn, 1831).
- 1917 Conus Berghausi Micht. Stefanini, p. 60, pl. 1, fig. 23.
- 1930 Conus (Dendroconus) maculosus Grateloup Peyrot, p. 96, no. 1169 (non Röding, 1798; non Sowerby, 1833).
- 1931 Conus (Dendroconus) maculosus Grateloup Peyrot, pl. 4, figs 2, 6, 8, 9, 13, 15. (non Röding, 1798; non Sowerby, 1833).
- 1952a Conus (Dendroconus) berghausi Michelotti 1847 – Glibert, p. 375, pl. 13, fig. 3.
- 1958 Conus (Dendroconus) berghausi var. semisulcatula Sacco – Erünal-Erentöz, p. 115, pl. 19, fig. 2.
- 1960 Conus (Dendroconus) berghausi Michelotti 1847 – Kojumdgieva & Strachimirov, p. 215, pl. 51, fig.
 3.
- 1962 *Conus (Cleobula) berghausi vaceki* Hoernes & Auinger Strausz, p. 147, pl. 71, figs 10-14.
- 1964 *Conus berghausi* Michelotti, 1847 Hall, p. 134, pl. 23, figs 11, 18, 22, 23, 28.
- 1966 Conus (Cleobula) berghausi vaceki Hoernes & Auinger, 1879 – Strausz, p. 464, pl. 71, figs 10-14.
- 1972 Conus berghausi Michelotti, 1847 Davoli, p. 78, pl. 2, figs 5, 9, pl. 3, figs 11-13, 17-27.

- 1973 Conus (Dendroconus) berghausi Michelotti 1847
 Bohn-Havas, p. 1124, pl. 7, fig. 11, pl. 9, fig. 10.
- 1984 *Conus berghausi* Michelotti Ruggieri & Davoli, p. 72, pl. 5, fig. 18.
- 1984 Dendroconus berghausi var. percommunis Sacco, 1893 – Ferrero-Mortara et al., p. 101, pl. 15, fig. 7.
- 1984 Dendroconus berghausi var. conicospira Sacco, 1893 – Ferrero-Mortara et al., p. 101, pl. 16, fig. 2.
- 1990 Conus berghausi Michelotti Davoli, p. 100, pl.9, fig. 16, 17, pl. 10, figs 10, 11.
- 1997 Conus (Lithoconus) berghausi Michelotti, 1847 Bałuk, p. 58, pl. 21, figs 1-4.
- 2002 *Conus (Lithoconus) berghausi* Michelotti, 1847 Harzhauser, p. 113, pl. 10, figs 4-6.
- 2003 *Conus (Lithoconus) berghausi* Michelotti, 1847 Mikuž, p. 308, pl. 10, fig. 30.
- 2009 Conus (Lithoconus) berghausi Michelotti, 1847 Mikuž, p. 36, pl. 12, fig. 164.
- 2009 *Kalloconus berghausi* (Michelotti, 1847) Tucker & Tenorio, p. 100.
- 2011 Conus berghausi Michelotti, 1847 Caprotti, p. 67, figs 7L-O.

Dimensions and material – Maximum height 84.4 mm. Locality 17: NHMW 1847/0058/0490-1847/0058/0495/6, 1847/0058/1461/1, 1847/0058/0955/1, 1847/0058/1222/1, JvdV/7, RGM 777 885/1 (ex JvdV collection), MTA 2013/070/2, YI 127/17.

Revised description – Shell medium to small, spire very short, slightly concave; spire whorls flat to slightly convex, smooth; subsutural flexure asymmetrically curved, depth equal to width; last whorl squat, round-shouldered, straight-sided, maximum diameter a short distance below shoulder; not constricted at base; bearing narrow spiral grooves on lower half to one-third of height, grooves becoming stronger and more closely spaced abapically; aperture straight, widening slightly abapically; siphonal canal very short; siphonal fasciole poorly developed; colour pattern of spiral rows of small brown dots preserved, enhanced under UV light (Pl. 81, fig. 1).

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0490*	40.9	27.7	37.9	32.6	(131)	1.48	0.73	0.86	(0.07)
NHMW 1847/0058/0491	45.2	29.7	37.3	31.8	115	1.52	0.79	0.85	0.17
NHMW 1847/0058/0492	41.9	27.4	36.1	31.2	126	1.53	0.76	0.86	0.14
NHMW 1847/0058/0493	44.5	27.9	36.6	32.6	121	1.6	0.76	0.89	0.18
NHMW 1847/0058/0494	38.7	22.0	32.4	27.3	107	1.76	0.68	0.84	0.16
NHMW 1847/0058/0495	45.0	28.1	36.9	31.1	110	1.60	0.76	0.84	0.18

* well-preserved but distorted depressed spire.

Table 12. Dimensions of Kalloconus berghausi (Michelotti, 1847).

Discussion - Hall (1964, p. 135) adopted a wide species concept for Kalloconus berghausi (Michelotti, 1847), including almost all the European Miocene small to medium-sized cones with a squat form and a spotted colour pattern. This colour pattern is preserved in some of the Karaman shells, and in others it can be seen under UV light. The Miocene Paratethyan Kalloconus fuscocingulatus (Hörnes, 1851) is characterised by a well-preserved colour pattern of narrow reddish stripes. The colour pattern is clearly different from that of K. berghausi, but in shell shape the two taxa are very similar, although K. fuscocingulatus is slightly the more slender, with a slightly higher spire and possibly more flattened spire whorls. Hall (1964, p. 135) placed Conus (Leptoconus) neumayri Hoernes & Auinger, 1879 in synonymy with K. berghausi, but we have excluded it here as it has guite a different colour pattern. Bałuk (1997) placed Conus (Lithoconus) hungaricus Hoernes & Auinger, 1879 in synonymy with K. berghausi, however, C. hungaricus is quite different, with a heavier, broader and even stockier shell, and quite a different colour pattern composed of close-set rows of horizontal dashes.

Distribution – Early Miocene: Paratethys (late Burdigalian): Austria (Harzhauser, 2002); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1893a; Hall, 1964; Glibert, 1960c). Middle Miocene: Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Peyrot, 1930, 1931; Hall, 1964), (Langhian): Loire Basin (Glibert, 1952a); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1851; Hoernes & Auinger, 1879), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Hoernes & Auinger, 1879; Strausz, 1962, 1966); Romania (Hoernes & Auinger, 1879); Poland (Friedberg, 1911; Bałuk, 1997); Slovenia (Mikuž, 2003, 2009); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1893a; Glibert, 1960c; Hall, 1964; Davoli, 1972, 1990; Ruggieri & Davoli, 1984; Caprotti, 2011). ?Pliocene (indet.): central Mediterranean, Italy (Sacco, 1893a).

Kalloconus hungaricus (Hoernes & Auinger, 1879)

Plate 37, figs 9, 10; Plate 38, fig. 1; Plate 41, fig. 8; Plate 42, fig. 2; Plate 81, fig. 2

- *1879 Conus (Lithoconus) Hungaricus Hoernes & Auinger, p. 29, pl. 4, fig. 1.
- ?1958 Conus (Dendroconus) gulemani Erünal-Erentöz, p. 113 (partim), pl. 18, figs 5, 6.
- 1962 *Conus* (*Lithoconus*) *hungaricus* Hoernes & Auinger Strausz, p. 146, pl. 67, fig. 14.
- 1966 Conus (Lithoconus) hungaricus Hoernes & Auinger, 1879 Strausz, p. 455, pl. 67, fig. 14.
- 1997 Conus (Lithoconus) berghausi Michelotti, 1847 Bałuk, p. 58 (partim) [non pl. 21, figs 1-4 = Kalloconus berghausi (Michelotti, 1847)].

Dimensions and material – Maximum height 84.4 mm. Localities 2 & 3: YI 130/1; locality 10: YI 131/1; locality 17: NHMW 1847/0058/0417-1847/0058/0430/14, RGM 777 886/1 (ex JvdV collection), JvdV/50+, RGM 783 704/5, RGM 794 042/15, MTA 2013/071/5, YI 132/50+. Exact locality unknown AÜ LE-K-248/2.

Revised description – Shell medium sized, solid, spire coeloconoid, almost flat; spire whorls flat, weakly striate; subsutural flexure shallow; last whorl wide, shoulder high, rounded, sides weakly convex, maximum diameter a short distance below shoulder; not constricted at base; bearing narrow wavey spiral grooves on lower half to one-third of height; aperture straight, widening slightly abapically; siphonal canal very short; siphonal fasciole weakly developed; colour pattern of close-set spiral rows of reddish dashes preserved, enhanced under UV light (Pl. 81, fig. 2).

Discussion – Bałuk (1997) discussed the excessive splitting of cone species by early authors such as Hoernes & Auinger (1879) and adopted an even broader species concept for *Kalloconus berghausi* (Michelotti, 1847) than the one followed above. In his synonymy he considered *Conus* (*Lithoconus*) *hungaricus* Hoernes & Auinger, 1879 to be another synonym of *K. berghausi*. We prefer to

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0417	58.8	40.0	54.2	45.3	141	1.47	0.74	0.84	0.08
NHMW 1847/0058/0418	52.2	35.9	47.8	39.6	146	1.45	0.75	0.83	0.08
NHMW 1847/0058/0419	55.7	35.3	51.4	45.2	156	1.58	0.69	0.88	0.08
NHMW 1847/0058/0420	46.5	30.7	43.0	37.4	148	1.51	0.71	0.87	0.08
NHMW 1847/0058/0421	46.5	31.4	43.2	36.2	155	1.48	0.73	0.84	0.07
NHMW 1847/0058/0422	44.6	31.3	40.5	33.7	143	1.42	0.77	0.83	0.09
NHMW 1847/0058/0423	44.7	30.5	40.7	33.0	135	1.47	0.75	0.81	0.09
NHMW 1847/0058/0424	46.0	30.9	43.4	36.1	154	1.49	0.71	0.83	0.06

Table 13. Dimensions of Kalloconus hungaricus (Hoernes & Auinger, 1879).

keep them distinct, as all the specimens from the Karaman assemblages we have identified as *K. hungaricus* have a well-preserved colour pattern of close-set spiral rows of dashes as opposed to the slightly more widespaced rows of dots typical of *K. berghausi*. We have compared our shells to a specimen from the Paratethyan middle Miocene of Bad Vöslau, near Baden (NHMW 1851/0013/0018), which has an identical colour pattern. A further constant difference between the two is the height of the spire. As seen from Tables 11 and 12 above, *K. berghausi* has a spiral angle 107-131°, whereas *K. hungaricus* has a much flatter spire, and therefore a wider spiral angle between 135-156°. Consequently, the relative spire height for the two species is different (*K. berghausi* 0.14-0.18; *K. hungaricus* 0.06-0.09).

In the Erünal-Erentöz collection at Ankara University are four shells labelled *Conus (Dendroconus) gulemani.* In our opinion these represent more than one species of juvenile cone, at least one of which is a juvenile specimen of *K. hungaricus*. None of these shells can be matched with the illustrations by Erünal-Erentöz (1958). One further specimen is recorded in the Paris museum website as a syntype (MNHN.F.A26722; not seen).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria, (Hoernes & Auinger, 1879), Hungary (Strausz, 1962, 1966); Romania (Hoernes & Auinger, 1879); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Lautoconus Monterosato, 1923

Type species – Conus mediterraneus Hwass *in* Bruguière, 1792, by original designation. Recent, Mediterranean Sea.

Lautoconus bitorosus (Fontannes, 1880)

Plate 38, figs 2-4; Plate 41, fig. 9; Plate 42, fig. 3; Plate 81, fig. 3

- 1866 Conus ventricosus Bronn Pereira da Costa, p. 19, pl. 4, figs 9-11 (non Gmelin, 1791; non Röding, 1798).
- *1880 Conus bitorosus Fontannes, p. 146, pl. 8, fig. 12.
- 1880 *Conus perpinianus* Fontannes, p. 148, pl. 8, fig. 14.
- 1890 Conus falloti Mayer Eymar, p. 294.
- 1890 Conus saucatsensis Mayer Eymar, p. 297.
- 1890 Conus falloti Mayer Eymar, p. 327, pl. 9, fig. 1.
- 1890 Conus saucatsensis Mayer Eymar, p. 333, pl. 10, fig. 3.
- 1891 Conus betulinoides Lam. var. pusilla Mylius, p. 335, fig. 1.
- 1893b Conus (Chelyconus) parvus var. taurocrassulosa Sacc., Sacco, p. 97, pl. 9, fig. 42.
- 1893b Conus (Chelyconus) parvus var. anomalocrassulosa Sacc., Sacco, p. 97, pl. 9, fig. 43.
- 1893b Conus (Chelyconus) avellana (Lk.) Sacco, p. 101, pl. 9, fig. 60 (non Lamarck, 1810).

- 1893b Conus (Chelyconus) avellana var. pseudofusata Sacc., Sacco, p. 102, pl. 9, fig. 61.
- 1893b Conus (Chelyconus) avellana var. pusilla Sacc., Sacco, p. 102, pl. 9, fig. 62.
- 1893b Conus (Chelyconus) avellana var. pseudoplanata Sacc., Sacco, p. 102, pl. 9, fig. 63.
- 1893b Conus (Chelyconus) avellana var. pseudocanaliculata Sacc., Sacco, p. 102, pl. 9, fig. 64.
- 1893b Conus (Chelyconus) avellana var. pseudoturbinata Sacc., Sacco, p. 102, pl. 9, fig. 65.
- 1893b Conus (Chelyconus) avellana var. longoturbinata Sacc., Sacco, p. 102, pl. 9, fig. 66.
- 1893b *Conus (Chelyconus) avellana* var. *pseudogibbosa* Sacc., Sacco, p. 103, pl. 9, fig. 67.
- 1893b Conus (Chelyconus) mediterraneus var. depressissima Sacc., Sacco, p. 105, pl. 10, fig. 8.
- 1893b Conus (Chelyconus) tauroventricosus Sacc., Sacco, p. 107, pl. 10, fig. 18.
- 1893b Conus (Chelyconus) bitorosus (Font.) Sacco, p. 108, pl. 10, fig. 19.
- 1893b Conus (Chelyconus) bitorosus var. tauroantiqua Sacc., Sacco, p. 108, pl. 10, fig. 20.
- 1893b Conus (Chelyconus) bitorosus var. elatoastensis Sacc., Sacco, p. 109, pl. 10, fig. 21.
- 1893b Conus (Chelyconus) bitorosus? var. crassovata Sacc., Sacco, p. 109, pl. 10, fig. 22.
- 1893b Conus (Chelyconus) bitorosus var. exventricosa Sacc., Sacco, p. 109, pl. 10, fig. 22bis.
- 1893b Conus (Chelyconus) bitorosus var. perpiniana (Font.) – Sacco, p. 109, pl. 10, fig. 23.
- 1893b Conus (Chelyconus) bitorosus var. pliotransiens Sacc., Sacco, p. 110, pl. 10, fig. 24.
- 1893b Conus (Chelyconus) bitorosus? var. exilior (Dod.) Sacc., Sacco, p. 110, pl. 10, fig. 26.
- Conus (Chelyconus) pelagicus Br. Cerulli-Irelli,
 p. 49, pl. 4, fig. 49 [non Varioconus pelagicus (Brocchi, 1814)].
- 1930 Conus (Dendroconus) Falloti Mayer Peyrot, p. 100, no. 1172.
- 1930 Conus (Chelyconus) gallicus Mayer Peyrot, p. 110, no. 1180.
- 1930 Conus (Leptoconus?) saucatsensis Mayer Peyrot, p. 119, no. 1186.
- 1931 Conus (Leptoconus?) saucatsensis Mayer Peyrot, pl. 1, figs 4, 5.
- 1931 Conus (Dendroconus) Falloti Mayer Peyrot, pl. 2, figs 27, 28.
- 1931 Conus (Chelyconus) gallicus Mayer Peyrot, pl. 3, figs 2, 3.
- 1954 Conus sp. Strausz, p. 113, pl. 7, fig. 145.
- 1964 *Conus bitorosus* Fontannes, 1880 Hall, p. 136, pl. 23, figs 1, 2, 7-9, 13-17, 19-21, 24, 25.
- 1972 Conus bitorosus Fontannes Davoli, p. 87, pl. 3, figs 7-10, pl. 8, figs 11-15.
- 1974 Conus (Chelyconus) bitorosus Fontannes, 1880 Malatesta, p. 378, pl. 30, fig. 12.
- 1975 *Conus bitorosus* Fontannes Pavia, p. 114, pl. 9, fig. 6.
- 1984 *Chelyconus avellana* (Lamarck, 1810) Ferrero Mortara *et al.*, p. 129, pl. 20, fig. 7.

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0431	73.4	43.6	65.8	55.8	134	1.68	0.66	0.85	0.10
NHMW 1847/0058/0432	70.2	40.4	59.7	50.6	123	1.74	0.68	0.85	0.15
NHMW 1847/0058/0433	63.4	37.3	55.2	47.7	148	1.70	0.68	0.86	0.13
NHMW 1847/0058/0434	64.9	36.1	58.1	49.9	133	1.80	0.62	0.86	0.10
NHMW 1847/0058/0435	58.0	34.4	51.2	41.3	127	1.69	0.67	0.81	0.12
NHMW 1847/0058/0436	54.4	30.9	48.2	40.7	124	1.76	0.64	0.84	0.11
NHMW 1847/0058/0437	50.2	29.9	45.2	36.2	133	1.68	0.66	0.80	0.10
NHMW 1847/0058/0438	57.5	31.6	49.7	42.3	122	1.82	0.64	0.85	0.14

Table 14. Dimensions of Lautoconus bitorosus (Fontannes, 1880).

- 1984 *Chelyconus avellana* var. *pusilla* (Mylius, 1891) Ferrero Mortara *et al.*, p. 129, pl. 20, fig. 5.
- 1984 Chelyconus avellana var. pseudoplanata (Mylius, 1891) Ferrero Mortara et al., p. 129, pl. 20, fig. 10.
- 1984 *Chelyconus tauroventricosus* Sacco, 1893 Ferrero Mortara *et al.*, p. 131, pl. 19, fig. 6.
- 1984 *Chelyconus bitorosus*? var. *crassovata* Sacco, 1893 – Ferrero Mortara *et al.*, p. 132, pl. 21, fig. 4.
- 1992 *Conus bitorosus* Fontannes, 1880 Cavallo & Repetto, p. 126, fig. 329.
- 1997 Conus (Chelyconus) bitorosus Fontannes, 1880 Chirli, p. 3, pl. 1, figs 1-3.
- 1999 Conus (Chelyconus) bitorosus Fontannes, 1880 Muñiz Solíz, p. 38, pl. 6, figs 6E-H.

Dimensions and material – Maximum height 98.2 mm. Locality 13: YI 146/1; locality 17: NHMW 1847/0058/0431-1847/0058/0440/10, JvdV/15, RGM 777 887/1 (ex JvdV collection), MTA 2013/072/8, YI 142/14.

Revised description – Shell medium-sized, spire coeloconoid, low to very low; spire whorls channelled, striate; subsutural flexure asymmetrically curved; last whorl elongate fig-shaped, shoulder high, rounded, sides convex, maximum diameter at about one quarter shell height; very weakly constricted at base; bearing very weak spiral grooves on the abapical third; aperture straight, widening and slightly flared abapically; siphonal canal short; siphonal fasciole weakly developed; colour pattern seen under UV light of small irregular dashes with a broader broken band of colour mid-whorl and on base (Pl. 81, fig. 3).

Discussion – Hall (1964) compared *Conus bitorosus* Fontannes, 1880, with *C. ventricosus* Bronn, 1831, which was said to differ in having flattish or weakly convex channelled spire whorls, whereas *C. ventricosus* has convex spire whorls. Hall (1964) illustrated specimens characterised by their medium-size, rather fig-shaped shell, striate and channelled spire whorls, rounded shoulder, and inflated abapical portion of the aperture. *Conus bitorosus* was described from the early Pliocene of France, and although the original figure is poor, other illustrations of early Pliocene specimens from Italy seem to agree with this form (i.e. Ferrero Mortara et al., 1984; Cavallo & Repetto, 1992). The specimens from the Karaman Basin have a lower spire and are more elongate than typical C. bitorosus, however, Hall (1964) used a very broad species concept in his interpretation of this species, including more elongate and quite low-spired forms, similar to the Turkish shells (i.e. Sacco, 1893b, pl. 10, fig. 23; Peyrot, 1931, pl. 1, figs 4, 5). We therefore follow Hall (1964) in considering the Turkish shells to be a form of Lautoconus bitorosus. The problems involved with the name Conus ventricosus Bronn, 1831 were discussed by Hall (1964, p. 137). This name is a junior homonym of C. ventricosus Gmelin, 1791, and was renamed Conus vindobonensis by Partsch in Hörnes (1851, p. 32). According to Hall (1964), Bronn's type is lost, so we are unsure what this taxon really represents, but Hall (1964) went on to suggest that C. vindobonenesis, C. argillicola Eichwald, 1830 and the living species C. ventricosus are conspecific. He commented that if the living species were considered different from the fossil, C. argillicola would be the fossil and ancestral form of the living C. ventricosus Gmelin. Eichwald's (1830) name would therefore have priority.

Distribution - Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Mayer Eymar, 1890, 1891; Peyrot, 1930, 1931); Proto-Mediterranean Sea (Burdigalian): Italy (Sacco, 1893b; Hall, 1964). Middle Miocene: Paratethys (Langhian-Serravallian): Austria, Hungary (Strausz, 1954); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Davoli, 1972; Ruggieri & Davoli, 1984). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Muñiz Solís, 1999), Roussillon Basin (Fontannes, 1880); central Mediterranean, Italy (Pavia, 1975; Cavallo & Repetto, 1992; Chirli, 1997). Late Pliocene: central Mediterranean, Italy (Sacco, 1893b; Hall, 1964; Malatesta, 1974). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1910).

Genus Monteiroconus da Motta, 1991

Type species – Conus ambiguus Reeve, 1844a, by original designation. Recent, West Africa.

Monteiroconus antiquus (Lamarck, 1810)

Plate 38, figs 5, 6; Plate 41, fig. 10; Plate 42, fig. 4; Plate 81, figs 4, 5

- *1810 Conus antiquus Lamarck, p. 439.
- 1820 Conus Acuminatus nobis, Borson, p. 194, pl. 1, fig. 2 (non Bruguière, 1792).
- 1835 Conus Tarbellianus Nob., Grateloup, p. 102.
- 1841 *Conus bisulcatus* Bell. et Mich., Bellardi & Michelotti, p. 154, pl. 6, figs 9, 10.
- 1845 Conus antiquus Broce. Grateloup, pl. 43, figs 1,8.
- 1845 Conus Tarbellianus Grat., Grateloup, pl. 43, figs 2,5.
- 1847 Conus Wheatleyi mihi, Michelotti, p. 339, pl. 13, figs 18, 18'.
- 1851 Conus Tarbellianus Grat. Hörnes, p. 33 (partim, pl. 4, figs 1, 2 only) [non fig. 3 = Plagioconus elatus (Michelotti, 1847)].
- 1852 Conus subacuminatus d'Orb., d'Orbigny, p. 5 (nom. nov. pro C. acuminatus Borson, 1820, non Bruguière, 1792).
- 1866 Conus Tarbellianus Grat. Pereira da Costa, p. 21 (partim, pl. 5, figs ?1, 2, pl. 6, figs ?1, 2, pl. 7, figs 1, 2 only) [?non pl. 5, fig. 1, pl. 6, fig. 1 = Plagioconus elatus (Michelotti, 1847)].
- 1885 Conus virginalis var. epellus Gregorio, p. 103 (nom. nov. pro C. tarbellianus Hörnes, 1851).
- 1885 Conus virginalis var. grolpus Gregorio, p. 103 (nom. nov. pro C. tarbellianus Pereira da Costa, 1866).
- 1891 Conus antiquus var. producta Mylius, p. 8, pl. 1, fig. 2.
- 1893a Conus (Lithoconus) subacuminatus (d'Orb.) Sacco, p. 21, pl. 3, fig. 1.
- 1893a Conus (Lithoconus) subacuminatus var. conoidospira Sacc., Sacco, p. 22, pl. 3, fig. 2.
- 1893a Conus (Lithoconus) subacuminatus var. subpyrulata Sacc., Sacco, p. 22, pl. 3, fig. 3.
- 1893a Conus (Lithoconus) subacuminatus var. subamarginata Sacc., Sacco, p. 23, pl. 3, fig. 4.
- 1893a Conus (Lithoconus) subacuminatus var. tauroconnectens Sacc., Sacco, p. 23, pl. 3, fig. 5.
- 1893a Conus (Lithoconus) antiquus (Lk.) Sacco, p. 23, pl. 3, figs 6-7.

- 1893a Conus (Lithoconus) antiquus var. Wheatleyi subvar. permucronata Sacc., Sacco, p. 24, pl. 3, fig. 8.
- 1893a Conus (Lithoconus) antiquus var. Wheatleyi subvar. perangulata Sacc., Sacco, p. 24, pl. 3, fig. 9.
- 1893a Conus (Lithoconus) antiquus var. concavespira Sacc., Sacco, p. 25, pl. 3, fig. 10.
- 1893a Conus (Lithoconus) antiquus var. percanaliculata Sacc., Sacco, p. 25, pl. 3, fig. 11.
- 1893a *Conus (Lithoconus) antiquus* var. *acanaliculata* Sacc., Sacco, p. 25, pl. 3, fig. 12.
- 1893a Conus (Lithoconus) antiquus var. elatocanaliculata Sacc., Sacco, p. 25.
- 1893a Conus (Lithoconus) antiquus var. subscalarata Sacc., Sacco, p. 25.
- 1893a Conus (Lithoconus) antiquus var. elatospirata Sacc., Sacco, p. 26, pl. 3, fig. 13.
- 1893a Conus (Lithoconus) antiquus var. perelatospira Sacc., Sacco, p. 26, pl. 3, fig. 14.
- 1893a Conus (Lithoconus) antiquus var. elongatissima Sacc., Sacco, p. 26, pl. 3, fig. 15.
- 1930 Conus (Lithoconus) antiquus Lamarck Peyrot, p. 89, no. 1165.
- 1931 Conus (Lithoconus) antiquus Lamarck Peyrot, pl. 2, figs 12, 16-18, 26.
- 1958 Conus (Lithoconus) antiquus Lamarck Erünal-Erentöz, p. 109, pl. 16, fig. 21, pl. 17, fig. 1.
- 1964 Conus antiquus Lamarck, 1810 Hall, p. 128, pl. 21, figs 1-12.
- 1972 Conus antiquus Lamarck Davoli, p. 76, pl. 1, figs 1, 4, 10.
- 1984 *Lithoconus antiquus* (Lamarck, 1810) Ferrero Mortara *et al.*, p. 104, pl. 17, fig. 1.
- 1984 *Conus antiquus* Lamarck, 1810 Ruggieri & Davoli, p. 71, pl. 5, figs 20, 21.
- 1990 Conus antiquus Lamarck, 1810 Davoli, p. 98, pl.
 9, fig. 14.
- 2004 *Conus antiquus* Lamarck 1810 İslamoğlu, p. 162, pl. 4, figs 5, 6.
- 2009 *Monteiroconus antiquus* (Lamarck 1810) Tucker & Tenorio, p. 110.
- ?non 1999 Conus (Lithoconus) antiquus Lamarck, 1810 Muñiz Solis, p. 79, fig. 10A-C.
- non 2004 Conus antiquus Lamarck 1810 İslamoğlu, p. 162, pl. 4, figs 5, 6.

Dimensions and material – Maximum height 139.2 mm. Localities 2 & 3: JvdV/1, YI 140/1; locality 13: JvdV/6, RGM 777 888/1 (ex JvdV collection), RGM 776 948/1 (ex JvdV collection), RGM 783 705/1; locality 17: NHMW 1847/0058/0441/1, YI 141/4.

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0441	139.2	72.4	122.5	109.0	120	1.92	0.59	0.89	0.12

Table 15. Dimensions of Monteiroconus antiquus (Lamarck, 1810).

Revised description – Shell large, spire short, coeloconoid; spire whorls concave, striate; subsutural flexure asymmetrically curved, depth less than width; last whorl elongate, sharply shouldered, straight-sided, maximum diameter a short distance below shoulder; weakly constricted at base, narrowed in abapical portion, bearing spiral grooves; grooves become stronger and more closely spaced abapically; aperture straight, relatively narrow; siphonal canal long, weakly recurved posteriorly; siphonal fasciole broad, rounded, moderately delimited; a colour pattern of narrow vertical flammules is enhanced under UV light (Pl. 81, figs 4, 5).

Discussion – Monteiroconus antiquus (Lamarck, 1810) is represented in the Karaman deposits, by a small number of specimens. It is the largest cone in the European Neogene assemblages. Hall (1964) discussed various subspecies, one with variously elongate last whorls, somewhat pinched in the mid-portion, *M. antiquus wheatleyi* (Michelotti, 1847), and another more robust, triangular, broad with weaker grooves on the base, *M. antiquus percanaliculatus* (Sacco, 1893). The Karaman specimens are somewhat intermediate in form; they are less elongate than the typical *wheatleyi* subspecies, with the later spire whorls less deeply canaliculate, but not as broadly triangular as the *percanaliculatus* form, and with relatively strong grooves on the base. Pending a generic review, we consider these to be extremes of a single species.

Specimens from the early Pliocene Zanclean of the Estepona Basin figured by Muñiz-Solís (1998) as *Conus antiquus* differ from Miocene specimens at hand in having the last whorl not constricted at the base, the siphonal fasciole is weaker and the siphonal canal markedly shorter. They may represent a Pliocene offshoot of the species, but should probably be considered to be a distinct species. In the synonymy of *Conus antiquus*, Hall (1964) listed two records of *Conus litteratus* Linnaeus, 1758, described by Noetling (1901) and Tesch (1915) from the Miocene of Burma and the Pliocene of Timor. Both records differ clearly from *Monteiroconus antiquus* in their flat or nearly flat spires and seem to be conspecific with or closely related to *C. litteratus*, and we have removed from the synonymy here.

Distribution - Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Peyrot, 1930, 1931; Glibert, 1960c); Proto-Mediterranean Sea (Burdigalian): Italy (Sacco, 1893a; Hall, 1964). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Peyrot, 1930, 1931), (Langhian): Loire Basin, France (Glibert, 1960c); Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1851); Proto-Mediterranean (Langhian): Kasaba Basin, Turkey (İslamoğlu, 2004); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1893a; Hall, 1964; Davoli, 1972, 1990; Ruggieri & Davoli, 1984). Early-late Pliocene: central Mediterranean, Italy (Sacco, 1893a).

Monteiroconus daciae (Hoernes & Auinger, 1879)

Plate 38, fig. 7; Plate 39, fig. 1; Plate 41, fig. 11; Plate 42, fig. 5; Plate 78, fig. 8; Plate 81, fig. 6

- 1851 Conus Mercati Brocc. Hörnes, p. 23 (partim, pl. 2, fig. 2 only) [non Monteiroconus mercati (Brocchi, 1814)].
- 1866 Conus Mercati Brocc in Hörnes Pereira da Costa, p. 11, (partim, pl. 3, fig. 3 only) [non Monteiroconus mercati (Brocchi, 1814)].
- *1879 *Conus (Dendroconus) Daciae* Hoernes & Auinger, p. 21, pl. 3, fig. 1.
- 1879 Conus (Dendroconus) Loroisi Kiener Hoernes & Auinger, p. 21, pl. 3, fig. 5 [non C. loroisii Kiener, 1845).
- 1958 *Conus (Lithoconus) planospira* Erünal-Erentöz, p. 111, pl. 17, fig. 4 [as *planispira (sic)*], pl. 18, fig. 1.
- 1960 *Conus (Lithoconus) mercati var. daciae* (Hoernes und Auinger, 1879) – Kojumdgieva & Strachimirov, p. 211, pl. 50, fig. 1.
- 1971b Conus mercati daciae (Hoernes et Auinger) Eremija, p. 78, pl. 5, fig. 10.

Dimensions and material – Maximum height 104.3 mm. Locality 17: NHMW 1847/0058/0442-1847/0058/0461/19, RGM 777 889/1 (ex JvdV collection), JvdV/45, RGM 794 047/4, RGM 794 048/5, MTA 2013/073/11, YI 130/29. Exact locality unknown: AÜ LE-K-249/3.

Revised description – Shell large, solid, spire very depressed to flat; spire whorls with adapical half flat, striate, abapical half convex, roundly elevated; subsutural flexure asymmetrically curved, depth less than width; last whorl broad, roundly shouldered, straight-sided, maximum diameter about one third height from apex; not constricted at base; bearing weak spiral grooves abapically; aperture straight, widening abapically; siphonal canal short, straight; siphonal fasciole broad, rounded, moderately delimited; colour pattern of axial comma-shaped reddish stripes on spire and irregular, elongate, oblong blotches arranged in three bands, coalescent into broad axial flammules on some specimens, preserved and enhanced under UV light (Pl. 81, fig. 6).

Discussion – Most of the Miocene specimens ascribed by previous authors to *Conus mercati* (Brocchi, 1814), characterised by spiral striae on the spire whorls, are here referred to *Monteiroconus daciae* (Hoernes & Auinger, 1879).

In this work we have considered the presence or absence of spiral cords or grooves an important species-specific character. Although the shells from the Paratethyan middle Miocene identified by most authors as *C. mercati* have a similar shape, *Monteiroconus mercati* does not have spiral striae on the spire whorls (see Rossi Ronchetti, 1955, description and fig. 158; holotype). *Monteiroconus mercati* was described from the Pliocene of Italy, and specimens at hand from the Pliocene of Italy and Spain (NHMW collection) all have smooth spire whorls. In contrast, almost all specimens identified as

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0442	104.3	68.8	93.0	80.0	148	1.52	0.74	0.82	0.11
NHMW 1847/0058/0443	93.5	65.0	84.7	72.2	146	1.44	0.77	0.85	0.09
NHMW 1847/0058/0444	93.8	61.4	81.0	67.3	129	1.53	0.76	0.83	0.14
NHMW 1847/0058/0445	80.7	58.5	75.8	61.6	157	1.38	0.77	0.81	0.06
NHMW 1847/0058/0446	88.6	58.9	82.8	64.9	145	1.50	0.71	0.78	0.07
NHMW 1847/0058/0447	71.1	51.5	64.9	52.9	149	1.38	0.79	0.82	0.09
NHMW 1847/0058/0448	78.4	51.6	71.1	58.2	137	1.52	0.73	0.82	0.09
NHMW 1847/0058/0449	65.0	46.2	58.5	49.1	146	1.41	0.79	0.84	0.1

Table 16. Dimensions of Monteiroconus daciae (Hoernes & Auinger, 1879)

C. mercati in the literature from Miocene deposits have spiral sculpture on the spire whorls. The specimens figured by Peyrot (1931, pl. 2, figs 9, 13, 14) as *C. mercati var. vasconiensis* from the Atlantic middle Miocene Langhian of France are an exception and do seem similar to Italian Pliocene specimens, as they have slightly more gradate spires.

A major problem arose through the use of Conus mercati by Hörnes (1856) and Pereira da Costa (1866), who each presented three shells of quite different shape. The shells illustrated by Hörnes (1851 pl. 2, fig. 1) and Pereira da Costa (1866, pl. 3, fig. 1) differ from Monteiroconus daciae clearly in their size, their elongate last whorl and their regularly raised spire. These shells are possibly conspecific with Conus mojsvari Hoernes & Auinger, 1879. Later, Sacco (1893a) proposed the name miocenica as a variety of Lithoconus mercati for the shell illustrated by Hörnes (1851, pl. 2, fig. 1). For the strongly depressed shell illustrated by Hörnes (1851, pl. 2, fig. 2), Sacco (1892a) proposed the varietal name supracompressa. This shell is very similar to that illustrated by Pereira da Costa (1866, pl. 3, fig. 3) and both are considered herein to represent Monteiroconus daciae (Hoernes & Auinger, 1879).

In the following synonymy we list some Paratethyan synonyms of *M. mojsvari* to illustrate our understanding of *Monteiroconus daciae* versus *M. mojsvari*:

- 1879 Conus (Dendroconus) Mojsvari Hoernes & Auinger, p. 18, pl. 3, fig. 2.
- 1893a Conus (Lithoconus) Mercati var. miocenica Sacc., Sacco, p. 20 (nom. nov. pro Conus mercati Hörnes, 1851, non Brocchi, 1814).
- 1956 Conus (Lithoconus) mercatii [sic] miocenica Sacco-Csepreghy-Meznerics, p. 421, pl. 10, figs 7, 8.
- 1962 Conus (Lithoconus) mercatii miocaenicus [sic] Sacco – Strausz, p. 148, pl. 68, fig. 3.
- 1966 Conus (Lithoconus) mercati miocaenicus [sic] Sacco, 1893 – Strausz, p. 455, pl. 68, fig. 3.

Hall (1964, p. 135) placed *Monteiroconus daciae* in synonymy with *Kalloconus berghausi* (Michelotti, 1847), but as rightly stated by Hall, this species has smooth spire whorls, whereas *C. daciae* has clearly striate spire whorls.

Monteiroconus aldrovandi (Brocchi, 1814), found in the European Miocene and Pliocene, differs in having a higher spire composed of rounded, gradate whorls, in having the spire whorls smooth, and in having a more elongate last whorl, with more convex sides. *Monteiroconus antiquus* (Lamarck, 1810) also has striate spire whorls, but they are more concave than in *M. daciae*, and the last whorl is much more elongate, especially in the abapical half.

Monteiroconus daciae is not uncommon in the Seyithasan deposits in the Karaman Basin, and attains a large size. The shells are somewhat variable in the height of the spire, which can be slightly elevated to completely flat, and the last adult whorl varies in height. The very flat-spired specimens were described as Conus (Lithoconus) planospira by Erünal-Erentöz (1958), but this form is here considered to be a junior subjective synonym of M. daciae. A specimen from the Erünal-Erentöz collection in Ankara University is illustrated (Pl. 78, fig. 8), but is not the specimen figured by Erünal-Erentöz, which is not present in the Ankara collection. This is possibly in the Paris collections, which has two syntypes (MNHN.F.A26723; not seen). Although the spire is very flat in C. planospira, the truncated abapical end, with very short siphonal canal and flared aperture are very characteristic of M. daciae, as is the colour pattern. The name Conus (Lithoconus) planospira Erünal-Erentöz (1958) is a junior homonym of Conus tarbellianus var. planospira Grateloup, 1847.

Distribution – **Middle Miocene**: northeastern Atlantic (Serravallian): Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1851; Hoernes & Auinger, 1879), Hungary (Csepreghy-Meznerics, 1956; Strausz, 1962, 1966); Romania (Hoernes & Auinger, 1879); Czech Republic (Hörnes, 1851); Bulgaria (Kojumdgieva & Strachimirov, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866).

Monteiroconus mercati (Brocchi, 1814)

Plate 39, figs 2-4; Plate 41, fig. 12; Plate 42, fig. 6; Plate 81, figs 7, 8

*1814	Conus Mercati nob., Brocchi, p. 287, pl. 2, fig. 6.
1866	Conus mercati Brocchi - Fischer, p. 241.
1880	Conus Mercatii [sic] var. funiculigera Fontannes,
	p. 140, pl. 8, fig. 8.
1893a	Conus (Lithoconus) Mercatii [sic] - Sacco, p. 14,
	pl. 2, fig. 1.

- 1893a Conus (Lithoconus) Mercatii [sic] var. elogatofusula Sacc., Sacco, p. 17, pl. 2, fig. 5.
- 1893a Conus (Lithoconus) Mercatii [sic] var. depressulospira Sacc., Sacco, p. 17, pl. 2, fig. 6.
- 1893a Conus (Lithoconus) Mercatii [sic] var. longoastensis Sacc., Sacco, p. 17, pl. 2, fig. 7.
- 1893a Conus (Lithoconus) Mercatii [sic] var. Baldichieri (Bors.) – Sacco, p. 18, pl. 2, fig. 8.
- 1893a Conus (Lithoconus) Mercatii [sic] var. fusuloidea Sacc., Sacco, p. 18, pl. 2, fig. 9.
- 1893a Conus (Lithoconus) Mercatii [sic] var. crassovata Sacc., Sacco, p. 18, pl. 2, fig. 10.
- 1893a Conus (Lithoconus) Mercatii [sic] var. turricula (Br.) – Sacco, p. 19, pl. 2, fig. 12.
- 1893a Conus (Lithoconus) Mercatii [sic] var. canaliculatodepressa Sacc., Sacco, p. 19, pl. 2, fig. 13.
- 1893a Conus (Lithoconus) Mercatii [sic] var. suprainflata Sacc., Sacco, p. 20, pl. 2, fig. 14.
- ?1893a Conus (Lithoconus) Mercatii [sic] var. acanaliculata Sacc., Sacco, p. 21, pl. 2, fig. 18.
- 1910 Conus (Lithoconus) Mercatii [sic] Br. Cerulli-Irelli, p. 48, pl. 4, fig. 47.
- 1930 Conus (Lithoconus) Mercati var. vasconiensis Peyrot, p. 93, no. 1167.
- 1931 Conus (Lithoconus) Mercati var. vasconiensis Peyrot, pl. 2, figs 9, 13, 14.
- 1955 Conus (Lithoconus) mercatii [sic] Brocchi 1814 Rossi Ronchetti, p. 292, fig. 156.
- 1955 Conus (Lithoconus) mercatii [sic] var. turricula Brocchi 1814 – Rossi Ronchetti, p. 293, fig. 157.
- 1964 Conus mercati Brocchi, 1814 Hall, p. 127, pl. 20, figs 6, 7.
- 1972 Conus mercati Brocchi Davoli, p. 119, pl. 1, figs

2, 3, 5-9.

- 1974 Conus (Lithoconus) mercati Brocchi, 1814 Malatesta, p. 391, pl. 30, fig. 16.
- 1975 *Conus mercatii* [sic] Brocchi Pavia, p. 114, pl. 9, fig. 2.
- 1975 Conus (Lithoconus) mercati Brocchi Fekih, p. 137, pl. 41, fig. 1.
- 1978 Conus mercati Brocchi, 1814 Pinna & Spezia, p.
 136, pl. 22, fig. 2.
- 1978 Conus turricula Brocchi, 1814 Pinna & Spezia,
 p. 138, pl. 22, fig. 1.
- 1981 Conus mercati Brocchi, 1814 Meco, p. 608, pl. 6, fig. 21.
- 1984 Lithoconus mercatii [sic] var. baldichieri (Borson, 1820) Ferrero Mortara et al., p. 103, pl. 16, fig. 6.
- 1988 Conus (Lithoconus) mercati Brocchi, 1814 Chirli, p. 22, pl. 10, fig. 3.
- 1992 *Conus mercatii* [sic] Brocchi, 1814 Cavallo & Repetto, p. 128, fig. 336.
- 1997 Conus (Lithoconus) mercati Brocchi, 1814 Chirli, p. 17 (partim, pl. 4, figs 11-16 only).
- 1999 Conus (Lithoconus) mercatii [sic] Brocchi, 1814 Muñiz Solís, p. 80, figs 10D-F.
- 2004 Conus antiquus Lamarck 1810 İslamoğlu, p. 162, pl. 4, figs 5, 6 [non Monteiroconus antiquus (Lamarck, 1810)].
- 2009 *Monteiroconus mercati* (Brocchi, 1814) Tucker & Tenorio, p. 110.
- non 1851 Conus Mercati Brocc. Hörnes, p. 23, pl. 2, figs 1-3.
- non 1866 Conus Mercati Brocc in Hörnes Hörnes, p. 11, pl. 3, figs 1-3.
- non 2003 Conus mercati Brocchi 1814 İslamoğlu & Taner, p. 60, pl. 5, figs 7, 8

Dimensions and material – Maximum height 100.0 mm. Localities 2 & 3: YI 144/1; locality 17: NHMW 1847/0058/0605-1847/0058/0623/18, RGM 777 890/1 (ex JvdV collection), RGM 776 949/1 (ex JvdV collection), JvdV/50+, RGM 794 042/9, MTA 2013/074/22, YI 145/50+.

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0605	100.0	58.3	88.4	77.8	128	1.72	0.66	0.88	0.12
NHMW 1847/0058/0606	98.5	56.8	81.7	74.3	119	1.73	0.70	0.91	0.17
NHMW 1847/0058/0607	89.2	51.3	76.2	67.2	128	1.74	0.67	0.88	0.15
NHMW 1847/0058/0608	86.1	47.0	74.8	63.3	119	1.83	0.63	0.85	0.13
NHMW 1847/0058/0609	80.5	47.5	64.9	59.8	112	1.69	0.73	0.92	0.19
NHMW 1847/0058/0610	77.1	46.4	67.9	61.6	137	1.66	0.68	0.91	0.12
NHMW 1847/0058/0611	63.3	33.5	52.3	44.1	101	1.89	0.64	0.84	0.17

Table 17. Dimensions of Monteiroconus mercati (Brocchi, 1814).

Revised description – Shell large, solid, spire coeloconoid, depressed, gradate; spire whorls shouldered, adapical half concave, canaliculate, abapical part convex; suture deeply impressed; subsutural flexure asymmetrically curved; last whorl elongate, shoulder roundly angular, sides weakly convex, maximum diameter just below shoulder, not constricted at base; bearing very weak spiral grooves abapically; aperture straight, widening abapically; siphonal canal short, straight; siphonal fasciole hardly developed, poorly delimited; colour pattern of axial flammules on spire and three broad, interrupted bands on last whorl preserved and enhanced under UV light (Pl. 81, figs 7, 8).

Discussion – Conus mercati Brocchi, 1814 was reported from the middle Miocene of the Paratethys by Hörnes (1851) and from the late Miocene of Portugal by Pereira da Costa (1866). The illustrated specimens represent different species of which none is conspecific with *Monteiroconus mercati*.

We disagree with Glibert (1952, p. 372) who considered all species within the 'Conus mercati group' to have three spiral cords on the spire whorls. Neither the holotype figured by Rossi Ronchetti (1955, fig. 156) nor any of the Pliocene Italian specimens have spiral sculpture on the spire whorls. As discussed above, we restrict *M. mercati* to forms with smooth spire whorls. Most of the Miocene forms identified in the literature with striate spire whorls are here considered to belong in *Monteiroconus daciae* (Hoernes & Auinger, 1879) and *Monteiroconus mojsvari* (Hoernes & Auinger, 1879). Other differences are the width in relation to height (LW, RD; see species morphometrics), the more rounded shoulder in *M. daciae*, and differences in colour pattern.

Monteiroconus aldrovandi (Brocchi, 1814), originally described as a variety of *M. mercati*, was considered to be a separate species by Hall (1964, p. 125), differing in having rounded, convex, scalariform spiral whorls. The spiral whorls in *M. mercati* are flat or concave, gradate, and the sides of the spire are more concave in most specimens.

Conus sharpeanus Pereira da Costa, 1866 from the late Miocene Tortonian of Portugal was placed in the synonymy of *M. mercati* by Muñiz Solís (1999, p. 81). Both the description and figure show the spire whorls to be striate and therefore Pereira da Costa's species is not conspecific with *M. mercati*.

The specimens of *M. mercati* from Karaman are very large indeed. The spire, although scalate, tends to be somewhat lower than is typical for Italian Pliocene specimens.

Distribution – Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Peyrot, 1930, 1931); Proto-Mediterranean Sea (Langhian): Kasaba Basin (İslamoğlu, 2004), (Serravallian): Karaman Basin, Turkey (Fischer, 1866). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Davoli, 1972). Early Pliocene: northeastern Atlantic, Canary Islands (Meco, 1981); western Mediterranean, Estepona Basin, Spain (Muñiz Solís, 1999), Roussillon Basin (Fontannes, 1880); central Mediterranean, Italy (Pavia, 1975; Cavallo & Repetto, 1992; Chirli, 1988, 1997), Tunisia (Fekih, 1975). Late Pliocene: central Mediterranean, Italy (Sacco, 1893a; Malatesta, 1974). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1910).

Genus Plagioconus Tucker & Tenorio, 2009

Type species – Conus elatus Michelotti, 1847, by original designation. Miocene, Europe.

Plagioconus puschi (Michelotti, 1847)

Plate 39, fig. 5; Plate 41, fig. 13; Plate 42, fig. 7; Plate 81, fig. 9

- *1847 *Conus Puschi* mihi, Michelotti, p. 340, pl. 14, fig.
 6.
- 1851 Conus Puschi Micht. Hörnes, p. 35, pl. 4, fig. 6,7.
- 1851 Conus Haueri Partsch, Hörnes, p. 34, pl. 4, fig.
 5 [non fig. 4 = Plagioconus elatus (Michelotti, 1847)].
- 1893b Conus (Chelyconus) oboesus var. pseudosuessi Sacc., Sacco, p. 58, pl. 5, fig. 34.
- 1893b Conus (Chelyconus) Puschi (Micht.) Sacco, p. 59, pl. 5, fig. 39.
- 1893b Conus (Chelyconus)Puschi var. demissespirata Sacc., Sacco, p. 60, pl. 5, fig. 40.
- 1893b Conus (Chelyconus) Puschi var. dertoelatoides Sacc., Sacco, p. 60, pl. 5, fig. 41.
- 1893b Conus (Chelyconus) Puschi var. scalaratula Sacc., Sacco, p. 61, pl. 5, fig. 48.
- 1893b Conus (Chelyconus) Puschi var. parvulespirata Sacc., Sacco, p. 61, pl. 5, fig. 49.
- 1930 *Conus (Chelyconus) Puschi* Michelotti Peyrot, p. 113, no. 1182.
- 1931 *Conus (Chelyconus) Puschi* Michelotti Peyrot, pl. 4, figs 10, 12.
- 1942 *Conus (Chelyconus) puschi* Michelotti Wenz, p. 211, pl. 1, fig. 11.
- 1958 Conus (Chelyconus) puschi Michelotti Erünal-Erentöz, p. 116, pl. 19, fig. 4.
- 1956 Conus (Chelyconus) puschi Micht. Csepreghy-Meznerics, p. 419, pl. 10, figs 3, 4.
- 1960 Conus (Chelyconus) austriaconoae Sacco 1893 Kojumdgieva & Strachimirov, p. 212, pl. 50, fig. 2.
- 1962 *Conus (Chelyconus) puschi* Michelotti Strausz, p. 144, pl. 70, figs 2-4 (non Sacco, 1893).
- 1964 Conus puschi Michelotti, 1847 Hall, p. 158, pl. 27, figs 10, 14, 19 (non Sacco, 1893).
- 1966 Conus (Chelyconus) puschi Michelotti, 1847 Strausz, p. 460, pl. 70, figs 2-4.
- 1972 Conus puschi Michelotti Davoli, p. 128, pl. 8, figs 17-20.
- 2004 *Conus puschi* Michelotti, 1847 İslamoğlu, p. 164, pl. 4, fig. 9.
- 2009 *Plagioconus puschi* (Michelotti, 1847) Tucker & Tenorio, p. 111.

- 2010 *Conus (Cheluyconus)* sp. Caze *et al.*, p. 32, fig. 5M.
- non 1866 Conus Puschi Micht. Pereira da Costa, p. 25 (partim, pl. 8, figs 3, 4, 6, 7 only) [= Plagioconus elatus (Michelotti, 1847)].
- non 1866 Conus Puschi Micht. Pereira da Costa, p. 25 (partim, pl. 9, figs 1, 2 only) [= Plagioconus oblongoturbinatus (Sacco, 1893)].
- non 1891 Conus Puschi Micht. Mylius, p. 9, pl. 1, fig. 3 [= Varioconus aquensis (d'Orbigny, 1852)].
- non 1893b Conus (Chelyconus) Puschi var. longovulata Sacco, p. 60, pl. 5, fig. 42 [= Plagioconus marii (Sacco, 1893)].
- non 1893b Conus (Chelyconus) Puschi var. pseudobiconica Sacc., Sacco, p. 60, pl. 5, fig. 43 [= Varioconus aquensis (d'Orbigny, 1852)].
- non 1893b Conus (Chelyconus) Puschi var. crassuloides Sacc., Sacco, p. 61, pl. 5, fig. 44 [= Lautoconus oboesus (Michelotti, 1847)].
- non 1893b Conus (Chelyconus) Puschi var. crassuloclava Sacc., Sacco, p. 61, pl. 5, fig. 45 [= Conus (Chelyconus) oboesus (Michelotti, 1847)].
- non 1893b Conus (Chelyconus) Puschi var. peracutolonga Sacc., Sacco, p. 61, pl. 5, fig. 46 [= Varioconus aquensis (d'Orbigny, 1852)].
- non 1893b Conus (Chelyconus) Puschi var. longogracilis Sacc., Sacco, p. 61, pl. 5, fig. 47 [= Plagioconus marii (Sacco, 1893)].
- non 1893b Conus (Chelyconus) Puschi var. ascalaris Sacc., Sacco, p. 61, pl. 5, fig. 51 [= Varioconus aquensis (d'Orbigny, 1852)].
- non 2004 Conus puschi Michelotti, 1847 İslamoğlu, p. 164, pl. 4, fig. 9.

Dimensions and material – Maximum height 84.4 mm. Localities 2 & 3: JvdV/1; locality 12: JvdV/2; locality 13: NHMW 1847/0058/0497-1847/0058/0499/3, RGM 777 891/1 (ex JvdV collection), JvdV/9, RGM 783 704/5, YI 139/4.

Revised description – Shell medium-sized, very slender, spire tall; spire whorls convex, early whorls beaded; subsutural flexure diagonal, depth less than width; last whorl slender, elongate, broadly rounded at shoulder, straightsided, maximum diameter a short distance below shoulder; not constricted at base; bearing narrow, finely wavy spiral grooves over lower two-thirds of height, grooves becoming stronger and more closely spaced abapically; aperture straight, damaged; siphonal canal long, almost straight; siphonal fasciole hardly developed; colour pattern of broad flammules on spire and three poorly delimited spiral bands of small, irregular blotches on last whorl, enhanced under UV light (Pl. 81, fig. 9).

Discussion - The genus Plagioconus Tucker & Tenorio, 2009 is characterised by shells with a spire that is cyrtoconoid in most species, spire whorls without cords, a rounded shoulder, an elongate last whorl, and a shallow anal sinus. Several closely similar species occur in the European Miocene. Plagioconus puschi (Michelotti, 1847) has a distinctly convex spire, with rounded whorls. Plagioconus elatus (Michelotti, 1847) (= Conus elongatus Borson, 1820, junior homonym of C. elongatus Holten, 1802; see Kohn, 1992), which has a similar geological and geographical distribution, has a more elevated spire, the individual spire whorls with a vertical wall and flat sloping top, and an almost horizontal top to the last spire whorl. Plagioconus oblongoturbinatus (Sacco, 1893), from the Burdigalian-Langhian of the Colli Torinesi of Italy and the Atlantic Tortonian of Portugal has a spire with early rounded whorls, later spire whorls somewhat flattened and angular, and a flattened, sloping infrasutural area on the last whorl, ending at a slightly angular shoulder. Plagioconus montisclavus (Sacco, 1893) from the Burdigalian-Langhian of the Colli Torinesi of Italy has a much broader shell, with a lower spire. Other species with a similar shell shape are Lautoconus oboesus (Michelotti, 1847), which is distinguished by the generic character of cords on the early spire whorls, and Varioconus aquensis (d'Orbigny, 1852), which has a relatively higher spire and shorter last whorl, and a weakly angular periphery on the early whorls.

Hall (1964) put *Conus puschi* in Pereira da Costa (1866, pl. 9, figs 1, 2 only) in the synonymy of both *Varioconus aquensis* (d'Orbigny, 1852) and *Plagioconus oblongotur-binatus* (Sacco, 1893). This was obviously an error, and the Miocene of Portugal is not included in Hall's distribution of *V. aquensis*. The shells illustrated by Pereira da Costa are clearly *P. oblongoturbinatus*.

The colour pattern (Pl. 81, fig. 2) is identical to that illustrated by Caze *et al.* (2010, fig. 5M) for a shell from the Paratethys of Romania.

Distribution – **Early Miocene**: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1893b; Hall, 1964; Davoli, 1972). **Middle Miocene**: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Peyrot,

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0497	69.3	23.8	52.1	47.5	68	2.91	0.47	0.91	0.25
NHMW 1847/0058/0498	82.4	29.4	67.6	61.8	73	3.01	0.44	0.91	0.18
NHMW 1847/0058/0499	78.5	27.0	61.3	57.5	64	2.91	0.44	0.94	0.22

Table 18. Dimensions of Plagioconus puschi (Michelotti, 1847).

1930, 1931); Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1851), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Csepreghy-Meznerics, 1956; Strausz, 1962, 1966), Romania (Caze *et al.*, 2010); Proto-Mediterranean Sea (late Burdigalian-Langhian): Kasaba Basin, Turkey (İslamoğlu, 2004), (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): southern Spain (Wenz, 1942); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1893a; Hall, 1964; Davoli, 1972).

Genus Varioconus da Motta, 1991

Type species – Conus bulbus Reeve, 1843a, by original designation. Recent, West Africa.

Varioconus pelagicus (Brocchi, 1814)

Plate 39, figs 6, 7; Plate 41, fig. 14; Plate 42, fig. 8; Plate 82, figs 1, 2

- *1814 Conus pelagicus nob., Brocchi, p. 289, pl. 2, fig. 9.
- 1851 Conus pelagicus Brocc. Hörnes, p. 31, pl. 3, fig. 4.
 1879 Conus (Chelyconus) Lapugyensis Hoernes &
- Auinger, p. 42, pl. 1, fig. 9, pl. 5, fig. 8.
- 1879 Conus (Chelyconus) Mariae Hoernes & Auinger, p. 49, pl. 6, fig.7.
- 1890 Conus granulato-cinctus Mayer-Eymar, p. 295.
- 1891 *Conus granulato-cinctus* Mayer-Eymar, p. 329, pl. 10, fig. 1.
- ?1893b Conus (Chelyconus) oboesus var. tauroconnectens Sacc., Sacco, p. 59, pl. 5, fig. 36.
- 1893b *Conus (Chelyconus) clavatus* var. *tauroclavatula* Sacc., Sacco, p. 70, pl. 7, fig. 1.
- ?1893b Conus (Chelyconus) Deshayesi var. taurosubscalaris Sacc., Sacco, p. 74, pl. 7, fig. 19.
- ?1893b Conus (Chelyconus) Deshayesi var. lineoclavata Sacc., Sacco, p. 74, pl. 7, fig. 20.
- 1893b *Conus (Chelyconus) ponderosus* var. *taurocrassa* Sacc., Sacco, p. 78, pl. 8, fig. 3.
- 1893b Conus (Chelyconus) ponderosus var. miosubtypica Sacc., Sacco, p. 78, pl. 8, fig. 6.
- 1893b Conus (Chelyconus) ponderosus var. miofusuloides Sacc., Sacco, p. 79, pl. 8, fig. 7.
- 1893b Conus (Chelyconus) pelagicus (Br.) Sacco, p. 90, pl. 9, fig. 17.
- 1893b Conus (Chelyconus) pelagicus var. monstruosa Sacc., Sacco, p. 91, pl. 9, fig. 18.
- 1893b Conus (Chelyconus) pelagicus subvar. permaculata Sacc., Sacco, p. 92, pl. 9, fig. 19.
- 1893b Conus (Chelyconus) pelagicus subvar. astensiscalaris Sacc., Sacco, p. 92, pl. 9, fig. 20.
- 1893b *Conus (Chelyconus) pelagicus* var. *taurogigantea* Sacc., Sacco, p. 92, pl. 9, fig. 22.
- 1893b Conus (Chelyconus) pelagicus var. acutiusculoides Sacc., Sacco, p. 92, pl. 9, fig. 23.
- 1893b Conus (Chelyconus) pelagicus var. pseudopyrula Sacc., Sacco, p. 92, pl. 9, fig. 24.
- 1893b Conus (Chelyconus) pelagicus var. depressoconica Sacc., Sacco, p. 93, pl. 9, fig. 26.

- 1893b Conus (Chelyconus) pelagicus var. colorata (Defr.) – Sacco, p. 93, pl. 9, fig. 28.
- 1893b Conus (Chelyconus) parvus var. miofusuluvoides Sacc., Sacco, p. 97, pl. 9, fig. 45.
- 1893b Conus (Chelyconus) mediterraneus var. taurovata Sacc., Sacco, p. 103, pl. 10, fig. 1.
- 1893b Conus (Chelyconus) Ottiliae? var. asperula (Gené) – Sacco, p. 119, pl. 11, fig. 21.
- 1893b Conus (Chelyconus) Ottiliae? var. ovulatina Sacc., Sacco, p. 120, pl. 11, fig. 22.
- 1893b Conus (Chelyconus) Ottiliae? var. longogracilis Sacc., Sacco, p. 120, pl. 11, fig. 23.
- 1930 *Conus (Chelyconus) clavatulus* Lamarck Peyrot, p. 105, no. 1176 (*partim*).
- 1931 *Conus (Chelyconus) clavatulus* Lamarck Peyrot (*partim*, pl. 1, fig. 13 only).
- 1955 *Conus (Puncticulis) (Chelyconus) pelagicus* Brocchi 1814 – Rossi Ronchetti, p. 284, fig. 152.
- 1964 Conus pelagicus Brocchi, 1814 Hall, p. 45, pl.
 27, figs 1-4, 7, 15, 16, 20-23.
- 1974 *Conus (Chelyconus) pelagicus* Brocchi, 1814 Malatesta, p. 381, pl. 30, figs 4, ?10.
- 1978 Conus pelagicus Brocchi, 1814 Pinna & Spezia,
 p. 137, pl. 18, fig. 4.
- 1988 *Conus (Chelyconus) pelagicus* Brocchi, 1814 Chirli, p. 22, pl. 9, fig. 1.
- 1992b *Conus pelagicus* Brocchi, 1814 Andreoli & Marsigli, p. 5, pl. 1, fig. 5.
- 1997 *Conus* (*Chelyconus*) *pelagicus* Brocchi, 1814 Chirli, p. 7, pl. 1, fig. 17, pl. 2, figs 1-5.
- 1999 *Conus (Chelyconus) pelagicus* Brocchi, 1814 Muñiz Solís, p. 55, figs 7Q, R.
- 2009 *Varioconus pelagicus* (Brocchi, 1814) Tucker & Tenorio, p. 128.
- 2010 *Conus pelagicus* Brocchi, 1814 Sosso & dell'Angelo, p. 49, unnumbered figure p. 65, top left.
- non 1845 Conus pelagicus Broc. Grateloup, pl. 14, fig. 8 [= Varioconus basteroti (Mayer Eymar, 1891)].
- non 1910 Conus (Chelyconus) pelagicus Br. Cerulli-Irelli, p. 49, pl. 4, fig. 49 [= Lautoconus bitorosus (Fontannes, 1880)].

Dimensions and material – Maximum height 73.5 mm. Localities 2 & 3: JvdV/11, RGM 783 939/7, YI 134/2; locality 6: RGM 783 866/1; localities 7 & 8: JvdV/1; locality 9: JvdV/1; locality 12: JvdV/3; locality 13: JvdV/6, MTA 2013/075/3, YI 137/4; locality 17: NHMW 1847/0058/0624-1847/0058/0641/18, JvdV/50+, RGM 777 892/1 (ex JvdV collection), RGM 777 893/1 (ex JvdV collection), RGM 783 703/13, RGM 794 043/26, MTA 2013/076/20, YI 133/50+.

Revised description – Shell medium-sized, relatively elongate, spire elevated; spire whorls flat to weakly convex, very weakly striate to smooth; subsutural flexure diagonal, depth less than width; last whorl slightly inflated, elongate, rounded at shoulder, weakly convex below; maximum diameter just above mid-height; slightly

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0624	73.5	36.3	55.6	49.7	93	2.02	0.65	0.89	0.24
NHMW 1847/0058/0625	53.2	26.6	44.2	37.6	93	2.0	0.60	0.85	0.17
NHMW 1847/0058/0626	59.1	26.9	41.0	35.5	93	2.02	0.67	0.87	0.31
NHMW 1847/0058/0627	64.5	33.0	50.6	44.3	95	1.95	0.65	0.88	0.22
NHMW 1847/0058/0628	57.7	27.8	45.1	40.2	95	1.97	0.62	0.89	0.22
NHMW 1847/0058/0629	52.1	26.5	42.5	37.2	97	1.97	0.62	0.88	0.18
NHMW 1847/0058/0630	64.8	31.5	51.4	44.2	93	2.06	0.61	0.86	0.21
NHMW 1847/0058/0631	55.9	28.3	46.5	38.3	97	1.98	0.61	0.82	0.17

Table 19. Dimensions of Varioconus pelagicus (Brocchi, 1814).

constricted at base; bearing fine, regularly spaced spiral ridges, and stronger grooves on abapical third; aperture straight, broadening in abapical half; siphonal canal relatively long, slightly recurved; siphonal fasciole well-developed, rounded; colour pattern of narrow spiral lines or dashes and larger irregular blotches, enhanced under UV light (Pl. 82, figs 1, 2).

Discussion - As discussed by Hall (1964), Varioconus pelagicus (Brocchi, 1814) is closely similar in shape to Varioconus ponderosus (Brocchi, 1814), but differs in having a more pronounced shoulder, spiral ridges on the last whorl, a colour pattern composed of spiral lines and blotches rather than vertical flammules, and in lacking the 'pencil-line' groove at the periphery of each whorl. The colour pattern is well figured in some of Sacco's figures (1893b, pl. 9, figs 17a, 19a). However, it must be noted that some of the specimens from Karaman do have a faint groove at the whorl periphery, although not as strong as typically seen in V. ponderosus. This would suggest the two taxa are indeed closely related. Varioconus deshayesi (Bellardi & Michelotti, 1840) from the early Pliocene Mediterranean belongs to the same species group, and some specimens also show a weak groove at the whorl periphery. It differs clearly from both V. ponderosus and V. pelagicus in having a broader, heavier, more inflated shell, with a very rounded shoulder. The colour pattern in V. deshayesi is quite different, consisting of narrow vertical flammules on the spire and very closely spaced reddish lines on the last whorl.

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Italy (Sacco, 1893b; Hall, 1964). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Mayer-Eymar, 1890, 1891); Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1851), Romania (Hoernes & Auinger, 1879); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1893b). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Muñiz Solís, 1999); central Mediterranean, Italy (Andreoli & Marsigli, 1992b; Chirli, 1997). Late Pliocene: central Mediterranean, Italy (Hall, 1964; Malatesta, 1974). **Early-late Pliocene**: central Mediterranean, Italy (Sacco, 1893b; Chirli, 1988).

Varioconus erunalerentoezae nov. sp.

Plate 40, figs 1-4; Plate 41, fig. 15; Plate 42, fig. 9; Plate 78, fig. 6; Plate 82, fig. 3

1958 Conus (Chelyconus) pelagicus var. inflatus Erünal-Erentöz, p. 120, pl. 19, fig. 10, pl. 20, fig. 1 (non C. inflatus G.B. Sowerby I, 1833).

Dimensions and material – Holotype AÜ LE-K-253/1, exact locality unknown. Paratype 1 NHMW 1847/0058/0974, height 46.8 mm; paratype 2 NHMW 1847/0058/0975, height 45.5 mm; paratype 3 NHMW 1847/0058/0976, height 43.9 mm; paratype 4 NHMW 1847/0058/0978, height 42.4 mm; paratype 5 NHMW 1847/0058/0979, height 40.3 mm; paratype 6 NHMW 1847/0058/0945, height 34.7 mm; paratype 7 NHMW 1847/0058/0946, height 33.8 mm; paratype 8 RGM 777 894 (ex JvdV collection), height 34.3 mm; furthermore three specimens in YI 490, height 56.0 mm, YI 491, height 51.5 mm, and YI 492, height 56.8 mm; all locality 17.

Other material – Maximum height 46.8 mm. Locality 17: NHMW 1847/0058/1660-1847/0058/1665/6, JvdV/10, MTA 2013/077/9, YI 138/19.

Etymology – Named in honour of Lütfiye Erünal-Erentöz, pioneer of Karaman Neogene molluscan work.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum –Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A medium-sized species of *Varioconus*, with a rather squat conoid shape and low to medium-height spire, with smooth spire whorls, a diagonal subsutural

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0974	46.8	29.2	39.5	32.0	114.4°	1.60	0.74	0.81	0.16
NHMW 1847/0058/0975	45.5	26.8	37.6	30.8	113.1°	1.70	0.71	0.82	0.17
NHMW 1847/0058/0976	43.9	25.0	36.9	30.9	115.0°	1.76	0.68	0.84	0.16
NHMW 1847/0058/0978	42.4	25.5	33.3	29.5	114.2°	1.66	0.77	0.89	0.21
NHMW 1847/0058/0979	40.3	22.7	33.8	28.1	112.3°	1.76	0.67	0.83	0.16
NHMW 1847/0058/0945	34.7	20.4	29.1	22.6	113.7°	1.70	0.70	0.78	0.16
NHMW 1847/0058/0946	33.8	20.3	30.8	24.4	131.5°	1.67	0.66	0.79	0.09

Table 20. Dimensions of Varioconus erunalerentoezae nov. sp.

flexure, a rather squat and inflated last teleoconch whorl, and a colour pattern seen under UV light of rows of small dots or dashes alternating in size.

Description – Shell medium-sized. Spire flat-sided to coeloconoid, low to medium in height. Spire whorls separated by deeply impressed suture, bearing close-set growth lines, spiral sculpture absent. Subsutural flexure diagonal. Last whorl rather squat, inflated, shoulder high, rounded to weakly angular, sides convex, maximum diameter at about three-quarters shell height; very weakly constricted at base; on abapical quarter bearing irregular wavy spiral grooves strengthening abapically. Aperture straight, widening abapically. Siphonal canal very short. Siphonal fasciole weakly developed. Colour pattern under UV light of rows of small dots or dashes alternating in size (Pl. 82, fig. 3).

Discussion - In the Turkish deposits this species is easily separated from its congeners under UV light, when a very distinctive pattern of spirally arranged dots of alternating size is easily seen. Once this species is distinguished, there is seen to be some variability in the shell width, height of the spire and the shoulder can be rounded or angular. However, the base is always rather truncated and the siphonal canal is very short. It is undoubtedly conspecific with the shells described by Erünal-Erentöz (1958, pl. 19, fig. 10, pl. 20, fig. 1) as Conus (Chelyconus) pelagicus var. inflatus. In her discussion the author stressed the very squat shell shape and inflated last adult whorl in order to distinguish it from Varioconus pelagicus (Brocchi, 1814). A specimen from the Erünal-Erentöz collection in Ankara University is illustrated (Pl. 78, fig. 6), but is not the specimen figured by the author, which was not found in the Ankara collection. It is not recorded in the Paris Museum collections either. This is the only specimen remaining in the Erünal-Erentöz collection and therefore has been chosen as the holotype.

Despite being originally described as a variety of *V. pelagicus* it has little in common with this species, which can easily be separated by its more slender shell shape, its long and slightly twisted siphonal canal and its quite different colour pattern. The name *inflatus* is not avail-

able, as it is a junior homonym of *C. inflatus* G.B. Sowerby I, 1833. We therefore propose the name *Varioconus erunalerentoezae* nov. sp.

Several Paratethyan species are similar in size and in having the spire whorls devoid of spiral sculpture. *Conus voeslauensis* Hoenes & Auinger 1879 is the most closely similar and has a similar colour pattern (see Hoernes & Auinger, 1879, pl. 1, fig. 8). The Paratethyan species has a less inflated last whorl and a more slender, less truncated anterior end than *V. erunalerentoezae* nov. sp.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Varioconus karamanensis (Erünal-Erentöz, 1958)

Plate 40, figs 5, 6; Plate 41, fig. 16; Plate 42, fig. 10; Plate 78, fig. 7; Pl. 82, fig. 4

*1958 *Conus (Chelyconus) pelagicus* var. *karamanensis* Erünal-Erentöz, p. 119, pl. 19, figs 7-9.

Dimensions and material – Maximum height 42.5 mm. Localities 2 & 3: YI 147/1; locality 17: NHMW 1847/0058/1550-1847/0058/1553/4, 1847/0058/1666-1847/0058/1667/2, JvdV/10, RGM 794 044/6, MTA 2013/-089/10, YI 148/47. Exact locality unknown: **lectotype** AÜ-LE-K-252/3.

Revised description – Shell medium-sized. Spire coeloconoid, tall. Spire whorls smooth, separated by impressed suture. Subsutural flexure asymmetrically curved. Last whorl tall, slender, shoulder high, angular, sides almost straight, maximum diameter at about three-quarters of the shell height; not constricted at base; bearing very weak spiral grooves on abapical quarter of shell height. Aperture straight, hardly widening abapically. Siphonal canal short. Siphonal fasciole hardly developed. Colour pattern under UV light of spirally arranged rows of spots (Pl. 82, fig. 4).

Discussion – This species is characterised by its relatively tall, strongly coeloconoid spire and its slender, almost

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/1550	41.6	21.0	33.4	30.0	98.7	1.98	0.63	0.90	0.20
NHMW 1847/0058/1551	42.6	21.6	34.7	30.6	100.5	1.97	0.62	0.88	0.19
NHMW 1847/0058/1552	35.9	17.4	27.4	24.5	87.6	2.06	0.64	0.89	0.24
NHMW 1847/0058/1553	36.5	17.6	27.8	24.0	84.7	2.07	0.63	0.86	0.24

Table 21. Dimensions of Varioconus karamanensis (Erünal-Erentöz, 1958)

straight-sided last whorl. It was originally described as a subspecies of V. pelagicus (Brocchi, 1814), from which it clearly differs in the shape of the subsutural flexure (see Table 25) and in the outline of the shoulder, which is much more angular in V. karamanensis. A specimen from the Erünal-Erentöz collection in Ankara University is illustrated (Pl. 78, fig. 7), but it does not match any of the three specimens illustrated by Erünal-Erentöz, which are not present in the Ankara collection. These may be present in the Paris Museum collection, which has eight syntypes recorded on the museum website (MNHN.F.A26724; not seen). It differs from Varioconus erunalerentoezae nov. sp. again in the character of the subsutural flexure (see Table 25) and in its more slender, less inflated form. The rows of spots seen under UV light are larger and more uniform in size than in V. erunalerentoezae. Conus gallicus Mayer-Eymar, 1890 from the early Miocene French and Italian assemblages also has a strongly coeloconoid spire, but differs in having much stronger spiral sculpture on the base.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Varioconus subraristriatus (Pereira da Costa, 1866) Plate 40, figs 7, 8; Plate 41, fig. 17; Plate 42, fig. 11

- 1851 Conus raristriatus Bell. et Mich. Hörnes, p. 28, pl. 3, fig. 2a-c [non Lautoconus raristriatus (Bellardi & Michelotti, 1840)].
- *1866 Conus subraristriatus Costa Pereira da Costa, p. 15 (partim, pl. 4, fig. 7a, b only) [non figs 2-6 = Kalloconus berghausi (Michelotti, 1847)].
- 1879 Conus (Chelyconus) Enzesfeldensis Hoernes & Auinger, p. 46 (nom. nov. pro Conus raristriatus Hörnes, p. 28, pl. 3, fig. 2, non Bellardi & Michelotti, 1840).
- non 1879 Dendroconus subraristriatus da Costa Hoernes & Auinger, p. 23, pl. 1, figs 20-22 (includes various species).
- ?non 1956 Conus (Dendroconus) subraristriatus Da Costa Csepreghy-Meznerics, p. 422, pl. 2, figs 1, 2.
- ?non 1966
 Conus (Cleobula) subraristriatus Costa, 1866 –

 Strausz, p. 465, pl. 71, figs 3-5, ?1, 2.

Dimensions and material – Maximum height 88.4 mm. Localities 2 & 3: JvdV/5; locality 6: JvdV/1; locality 13: JvdV/2; locality 17: NHMW 1847/0058/0600-1847/0058/0604/5, JvdV/2, YI 143/5.

Revised description – Shell medium-sized, spire of medium height, cyrtoconoid; spire whorls very weakly convex, smooth; subsutural flexure diagonal, depth less than width; last whorl elongate, roundly shouldered, straightsided, maximum diameter at shoulder; hardly constricted at base; bearing few, weak, finely beaded spiral cords abapically in some specimens; aperture straight, relatively narrow, widening slightly abapically; siphonal canal short, straight; siphonal fasciole rounded, relatively well-developed; colour pattern of widely spaced, narrow brownish dots and dashes, coalescing into straight spiral lines.

Discussion - The specimens from Karaman are fairly constant in shape and are clearly conspecific with the shell illustrated by Hörnes (1851, pl. 3, fig. 2) from the Paratethyan middle Miocene of Austria as Conus raristriatus. Pereira da Costa (1866) recognised that the Viennese species and his own specimens from the late Miocene Atlantic Tortonian of Portugal were not conspecific with C. raristriatus Bellardi & Michelotti, 1840, and proposed C. subraristriatus as new species name. However, of the shells illustrated by Pereira da Costa, we restrict the name to his figure 7, as the rest of the series are specimens of Kalloconus berghausi (Michelotti, 1847). The two species can easily be distinguished by the larger shell of Varioconus subraristriatus (Pereira da Costa, 1866), which has a more elevated spire and a more elongate last whorl than K. berghausi. The spiral sculpture on the abapical portion of the last whorl is also much stronger in K. berghausi and the siphonal canal is shorter. The colour pattern is also different, as although both have spiral lines of dots, they are more widely spaced in V. subraristriatus. Similarly, Hoernes & Auinger (1879) doubted the identification made by Hörnes (1851) and proposed C. enzesfeldensis as a new name, which we consider to be a synonym of V. subraristriatus.

In the same paper, Hoernes & Auinger (1879) also discussed *Conus subraristriatus* Pereira da Costa, 1866 and referred explicitly to the specimens figured by Pereira da Costa (1866, pl. 4, figs, 2, 6). Therefore, their understanding of this species differs clearly from ours. As the act of Hoernes & Auinger (1879) does not fulfill the requirements of type selection according to ICZN Art. 74.5,

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0600	79.5	41.8	56.0	55.0	103	1.9	0.75	0.98	0.3
NHMW 1847/0058/0601	86.2	46.8	65.1	57.1	93	1.84	0.72	0.88	0.25
NHMW 1847/0058/0602	88.8	46.7	63.1	58.8	92.7	1.9	0.74	0.93	0.29

Table 22. Dimensions of Varioconus subraristriatus (Pereira da Costa, 1866).

we are the first revisers and designate the specimen in Pereira da Costa (1866, pl. 4, fig. 7) as lectotype of *V. subraristriatus*.

Despite some superficial similarities with *Chelyconus austriaconae* Sacco, 1893 (proposed by Sacco 1893b, p. 85 for the middle Miocene Austrian *Conus noe* Hörnes, 1851, pl. 3, fig. 1 *non* Brocchi, 1814), the two species are distinguished easily by the much longer last whorl and the very long siphonal canal of *C. austriaconus*, which also has a higher spire in most specimens.

Varioconus noe (Brocchi, 1814) seems to be a rather rare Pliocene species from Italy. The holotype, illustrated by Rossi Ronchetti (1955, fig. 151), can immediately be distinguished from V. subraristriatus by the presence of distinct spiral sculpture on the spire whorls and all specimens we have seen have a spiral groove running around the shoulder at, or just above the periphery. Further differences are its more slender, elongate shell shape, higher spire and weaker shoulder. Varioconus ponderosus (Brocchi, 1814) from the Miocene Proto-Mediterranean and Pliocene Mediterranean has a similar shape to V. subraristriatus, but the spire whorls of most specimens are more convex and weakly striate, the shoulder of many specimens bears a fine groove running around the shoulder, and the cords on the base, although not strongly developed, are more prominent than in C. austriaconoe, not beaded, and more extensive. Specimens with the colour preserved show quite a different pattern in V. ponderosus, consisting of fine vertical flammules (see Chirli, 1997, pl. 2, figs 8-11). The narrow groove around the shoulder is

uncommon in Conidae, and as suggested by Hall (1964), *V. noe* possiblyrepresents merely an extremely elongate form of *V. ponderosus. Varioconus clavatulus* (d'Orbigny, 1852) from the Miocene Atlantic and Proto-Mediterranean also has a somewhat elevated, convex spire, but differs in having striate spire whorls, a more elongate last whorl, narrower in the abapical portion, a longer, slightly recurved siphonal canal, and extensive, well-developed striations on the abapical portion of the last whorl.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria, Hungary, Romania (Hörnes, 1851; Hoernes & Auinger, 1879); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866).

Varioconus taurinensis (Bellardi & Michelotti, 1840) Plate 41, figs 4-6; Plate 41, fig. 19; Plate 42, fig. 13; Plate 82, figs 6, 7

- *1840 *Conus striatulus* var. *taurinensis* Bell. et Mich. Bellardi & Michelotti, p. 154, pl. 7, figs 12, 13.
- 1893b Conus (Cheliconus [sic]) taurinensis (Bell. Micht.) – Sacco, p. 98, pl. 9, fig. 47.
- 1893b Conus (Cheliconus [sic]) taurinensis var. fusolivoides Sacc., Sacco, p. 99, pl. 9, fig. 50.
- 1893b Conus (Cheliconus [sic]) taurinensis? var. anomalomamilla Sacc., Sacco, p. 99, pl. 9, fig. 52.

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0510	30.4*	12.9	19.9	17.2	62	2.36	0.65	0.86	0.35
NHMW 1847/0058/0511	28.2	12.4	20.3	18.2	68	2.27	0.61	0.90	0.28
NHMW 1847/0058/0512	32.3	16.5	25.1	23.4	80	1.96	0.66	0.93	0.23
NHMW 1847/0058/0513	31.2	15.2	25.2	23.2	82	2.05	0.60	0.92	0.19
NHMW 1847/0058/0514	30.1	13.3	22.0	20.3	64	2.26	0.60	0.93	0.29
NHMW 1847/0058/0515	25.8	13.2	20.7	18.5	83	1.95	0.64	0.89	0.20
NHMW 1847/0058/0516	25.8	12.9	19.2	17.3	71	2.0	0.67	0.90	0.26
NHMW 1847/0058/0517	24.2	11.5	18.2	16.5	72	2.1	0.63	0.91	0.25
NHMW 1847/0058/0984	31.1	14.9	23.9	20.6	84	2.08	0.62	0.86	0.23

* reconstructed height

Table 24. Dimensions of Varioconus taurinensis (Bellardi & Michelotti, 1840).

- 1964 Conus taurinensis Bellardi & Michelotti, 1840 Hall, p. 159, pl. 20, figs 2-4.
- 1972 *Conus taurinensis* Bellardi & Michelotti Davoli, p. 134, pl. 8, fig. 12.
- 1984 Chelyconus taurinensis (Bellardi & Michelotti, 1840) – Ferrero Mortara et al., p. 128, pl. 20, fig.
 3.
- 1984 Chelyconus taurinensis? var. anomalomamilla Sacco, 1893 – Ferrero Mortara et al., p. 128, pl. 20, fig. 2.
- 1999 Conus (Chelyconus) taurinensis (Bellardi y Michelotti, 1840) Muñiz Solís, p. 64, figs 8G, H.

Dimensions and material – Maximum height 29.5 mm. Locality 13: YI 136/1; locality 17: NHMW 1847/0058/0510-1847/0058/0517/8, 1847/0058/0984/1, 1847/0058/1668/4, JvdV/7, RGM 794 046/2, RGM 777 896/1 (ex JvdV collection), RGM 777 897/1 (ex JvdV collection), YI 135/3.

Revised description – Shell small, relatively elongate, spire mammillate, elevated, weakly gradate; early spire whorls flat-sided, smooth, later spire whorls carinate just above mid-whorl; surface very weakly striate; subsutural flexure asymmetrically curved; last whorl weakly angular at shoulder, straight below, maximum diameter below carina; not constricted at base; bearing grooves on abapical third; aperture straight, narrow; siphonal canal of medium length, straight; siphonal fasciole not developed; colour pattern clearly visible under UV light of irregular spiral and vertical blotches forming a cross-like pattern (Pl. 81, figs 7, 8).

Discussion – Varioconus taurinensis (Bellardi & Michelotti, 1840) is a strange little cone, in which the spire whorls of many specimens seem to have grown irregularly. This is also seen in specimens illustrated in the literature (see Sacco, 1893b; Hall, 1964). The height of the spire, spire angle and shape are very variable, ranging from low mammillate to relatively high and gradate. There are at least seven teleoconch whorls in the Turkish shells. The early whorls are flat-sided and on the third whorl a carina suddenly appears and the whorls become taller. Apart from the irregular spire, the dropped shoulder and weakly carinate last adult whorl are quite characteristic.

This species is unknown so far from the Paratethys. Some shells identified as *Conus ponderosus* Brocchi, 1814, however, possibly represent *C. taurinensis* (e.g. Krach, 1981, pl. 20, fig. 16).

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1893b; Hall, 1964). Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1893b). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Muñiz Solís, 1999). Genus Conilithes Swainson, 1840

Note – This genus is frequently mis-spelled *Conolithus* or *Conolithes* in the literature although Fleming (1968) has demonstrated that *Conilithes* Swainson, 1840 has priority over *Conolithus* Hermannsen, 1846.

Type species – Conus antidiluvianus Bruguière, 1792, by monotypy, Miocene-Pliocene, Europe.

Conilithes dujardini (Deshayes, 1845)

Plate 41, figs 1-3; Plate 41, fig. 18; Plate 42, fig. 12; Plate 82, fig. 5

- 1824 Conus antediluvianus [sic] Lamk. Deshayes, p. 749 (partim) [non Conilithes antidiluvianus (Bruguière, 1792)].
- 1831 Conus antidiluvianus Brug. Dubois de Montpereux, p. 23, pl. 1, fig. 1 [non Conilithes antidiluvianus (Bruguière, 1792)].
- *1845 Conus Dujardini Desh. Deshayes, p. 158.
- 1845 Conus Dujardini Deshayes, pl. 120, fig. 8.
- 1851 Conus Dujardini Desh. Hörnes, p. 40 (partim, pl. 5, figs 5, 6, 8 only) [non pl. 5, fig. 3 = Conilithes canaliculatus (Brocchi, 1814), non pl. 5, fig. 7 = Conilithes brocchii (Bronn, 1828)].
- 1866 Conus dujardini Deshayes Fischer, p. 240.
- 1879 Conus (Leptoconus) Brezinae Hoernes & Auinger, p. 36.
- 1890 Conus Cazioti Mayer-Eymar, p. 294.
- 1891 Conus Cazioti Mayer-Eymar, p. 325, pl. 9, fig. 3.
- 1893a Conus (Conospirus) Dujardini var. taurostriolata Sacc., Sacco, p. 46, pl. 5, fig. 1.
- 1893a Conus (Conospirus) Dujardini var. pseudoantediluviana Sacc., Sacco, p. 46, pl. 5, fig. 2.
- 1893a Conus (Conospirus) Dujardini var. pseudocatenata Sacc., Sacco, p. 46, pl. 5, fig. 3.
- 1893a Conus (Conospirus) Dujardini var. depressulina Sacc., Sacco, p. 47, pl. 5, fig. 4.
- 1893a Conus (Conospirus) Dujardini var. taurominor Sacc., Sacco, p. 47, pl. 5, fig. 5.
- 1893a Conus (Conospirus) Dujardini var. brevicaudata Sacc., Sacco, p. 47, pl. 5, fig. 6.
- 1911 Conus Dujardini Desh. Friedberg, p. 47 (partim, pl. 2, fig. 11 only) [non text-fig. 9 = Conilithes canaliculatus (Brocchi, 1814)].
- 1911 Conus Dujardini var. exaltatus Eichw. Friedberg, p. 50, pl. 2, fig. 12.
- 1911 Conus cf. avellana Lam. Friedberg, p. 56 (partim, pl. 2, fig. 20 only) [fig. 19 = Lautoconus pyrula (Brocchi, 1814)].
- 1925 Conus (Conospira) Dujardini Desh. Kautsky, p. 145, p. 10, figs 14, 15.
- 1930 Conus (Conospira) Dujardini Deshayes Peyrot, p. 85, no. 1162.
- 1930 *Conus (Conospira) subturritus* D'Orbigny Peyrot, p. 87, no. 1163.
- 1931 *Conus (Conospira) Dujardini* Deshayes Peyrot, pl. 1, figs 45-51.
- 1931 *Conus (Conospira) subturritus* D'Orbigny Peyrot, pl. 1, figs 8, 17, 20, 28.
- 1952a Conus (Conospira) Dujardini Deshayes, 1845 Glibert, p. 371, pl. 12, fig. 11.
- 1952b Conus (Conospira) Dujardini Deshayes, 1845 Glibert, p. 132, pl. 10, fig. 3.
- 1955 Conus (Conuspira) [sic] dujardini Deshayes, 1831
 Miosescu, p. 159, pl. 14, figs 15-18.
- 1958 Conus Dujardini Deshayes Sorgenfrei, p. 248, pl. 52, fig. 171.
- 1958 Conus (Conospirus) dujardini Deshayes Erünal-Erentöz, p. 123, pl. 20, fig. 9.
- 1958 Conus (Conospirus) subturritus d'Orbigny Erünal-Erentöz, p. 124, pl. 20, fig. 10.
- 1960 Conus (Conolithus) dujardini Deshayes 1845 Kojumdgieva & Strachimirov, p. 209, pl. 49, fig. 4.
- Conus (Conolithus) dujardini brezinae Hoernes & Auinger – Strausz, p. 151 (partim, pl. 43, figs 3-5, pl. 62, figs 8, 9 only).
- Conus (Conolithus) dujardini brezinae Hoernes & Auinger, 1879 – Strausz, p. 452 (partim, pl. 43, figs 3-5, pl. 62, figs 8, 9 only).
- 1967 Conus (Conolithus) dujardini Deshayes 1845 Tejkal et al., p. 208, pl. 12B, fig. 1.
- 1970 Conus (Conolithus) dujardini Deshayes Bałuk, p. 119, pl. 13, figs 15, 16.
- 1971b *Conus dujardini* Deshayes 1845 Eremija, p. 79, pl. 5, fig. 9.
- 1973 Conus (Conospirus) dujardini Deshayes Steininger, p. 446, pl. 9, fig. 6.
- 1973 Conus (Conospira) dujardini Deshayes 1845 Bohn-Havas, p. 1066, pl. 8, figs 1, 2.
- 1981 Conus (Conolithus) dujardini Deshayes 1845 Krach, p. 75 (partim, pl. 21, figs 10, 14, 20, 23 only).
- 1984a *Conus* (*Conolithus*) *antediluvianus* [*sic*] Bruguière, 1792 *s. lat.* – A.W. Janssen, p. 334 (*partim*, pl. 76, fig. 5 only) [*non Conolithus antediluvianus* (Bruguière, 1792)].
- 1985 Conus (Conolithus) dujardini brezinae Hoernes & Auinger – Atanacković, p. 179, pl. 40, figs 1, 2.
- 1997 Conus (Conolithus) dujardini Deshayes, 1845 Bałuk, p. 55 (partim, pl. 19, figs 1-4 only).
- 1998 Conus (Conolithus) brezinae Hoernes & Auinger - Schultz, p. 72, pl. 29, fig. 10.
- 1998 *Conus (Conolithus) dujardini* Deshayes Schultz, p. 72, pl. 29, fig. 11.
- 2001 Conus (Conolithus) dujardini dujardini Deshayes,
 1845 Chira & Voia, p. 153, pl. 1, fig. 5.
- 2002 *Conus (Conolithus) dujardini* Deshayes, 1845 Harzhauser, p. 112, pl. 9, fig. 12.
- 2003 Conus (Conolithus) dujardini Deshayes 1831 İslamoğlu & Taner, p. 62, pl. 5, fig. 13.
- 2009 Conus (Conolithus) dujardini Deshayes, 1845 Mikuž, p. 35, pl. 12, figs 159-161.
- 2009 *Conilithes dujardini* (Deshayes, 1845) Tucker & Tenorio, p. 137.
- 2010 Conus (Conolithus) dujardini Deshayes, 1845 Caze et al., p. 32, fig. 5N.

- non 1853 Conus Dujardini Desh. Beyrich, p. 295, pl. 1, fig. 3 [= Conilithes canaliculatus (Brocchi, 1814)].
- non 1866 Conus Dujardini Desh. Pereira da Costa, p. 27, pl. 9, figs 3-17 [= Conilithes canaliculatus (Brocchi, 1814)].
- non 1893a Conospirus dijardini var. astensis Sacc., Sacco, p. 47, pl. 5, fig. 7 [= Conilithes canaliculatus (Brocchi, 1814)].
- non 1914 Conus (Conospira) Dujardini Desh. var. Telegdi-Roth, p. 35, pl. 4, fig. 6 [= Conilithes egerensis (Noszky, 1936)].
- non 1954 Conus (Conospira) dujardini Desh. Strausz, p. 113, pl. 7, fig. 144 [= Conilithes canaliculatus (Brocchi, 1814)].
- non 1954 Conus (Conospira) dujardini brezinae H. et Au. – Strausz, p. 113, pl. 4, fig. 80 [= Conilithes canaliculatus (Brocchi, 1814)].
- non 1960 Conus (Conolithus) dujardini var. brezinae (Hoernes und Auinger, 1879) Kojumdgieva & Strachimirov, p. 209, pl. 49, fig. 7 [= Conilithes canaliculatus (Brocchi, 1814)].
- non 1962 Conus (Conolithus) dujardini brezinae Hoernes & Auinger – Strausz, p. 151 (partim, pl. 22, fig. 16, p. 62, fig. 10 only) [= Conilithes canaliculatus (Brocchi, 1814)].
- non 1966 Conus (Conolithus) dujardini brezinae Hoernes & Auinger, 1879 – Strausz, p. 452 (partim, pl. 22, fig. 16, p. 62, fig. 10 only) [= Conilithes canaliculatus (Brocchi, 1814)].
- non 1971 Conus (Conospirus) cf. dujardini Deshayes Steininger, p. 406, pl. 11, figs 8, 9.
- non 1972 Conus dujardini Deshayes, 1845 Davoli, p. 101,
 pl. 5, figs 5-7, 10, 12, 13, 17, 18, 22, 23 [= Conilithes canaliculatus (Brocchi, 1814)].
- non 1973 Conus (Conospira) dujardini brezinae Hoernes & Auinger 1879 – Bohn-Havas, p. 1067, pl. 8, fig. 6 [= Conilithes canaliculatus (Brocchi, 1814)].
- non 1985 Conus (Conolithus) dujardini Deshayes, 1845 Atanacković, p. 178, pl. 39, figs 18, 19 [= probably Conilithes canaliculatus (Brocchi, 1814)].
- ?non 1997 Conus (Conolithus) dujardini Deshayes, 1845 Chirli, p. 13, pl. 3, fig. 14.

Dimensions and material – Maximum height 46.7 mm. Localities 2 & 3: JvdV/45, RGM 783 939/7, YI 151/22; locality 6: NHMW 1847/0058/150/6, JvdV/3, RGM 783 866/1; localities 7 & 8: JvdV/13, RGM 777 895 (ex JvdV collection); locality 9: JvdV/1; locality 10: YI 150/5; locality 12: JvdV/2; locality 13: NHMW 1847/0058/0509/5, JvdV/13, RGM 783 703/13, MTA 2013/078/4, YI 152/12; locality 17: NHMW 1847/0058/0500-1847/0058/0507/8, 1847/0058/0508/23, JvdV/50+, RGM 783 703/13, RGM 794 045/16, MTA 2013/079/20, YI 149/50+ (+15 juveniles). Exact locality unknown: AÜ-LE-K-254/2.

Revised description – Shell small, relatively elongate, spire elevated, slightly coeloconoid; spire whorls flat to weakly convex, smooth, carinate just below mid-whorl, early whorls beaded at carina; subsutural flexure symmetrically curved; last whorl angular at shoulder, weakly

Specimen	SL (mm)	MD (mm)	AH (mm)	HMD (mm)	SA (°)	LW	RD	PMD	RSH
NHMW 1847/0058/0500	36.0	14.5	22.4	21.0	52	2.48	0.65	0.94	0.38
NHMW 1847/0058/0501	46.7	19.4	30.1	28.7	55	2.44	0.64	0.95	0.36
NHMW 1847/0058/0502	45.4	19.6	31.5	28.7	58	2.32	0.62	0.91	0.31
NHMW 1847/0058/0503	39.3	18.1	27.0	24.7	53	2.17	0.67	0.91	0.32
NHMW 1847/0058/0504	43.1	16.6	30.2	27.5	62.8	2.60	0.55	0.91	0.30
NHMW 1847/0058/0505	32.2	12.3	20.9	18.8	48	2.62	0.59	0.90	0.35
NHMW 1847/0058/0506	33.4	12.7	22.7	20.2	52	2.63	0.56	0.89	0.32
NHMW 1847/0058/0507	29.6	11.8	19.7	18.1	53	2.51	0.60	0.92	0.33

Table 23. Dimensions of Conilithes dujardini (Deshayes, 1845).

convex below, maximum diameter at carina, hardly constricted at base; bearing prominent grooves on abapical half to third; aperture straight, narrow; outer lip arcuate; siphonal canal of medium length, very slightly recurved; siphonal fasciole weakly developed; colour pattern under UV light of irregular horizontal dashes, blotches and bands (Pl. 82, fig. 5).

Discussion – Conilithes dujardini (Deshayes, 1845), which is widespread in the European Miocene North Sea, Proto-Mediterranean Sea and Paratethys, differs from Conilithes canaliculatus (Brocchi, 1814), which is found in the Miocene Paratethys and Proto-Mediterranean and Pliocene Mediterranean, in having beaded early whorls, a narrower spire angle, a slighty coeloconoid spire, with the spire whorls flat to convex as opposed to slightly concave in C. canaliculatus, and the carina on the spire whorls is less sharp and placed higher than in C. canaliculatus. In all specimens of C. canaliculatus seen spiral sculpture of two or more narrow grooves is present below the carina and just below the shoulder on the last whorl, a character not seen in C. dujardini. Conilithes antidiluvianus (Brocchi, 1814) has more strongly beaded spire whorls than C. dujardini, the beading persisting onto the penultimate or last whorls, whereas even in juvenile specimens of C. dujardini it does not. Conilithes antidiluvianus has the most elongate last whorl of these three species and also has irregularly spaced fine and coarse spiral cords at the base. Conus brezinae Hoernes & Auinger, 1879 is considered to be a junior subjective synonym of C. dujardini, although most specimens figured under this name by subsequent authors (Strausz, 1954, 1966; Kojumdgieva & Strachimirov, 1960; Bohn-Havas, 1973) in our opinion represent C. canaliculatus.

The Karaman population of *C. dujardini* tends to have less strongly beaded early whorls, and the beads disappear earlier than in specimens from other assemblages we have compared. The colour pattern of alternating broad light and dark spiral bands is also seen in one of the specimens illustrated by Hörnes (1851, pl. 5, fig. 8b). It is similar to that illustrated for the Romanian Paratethyan specimen by Caze *et al.* (2010, fig. 5N). Distribution - Early Miocene: Paratethys (middle and late Burdigalian): Germany (Steininger, 1973), Austria (Harzhauser, 2002); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1893a). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Denmark (Sorgenfrei, 1958), Netherlands (A.W. Janssen, 1984a), Germany (Kautsky, 1925), Belgium (Glibert, 1952b). Middle Miocene: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Peyrot, 1930, 1931), (Langhian): Loire Basin, France (Glibert, 1952a); Paratethys, Langhian-Serravallian, Austria, (Hörnes, 1851; Hoernes & Auinger, 1879; Tejkal et al., 1967; Schultz, 1998), Poland (Friedberg, 1911; Bałuk, 1970, 1997), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Hoernes & Auinger, 1879; Strausz, 1962, 1966; Bohn-Havas, 1973), Romania (Hoernes & Auinger, 1879; Moisescu, 1955; Chira & Voia, 2001; Caze et al., 2010), Slovenia (Mikuž, 2009), Bosnia (Atanackovič, 1985); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Fischer, 1866; Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (early Tortonian): Antalya Basin, Turkey (İslamoğlu & Taner, 2003).

Synoptic table of shell characters for Conidae found in the Karaman assemblages

In view of the difficulty in identifying cone species, we consider it useful to include a key to the species found in the Karaman deposits. We have concentrated on the characters highlighted by Hendricks (2008; see under family discussion), although we point out that the shape of the subsutural flexure is not as useful for distinguishing between species in the Karaman assemblages as was suggested by Muñiz Solís (1999) for the Estepona assemblage.

species	spire height**	spire whorls	subsutural flexure	relative diameter	colour pattern*	
K. berghausi	medium-low	smooth	asymmetrically curved	wide	2. spiral rows of dots	
K. hungaricus	low	weakly striate	shallow	medium-wide	2. spiral rows of dashes	
L. bitorosus	low	striate	asymmetrically curved	medium	2. spiral rows of dashes and interrupted bands	
M. antiquus	low	striate	asymmetrically curved	elongate	2. narrow vertical flammules	
M. daciae	low	striate	asymmetrically curved	wide	1. axial stripes; 2. blotches	
M. mercati	medium-low	smooth	asymmetrically curved	medium-wide	2. broad bands of irregular blotches	
P. puschi	high	smooth	diagonal	elongate	1. flammules; 2. spiral bands of small, blotches	
V. pelagicus	medium-high	weakly striate- smooth	diagonal	medium	2. spiral lines or dashes and larger blotches	
<i>V. erunalerentoezae</i> nov. sp.	medium	smooth	diagonal	medium-wide	spiral rows of dots of alternate strength	
V. karamanensis	high	smooth	asymmetrically curved	medium	spiral rows of dots	
V. subraristriatus	high	smooth	diagonal	wide	2. spiral lines	
V. taurinensis	high	smooth	asymmetrically curved	medium	2. cross-like blotches	
C. dujardini	high	smooth	symmetrically curved	elongate-medium	2. coalescent spiral bands and dashes	

* Colour pattern: 1. spire, 2. last adult whorl below shoulder.

** Spire height: low RSH < 0.15, medium RSH 0.16-0.19, high RSH > 0.2; relative diameter: elongate RD < 0.6, medium RD 0.60-0.7, wide RD > 0.7.

Table 25. Synoptic table of shell characters for Conidae from the Karaman Basin.

Family Borsoniidae Bellardi, 1875 Genus Asthenotoma Harris & Burrows, 1891

Type species – Pleurotoma meneghinii Mayer, 1868, by original designation. Neogene, Europe.

Asthentoma nov. sp.

Plate 70, fig. 1

Dimensions and material – Height 7.7 mm. Locality 13: NHMW 1847/0058/1515/1.

Discussion – A single small shell from the Akpınar deposits probably represents an undescribed species of Asthenotoma. We refrain from describing it formally, as we are unsure whether this shell represents a full-sized specimen, although with a teleoconch consisting of six whorls it is probably an adult. Apart from its very small size for the genus, the shell is slender and characterised by a globose, smooth paucispiral protoconch comprising less than two whorls (dp = 540 μ m, hp = 490 μ m, dp/hp = 1.1; Pl. 70, fig. 1). The last quarter-whorl bears a few sinuous collabral riblets and the beginning of the teleoconch is marked by the appearance of spiral sculpture. The spiral sculptural component is predominant. It consists of narrow, elevated cords, three on early teleoconch whorls, and with a secondary cord in the interspaces on the last teleoconch whorl below the periphery. The cords override narrow sinous axial ribs, without forming tubercles where they intersect. The siphonal canal is also relatively long compared to its congeners.

The genus Asthenotoma Harris & Burrows, 1891 in the European Neogene was reviewed by Gatto (1997). The Turkish shell is most similar to A. festiva (Hörnes, 1854) from the early and middle Miocene Paratethys and Proto-Mediterranean, but differs not only in being much smaller, but also in having a relatively longer siphonal canal. In A. festiva the protoconch is also paucispiral, but the whorls are higher, weakly convex and covered by a microsculpture of granules. There are also differences in sculpture, especially in the subsutural area. Asthenotoma pannus (de Basterot, 1825) can immediately be distinguished by having a protoconch with 2.5 whorls. It also differs in having broader axial ribs and a prominent, broad subsutural cord. The other Miocene European congeners such as A. tuberculata (Pusch, 1837), A. intersecta (Bellardi, 1877), A. bellardiana Gatto, 1997, A falunica

Peyrot, 1938, *A. ornata* (Defrance, 1826) and the Pliocene species *A. orcianensis* Gatto, 1997 all have coarser, usually tubercular sculpture (see Gatto, 1997).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Bathytoma Harris & Burrows, 1891

Type species – Murex cataphractus Brocchi, 1814, by original designation. Neogene, Europe.

Bathytoma cataphracta (Brocchi, 1814)

Plate 42, fig. 14

- *1814 Murex cataphractus Brocchi, p. 427, pl. 8, fig. 16.
 1829 Pleurotoma cataphracta Brocc. de Serres, p. 112, pl. 2, figs 3, 4.
- 1846 Pleurotoma cataphracta var. Aquensis Grateloup, pl. 20, figs 41, 43, pl. 21, fig. 20.
- 1846 Pleurotoma cataphracta var. Burdigalensis Grateloup, pl. 20, figs 41, 43, pl. 21, fig. 21.
- 1847 *Pleurotoma cataphracta* Brocc. Bellardi, p. 20, pl. 1, fig. 14.
- 1854 Pleurotoma cataphracta Brocc. Hörnes, p. 333, pl. 36, figs 5-9.
- 1856 *Pleurotoma cataphracta* Brocc. Bronn, p. 539, pl. 41, fig. 12.
- 1867 *Pleurotoma cataphracta* Brocchi Pereira da Costa, p. 214, pl. 26, fig. 6.
- 1877 Dolichotoma cataphracta (Brocch.) vars B-D Bellardi, p. 230, pl. 7, figs 20a-d.
- 1880 Dolichotoma cataphracta Brocchi Fontannes, p. 259, pl. 12, figs 32, 33.
- 1890d Dolichotoma cataphracta var. dertogranosa Sacc. – Sacco, p. 279.
- 1891 *Pleurotoma (Dolichotoma) cataphracta* Brocch. Hoernes & Auinger, p. 379, pl. 50, figs 15-22.
- 1896 Bathytoma cataphracta (Brocchi) Cossmann, p. 101, pl. 6, fig. 19, pl. 8, fig. 12, 14.
- 1904 Bathytoma cataphracta (Br.) Sacco, p. 50, pl. 13, figs 21, 22.
- 1904 Bathytoma cataphracta var. apenninica Sacco, p. 50, pl. 13, fig. 23.
- 1912 Bathytoma cataphracta Brocch. Friedberg, p. 224, pl. 14, fig. 5.
- 1914 Bathytoma cataphracta Brocchi Cipolla, p. 134, pl. 13, fig. 1.
- ?1914 Bathytoma cataphracta var. humilis Telegdi-Roth, p. 23, pl. 1, fig. 28.
- 1932 Bathytoma cataphracta var. dertogranosa Sacco Peyrot, p. 16, no. 1279, pl. 8, figs 45, 47.
- 1932 Bathytoma cataphracta mut. burdigalica Peyrot, no. 1280, pl. 8, fig. 50.
- 1932 Bathytoma cataphracta mut. pyrenaica Peyrot, no. 1280, pl. 8, fig. 51.
- 1937 Bathytoma cataphracta (Br.) Montanaro, p. 162, pl. 7, figs 51, 52, 57-60.
- 1937 Bathytoma cataphracta var. taurodenticulata

Montanaro, p. 163, pl. 7, fig. 54.

- 1937 Bathytoma cataphracta nov. var. Montanaro, p. 164, pl. 7, figs 55, 56.
- 1952 Bathytoma cataphracta Brocchi Lecointre, p. 137, pl. 18, fig. 8.
- 1953 *Moniliopsis (Bathytoma) cataphracta orientalis* Csepreghy-Meznerics, p. 16, pl. 3, figs 19-20.
- 1953 Moniliopsis (Bathytoma) cataphracta dertogranosa Sacco – Csepreghy-Meznerics, p. 16, pl. 3, figs 21-22.
- 1955 *Moniliopsis (Bathytoma) cataphracta* (Brocchi 1814) Rossi Ronchetti, p. 329, fig. 177.
- 1958 *Moniliopsis (Bathytoma) cataphracta* (Brocchi) Erünal-Erentöz, p. 107, pl. 16, figs 14-16.
- 1959 Bathytoma cataphracta (Brocchi) Ruggieri & Curti, p. 118, pl. 30, fig. 168.
- 1959 Bathytoma cataphracta Pliodebilis Ruggieri & Curti, p. 119, pl. 29, fig. 167.
- 1960 Bathytoma (Bathytoma) cataphracta var. dertogranosa (Sacco 1890) – Kojumdgieva & Strachimirov, p. 196, pl. 47, figs 4, 5.
- Bathytoma (Bathytoma) cataphracta var. orientalis Meznerics, 1953 – Kojumdgieva & Strachimirov, p. 197, pl. 47, fig. 6.
- 1962 Bathytoma subdenticulata (v. Münster in Goldfuss 1834/40) – Hölzl, p. 195, pl. 10, fig. 12.
- 1962 Moniliopsis (Bathytoma) cataphracta Brocchi Strausz, p. 67, pl. 18, figs 11-15.
- Moniliopsis (Bathytoma) cataphracta orientalis
 Csepreghy-Meznerics Strausz, p. 67, pl. 19, figs
 1-6.
- 1963 Bathytoma cataphracta subdenticulata Münst. Báldi, p. 95, pl. 7, fig. 7.
- 1963 Moniliopsis cataphracta (Br.) Caretto, p. 24, pl. 3, fig. 20.
- 1966 Bathytoma cataphracta (Brocchi, 1814) Powell, p. 63, pl. 9, fig. 13.
- 1966 Moniliopsis (Bathytoma) cataphracta Brocchi, 1814 – Strausz, p. 428, pl. 18, figs 11-15.
- Moniliopsis (Bathytoma) cataphracta orientalis
 Csepreghy-Meznerics, 1953 Strausz, p. 429, pl.
 19, figs 1-6.
- 1967 Epalxis (Bathytoma) cataphracta (Brocchi) Pelosio, p. 164, pl. 46, figs 20-22.
- 1967 *Epalxis (Bathytoma) cataphracta* (Brocchi, 1814) – Palla, p. 1001, pl. 75, fig. 13.
- 1968 Bathytoma cataphracta (Brocchi, 1814) Zelinskaya et al., p. 220, pl. 50, figs 14, 15.
- 1973 Epalxis (Bathytoma) cataphracta (Brocchi), 1814
 Caprotti & Vescovi, p. 180, pl. 3, fig. 19.
- 1973 Bathytoma cataphracta (Brocchi, 1814) Báldi,
 p. 317, pl. 49, fig. 6.
- 1974 Bathytoma (Bathytoma) cataphracta (Brocchi, 1814) – Malatesta, p. 416, pl. 31, fig. 24.
- 1976 *Epalxis cataphracta* (Brocchi) Caprotti, p. 12, pl. 17, fig. 19 (not seen).
- 1978 *Murex cataphractus* Brocchi, 1814 Pinna & Spezia, p. 146, pl. 30, fig. 3.
- 1984 Bathytoma cataphracta (Brocchi) Bernasconi & Robba, p. 297, pl. 6, figs 1, 2.

- 1984 Epalxis (Bathytoma) cataphracta (Brocchi) Ruggieri & Davoli, p. 69, pl. 4, fig. 24.
- 1986 Epalxis (Bathytoma) cataphracta (Brocchi) Martinell & Domènech, p. 119, pl. 1, fig. 9.
- Bathytoma cataphracta (Brocchi, 1814) Chirli,
 p. 24, pl. 11, fig. 16.
- Bathytoma cataphracta (Brocchi, 1814) Davoli,p. 96, pl. 8, fig. 25.
- 1992 Epalxis (Bathytoma) cataphracta (Brocchi, 1814)
 Cavallo & Repetto, p. 130, fig. 345.
- 1992 *Epalxis (Bathytoma) cataphracta* (Brocchi, 1814) – González Delgado, p. 34, pl. 3, figs 4-5.
- 1997 Epalxis cataphracta (Brocchi) Ruiz Muñoz, p. 184, pl. 39, figs 13-14.
- 1997 Bathytoma cataphracta (Brocchi, 1814) Chirli, p. 33, pl. 9, figs 7-9.
- 1998 *Epalxis (Bathytoma) cataphracta dertogranosa* (Sacco) Schultz, p. 76, pl. 31, fig. 7.
- 2002 Bathytoma (Bathytoma) cataphracta (Brocchi, 1814) – Vera-Peláez et al., p. 192, pl. 2, figs G, H, pl. 10, figs E. F.
- 2003 *Bathytoma cataphracta* (Brocchi, 1814) Bałuk, p. 53, pl. 17, figs 2-4.
- 2007 Bathytoma cataphracta (Brocchi, 1814) della Bella & Scarponi, p. 13, figs 1-8.
- 2008 Bathytoma cataphracta (Brocchi, 1814) Chirli & Richard, p. 61, pl. 12, fig. 3.
- 2009 Bathytoma cataphracta (Brocchi, 1814) Zunino & Pavia, p. 359, pl. 2, fig. 2.
- 2010 Bathytoma cataphracta (Brocchi, 1814) Sosso & dell'Angelo, p. 46, unnumbered fig. p. 61 bottom right.
- 2011 Bathytoma cataphracta (Brocchi, 1814) Landau et al., p. 32, pl. 16, fig. 12.
- non 1861 Pleurotoma cataphracta Brocchi Nyst, p. 14, no. 44 [= Bathytoma jugleri (Philippi, 1847)].
- non 1907 Pleurotoma cataphracta Brocchi Ravn, p. 350, pl. 7, fig. 12 [= Bathytoma mioturbida (Kautsky, 1925)].
- non 1925 Bathytoma cataphracta Brocch. Kautsky, p. 179, pl. 11, fig. 33 [= Bathytoma jugleri (Philippi, 1847)].
- non 1937 Bathytoma cataphracta var. dertogranosa Sacco – Montanaro, p. 163, pl. 7, fig. 53 [= Bathytoma pagoda della Bella & Scarponi, 2007].
- non 1956 Bathytoma cataphracta (Brocchi) Rasmussen, p. 91, pl. 9, fig. 3 [= Bathytoma mioturbida (Kautsky, 1925)].
- non 1958 Bathytoma cataphracta (Brocchi) Rasmussen, p. 260, pl. 54, fig. 179 [= Bathytoma mioturbida (Kautsky, 1925)].

Dimensions and material – Maximum height 45.0 mm. Locality 6: JvdV/1; locality 12: RGM 794 555/1 (ex JvdV collection); locality 13: JvdV/4, RGM 783 706/5, YI 422/1. Exact locality unknown: AÜ-LE-K-246/3.

Discussion – The European Miocene species of *Bathy*toma have been recorded by most authors as conspecific with or as subspecies of *Bathytoma cataphracta* (Brocchi, 1814), which was originally described from the Pliocene of Italy. As pointed out by della Bella & Scarponi (2007), this position cannot be supported, as the early-middle Miocene North Sea Basin species *Bathytoma jugleri* (Philippi, 1847) and the late Miocene North Sea Basin species *Bathytoma mioturbida* (Kautsky, 1925) both have protoconchs consisting of five whorls, whereas the protoconch of Pliocene specimens of *B. cataphracta* has only three whorls. The two North Sea Basin species are easily separated from each other by their shape, *B. jugleri* being more slender with a taller spire, and sculpture, which is much finer in *B. jugleri* and the row of nodules at the carina is far less strongly developed.

Having distinguished the North Sea Basin species, the late Oligocene-Pliocene species Bathytoma cataphracta is extremely variable in both shape and sculpture. This variability was illustrated by della Bella & Scarponi (2007, figs 2-4, 6-8). In the Turkish deposits this species is rare and the shells are of the rather broad biconic form, with relatively strongly granular sculpture. Unfortunately the protoconch is not preserved in the Karaman material. Della Bella & Scarponi (2007) described a second species from the Pliocene of Italy, Bathytoma pagoda, which was said to differ from *B. cataphracta* in having a smaller protoconch, also composed of three whorls, in having a more irregular suture, in having a more strongly concave subsutural area and in having a single secondary spiral thread in the interspaces between the primary cords on the last teleoconch whorl as opposed to B. cataphracta, in which most specimens have two threads in each interspace.

Distribution - Late Oligocene: northeastern Atlantic (Chattian): Aquitaine Basin, France (Peyrot, 1932); Proto-Mediterranean, Italy (della Bella & Scarponi, 1984). Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, France (Peyrot, 1932); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1877; Sacco, 1904; Zunino & Pavia, 2009), Mut Basin, Turkey (MH personal observation); Paratethys (Aquitanian): Hungary (Báldi, 1963, 1973). Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Peyrot, 1932); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854; Schultz, 1998), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1962, 1966), Poland (Friedberg, 1912, 1951; Bałuk, 2003), Romania (Hoernes & Auinger, 1891), Ukraine (Zelinskava et al., 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1867); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1877; Sacco, 1890d; Montanaro, 1937; Ruggieri & Davoli, 1984; Davoli, 1990). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Gonzàlez Delgado, 1992; Ruiz Muñoz, 1997; Landau et al., 2011), western Mediterranean, Estepona Basin, Spain (Vera-Peláez et al., 2002), Roussillon Basin, France (Fontannes, 1880; Chirli & Richard, 2008), Morocco (Lecointre, 1954); central Mediterranean, Italy (Bellardi, 1877; Pelosio, 1967; Bernasconi & Robba, 1984; Chirli, 1997). **Earlylate Pliocene**: western Mediterranean, France (Martinell & Domènech, 1986); central Mediterranean, Italy (Bellardi, 1877; Sacco, 1904; Cipolla, 1914; Ruggieri & Curti, 1959; Caretto, 1963; Palla, 1967 ; Caprotti & Vescovi, 1973; Malatesta, 1974; Chirli, 1988; Cavallo & Repetto, 1992, della Bella & Scarponi, 2007; Sosso & dell'Angelo, 2010).

Genus Genota H. Adams & A. Adams, 1853

Type species – Murex mitriformis W. Wood, 1828, by subsequent designation (Fischer, 1883). Recent, West Africa.

Genota rudolfi (Toula, 1901)

Plate 42, figs 15, 16; Plate 70, fig. 2; Plate 82, fig. 9

- *1901 Pleurotoma (Genota) Rudolfi Toula, p. 258, pl. 8, fig. 8.
- 1958 Genota ramosa var. tortonica Toula Erünal-Erentöz, p. 108, pl. 16, figs 17-20 [non Genota tortonica (Peyrot, 1931)].

Dimensions and material – Maximum height 60.0 mm. Localities 2 & 3: JvdV/3, YI 368/4; locality 9: JvdV/5, RGM 783 838/4; locality 12: JvdV/34; locality 13: NHMW 1847/0058/1137/1, 1847/0058/1138/2, 1847/0058/1139/30, JvdV/50+, RGM 777 899/1 (ex JvdV collection), RGM 784 026/1, RGM 783 707-708/50+, MTA TN76/10, YI 366/50+. Exact locality unknown: AÜ-LE-K-247/2.

Discussion - Genota rudolfi (Toula, 1901) has a domeshaped protoconch, consisting of 2.75 convex whorls (dp $= 700 \ \mu m$, hp $= 900 \ \mu m$, dp/hp = 0.78, dV1 $= 340 \ \mu m$, n = 130 μ m; Pl. 70, fig. 2), with the teleoconch boundary sharply defined. The early teleoconch whorls are angular, with the periphery at mid-whorl. It bears about 18 opisthocline axial ribs and 11-12 narrow spiral cords. Abapically the axial sculpture weakens, leaving the ribs strongly developed into tubercles at the shoulder. The spiral sculpture remains narrow, but elevated, and is cut by close-set growth lines, giving the cords a beaded appearance. A colour pattern can be seen under UV light consisting of a spiral band on the sutural ramp and two broad spiral bands on the last teleoconch whorl below the shoulder (Pl. 82, fig. 9). There are also small spots at the intersections of the axial and spiral elements. This species is found almost exclusively in the clavey Karaman assemblages.

The genus *Genota* is speciose in the European Neogene and both protoconch and teleoconch characteristics are required to separate species reliably. *Genota rudolfi* (Toula, 1901) is similar to *Genota bonnani* Bellardi, 1877 from the Mediterranean Pliocene, but differs in having a lower protoconch (dp/hp = 0.78 vs. dp/hp = 0.92), in having more numerous spiral cords on the spire whorls, in having the tubercles at the shoulder slightly less strongly developed, and in lacking the rugae developed on the last

teleoconch whorl (see della Bella & Scarponi, 2007, figs 131-134). Genota ramosa (de Basterot, 1825) from the early Miocene Aquitaine Basin of France is more slender, with a higher, more stepped spire, with the suture more oblique and with more numerous axial ribs and therefore more numerous, smaller tubercles at the shoulder. Genota domenechae Vera-Peláez & Lozano Francisco, 2001 from the early Pliocene of Estepona is immediately distinguished by its paucispiral protoconch and weaker sculpture. Genota lusitanae Vera-Peláez & Lozano Francisco (2001) from the Atlantic early Pliocene of Spain is closely similar to G. bonnani and further detailed comparison is required to conclude whether the two are indeed distinct (see Landau et al., 2011, p. 33). Genota pliocraverii Vera-Peláez & Lozano Francisco (2001), also from the Atlantic early Pliocene of Spain was based on shells similar to G. bonnani, but rather squatter, with more strongly developed tubercles at the shoulder and stronger spiral sculpture. Genota craverii Bellardi, 1877 from the late Miocene Proto-Mediterranean of Italy is the most closely similar species to G. rudolfi, but differs in having fewer tubercles at the shoulder (10-14; Bellardi, 1877, p. 86, vs. about 18 in G. rudolfi). It is possible that the two are conspecific, but in view of the high endemicity of the genus and the absence of information regarding the protoconch of G. craverii, we prefer to keep them as distinct species.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Toula, 1901; Erünal-Erentöz, 1958).

Genota pseudoelisae nov. sp.

Plate 43, figs 1, 2; Plate 70, fig. 3; Plate 82, fig. 8

Materialand dimensions – Holotype NHMW 1847/-0058/1143, height 42.0 mm; paratype 1 NHMW 1847/0058/1144, height 39.5 mm; paratype 2 NHMW 1847/0058/1603, height 41.9 mm; paratype 3 NHMW 1847/0058/1604, height 37.5 mm; paratype 4 NHMW 1847/0058/1605, height 42.6 mm; paratype 5 NHMW 1847/0058/1606, height 43.2 mm; paratype 9 RGM 783 803, height 43.0 mm; furthermore two specimens in YI 486, height 42.0 mm and YI 487, height 38.2 mm; all locality 17. Paratype 6 RGM 784 025 (juvenile); paratype 7 RGM 777 898 (ex JvdV collection), height 28.5 mm; localities 7 & 8. Paratype 8 RGM 783 940, localities 2 & 3.

Other material and dimensions – Maximum height 42.6 mm. Localities 2 & 3: JvdV/10, RGM 783 946/1 fragment, YI 372/6; locality 6: JvdV/2; localities 7 & 8: NHMW 1847/0058/1140/1, JvdV/17, RGM 783 892/8; locality 11: RGM 794 025/3; locality 13: NHMW 1847/0058/1140/1, YI 373/1 (incomplete); locality 17: 1847/0058/1145/3, JvdV/3, RGM 783 929/2 fragments, YI 367/4.

Etymology – Name reflecting the close similarity, but not conspecificity, with *Genota elisae* (Hoernes & Auinger, 1891).

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A species of *Genota* with a rather short spire, with a multispiral protoconch bearing axial riblets on the last half-whorl, with angular whorls with a concave, almost smooth sutural ramp delimited by a sharp, tubercular, ridge-like shoulder, with fine sculpture, predominantly axial on early teleoconch whorls, weakening abapically, sculpture of equal strength on last whorl and with a shallow, broad anal sinus.

Description - Shell fusiform, spire relatively short for genus. Protoconch multispiral, tall, consisting of 3.25 convex whorls, last half-whorl bearing sharp axial riblets (dp = 970 μ m, hp = 1900 μ m, dp/hp = 0.51, dV1 = 520 μ m, n = 270 μ m; Pl. 70, fig. 3). Teleoconch of 6-7 angular whorls with broad, weakly concave, steeply sloping sutural ramp, delimited by sharp, tuberculate shoulder, whorl almost straight-sided below shoulder. Suture linear, weakly impressed. Axial ribs present only below shoulder, close-set, opisthocline. Spiral sculpture on sutural ramp subobsolete, below shoulder consisting of close-set narrow cords, each roughly equal in width to one interspace, crossing axial ribs, axial and spiral elements of nearly equal strength on last whorl. Last whorl 71-74% of total height, sutural ramp concave, shoulder nodular, whorl weakly convex below, slightly constricted at base. Aperture elongate, 54-58% of total height, outer lip simple, convex in profile. Anal sinus broad, relatively shallow, apex at lower third of sutural ramp. Siphonal canal relatively long, open, slightly twisted. Columella almost straight, smooth. Columellar callus very weakly developed and expanded. Colour pattern seen only under UV light, of large blotches on sutural ramp and rows of irregular blotches on last whorl (Pl. 82, fig. 8).

Discussion – This species resembles *Genota valeriae* (Hoernes & Auinger, 1891). However, the latter, a Miocene Paratethyan species, differs in its distinctly more slender shell and higher spire. Its shoulder is weaker and the sculpture is finer. Bałuk (2003) synonymised the French Atlantic Serravallian specimens described as *Genota ramosa* var. *tortonica* by Peyrot (1931, pl. 1, fig. 32) with *G. valeriae*. However, Peyrot's single illustration shows a shell somewhat squatter than those illustrated by Bałuk (2003, pl. 18, figs 4-6) and the carina on the last teleoconch whorl is not as sharp.

The overall outline of *G. pseudoelisae* nov. sp., with a rather stout and gradate spire is comparable with *Genota stephaniae* (Hoernes & Auinger, 1891), which also develops very similar sculpture. A clear difference between *G. stephaniae* and the Turkish species is the profile of the early teleoconch whorls, which are rather convex than angulate and very low in *G. stephaniae*. Another closely similar species is *Genota elisae* (Hoernes & Auinger, 1891), also from the middle Miocene Paratethys, but it

differs in having an even more stepped spire, an even more concave sutural ramp and far stronger tubercles at the shoulder. The protoconch preserved on one specimen from Várpalota, Hungary (NHMW collection) consists of three whorls and is similar in shape to that of *G. pseudoelisae* nov. sp., but does not have axial riblets on the last half-whorl. Moreover, the specimen illustrated by Hörnes (1854, pl. 36, fig. 13a) as *Pleurotoma ramosa* Bast. [*non Genota ramosa* (de Basterot, 1825)], later described as *Genota elisae* by Hoernes & Auinger (1891, p. 310), has a much deeper and narrower anal sinus than does *G. pseudoelisae*.

In the Karaman assemblages Genota pseudoelisae nov. sp. is found in most of the fully marine assemblages, although it is not common. It is easily distinguished from Genota rudolfi (Toula, 1901) by its smaller shell, taller protoconch with an extra half-whorl bearing axial riblets, in having a more stepped spire and the tubercles at the shoulder elongated, almost forming a ledge. Genota pseudoelisae nov. sp. is also very similar to Genota mayeri Bellardi, 1877 from the late Miocene Proto-Mediterranean of Italy (syntype figured by Fererro Mortara et al., pl. 10, fig. 5), but this species is only half the size of G. pseudoelisae and the axial sculpture is far more subdued. It is likely both G. pseudoelisae and G. rudolfi (discussed above) are endemic to the Karaman Basin, and that each of the European Neogene Basins has its own endemic Genota species, differing subtly in protoconch and teleoconch characters.

Distribution – Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Microdrillia Casey, 1903

Type species – Pleurotoma cossmanni Meyer, 1887, by subsequent designation (Cossmann, 1906). Eocene, USA.

Microdrillia teretiaeformis A.W. Janssen, 1972 Plate 43, fig. 3; Plate 70, fig. 4

- ?1938 Drillia crispata (Jan) Friedberg, p. 146, text-fig.47.
- ?1960 Drilla? crispata Jan, 1832 Kojumdgieva & Strachimirov, p. 202, pl. 48, fig. 11.
- *1972 Microdrillia teretiaeformis A.W. Janssen, 1972, p. 44, pl. 10, fig. 6, pl. 11, fig. 1.
- 1984a Microdrillia teretiaeformis A.W. Janssen, 1972 –
 A.W. Janssen, p. 299, pl. 12, figs 12, 13, pl. 71, pl. 12.
- ?2003 Microdrillia crispata (de Cristofori & Jan, 1832) Bałuk, p. 52, pl. 17, figs 5-7.
- 2007 Microdrillia aff. serratula (Bellardi, 1878) R. Janssen & Wienrich in Wienrich, p. 684, pl. 112, fig. 1, pl. 146, figs 6, 7.
- 2007 Microdrillia teretiaeformis A.W. Janssen, 1972
 R. Janssen & Wienrich in Wienrich, p. 685, pl. 112, fig. 2, pl. 146, fig. 8.

Dimensions and material – Maximum height 11.1 mm. Locality 13: NHMW 1847/0058/1146/1, 1847/0058/1147/2, JvdV/3, RGM 784 073/1, YI 418/1.

Discussion – The shells from Karaman are not conspecific with Microdrillia crispata (de Cristofori & Jan, 1832) from the Pliocene Mediterranean. The protoconch of the Pliocene shells is dome-shaped (hp/dp = 0.8-1.0, see Bernasconi & Robba, 1984, pl. 1, figs 5-6; della Bella & Scarponi, 2007, figs 111, 115), consisting of 5-4.75 convex whorls. The sculpture consists of close-set, opisthocline, comma-shaped riblets and very fine spiral threads. The protoconch of the Turkish shells is composed of the same number of whorls, but much taller (hp/dp = 1.2; Pl. 70, fig. 4) and more pointed. The whorls are not regularly convex, but flat-sided, angulated abapically at their periphery and the comma-shaped riblets are less dense. It is difficult to identify any constant differences in the teleoconch between the two, as *M. crispata* is quite variable, but in the Turkish shells the number of primary spiral cords below the shoulder is slightly greater than in M. crispata.

The character of the protoconch places the Turkish shells closer to *Microdrillia teretiaeformis* A.W. Janssen, 1972, which was described from the late Burdigalian-Langhian North Sea Basin. We (BL) have compared the Turkish shells with *M. teretiaeformis* from the Zonderschot Sand Member of Antwerp, Belgium and find the protoconch characters indistinguishable. The teleoconch of the North Sea Basin shells tends to have the last teleoconch whorl less strongly carinate, but in the Zonderschot shells this is variable.

Microdrillia teretiaeformis has been recorded fairly widely in the middle Miocene Paratethyan assemblages as *M. crispata*. The protoconch has never been illustrated, however, careful examination of the specimens illustrated by Bałuk (2003, pl. 17, figs 5-7) suggests that it has a tall carinate protoconch, much more in keeping with that of the Turkish shells. Moreover, the number and disposition of the cords below the shoulder on the last teleoconch whorl resembles the Turkish shells illustrated here.

Protoconchs are rarely preserved in the material that was considered to be *M. crispata* by Hoernes & Auinger (1891, pl. 42, figs 7-10). One specimen, however, has a moderately tall protoconch with more convex whorls and low pointed initial part, differing distinctly from that of the Turkish shells. The Viennese shells are thus most probably different from *M. teretiaeformis*. Without information on protoconchs, it is difficult to evaluate the various other records from the Paratethys.

Microdrillia serratula (Bellardi, 1877) from the early Miocene of Italy, but also recorded from the middle Miocene Paratethys (Hoernes & Auinger, 1891, p. 325, pl. 42, fig. 1) and *M. adelae* (Hoernes & Auinger, 1891) differ in developing tubercles on the carina. These and numerous other species described by Bellardi (1877) are in need of revision.

Distribution – **Early-middle Miocene**: North Sea Basin (late Burdigalian-Langhian): Netherlands (A.W. Jans-

sen, 1984a), Germany (?Anderson, 1964; A.W. Janssen, 1972; R. Janssen & Wienrich *in* Wienrich, 2007). **Middle Miocene**: Paratethys (Langhian-Serravallian): ?Poland (Friedberg, 1928; Bałuk, 2003); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Clathurellidae H. Adams & A. Adams, 1858 Genus *Clathurella* Carpenter, 1857

Type species – Clavatula rava Hinds, 1843, by subsequent designation (opinion 666 ICZN, 1963). Tropical western America.

Clathurella casilorica Boettger, 1906

Plate 43, figs 4-5; Plate 70, fig. 5

- *1906 *Clathurella casilorica* Boettger, p. 68, no. 262.
- 1934 Clathurella casilorica Boettger Zilch, p. 272, pl. 21, fig. 90.
- 2003 Clathurella casilorica Boettger, 1906 Bałuk, p. 65, pl. 25, fig. 8.

Dimensions and material – Maximum height 9.6 mm. Locality 17: NHMW 1847/0058/1148/1, 1847/0058/1149/1, 1847/0058/1150/2, JvdV/3, RGM 783 243/3, YI 376/1.

Discussion - Clathurella casilorica Boettger, 1906 is characterised by its rather convex whorls, its sculpture of very broad, rounded axial ribs, nine on the penultimate whorl, and by narrow, close-set, flattened spiral cords. The protoconch is preserved on one specimen, and is typical of the genus (see Bernasconi & Robba, 1984; della Bella & Scarponi, 2007), tall, multispiral, about four whorls, with the last two whorls carinate (Pl. 70, fig. 5a) and with the pustular microsculpture, also characteristic of the genus (Pl. 70, fig. 5b). Boettger (1902, 1906) described several similar Clathurella species from the middle Miocene Paratethys of Romania, such as C. annamariae Boettger, 1902, C. postuma Boettger, 1906 and C. undatolirata Boettger, 1902, which all differ in having stronger spiral sculpture. Most of the Italian Pliocene Clathurella species revised by Bernasconi & Robba (1984) and della Bella & Scarponi (2007) are taller, less solid and more slender than C. casilorica, with the exceptions of C. ringens (Bellardi, 1847) and C. spreafici Bellardi, 1877 (= C. albigonensis Bellardi, 1877), which can be separated by their much stronger spiral sculpture.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 2003), Romania (Boettger, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Clathurella pouweri nov. sp.

Plate 43, figs 6-8

Type material – Holotype NHMW 1847/0058/1151, height 19.2 mm; paratype 1 NHMW 1847/0058/1152, height 14.7

mm; paratype 2 NHMW 1847/0058/1153, height 14.4 mm; paratype 3 NHMW 1847/0058/1154, height 14.5 mm; paratype 4 NHMW 1847/0058/1155, height 14.7 mm; paratype 5 RGM 783 845, height 12.9 mm.

Other material and dimensions – Maximum height 15.3 mm. Localities 2 & 3: JvdV/1; localities 7 & 8: NHMW 1847/0058/1157/4; locality 13: NHMW 1847/0058/1156/17.

Etymology – Named for Ronald Pouwer, collection manager fossil Mollusca at Naturalis, Leiden (The Netherlands), in recognition of his great help and support in this project.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tirtar Formation, Serravallian, middle Miocene.

Diagnosis – A small to medium-sized species of *Clathurella* with a carinate multispiral protoconch covered in a lattice-work microsculpture, strongly angular, depressed teleoconch whorls with a broad sutural ramp, sculpture of ten axial ribs and three primary spiral cords on each spire whorl, a broad biangular last teleoconch whorl, strongly thickened outer lip with a strong tubercle abapically and a strong parietal tooth on the columella.

Description -Shell small to medium-sized, with stepped spire. Protoconch multispiral, of four whorls, last two whorls bearing a sharp carina mid-whorl strengthening abapically, nucleus small. Whole protoconch surface covered with delicate lattice-work diagonal microsculpture. Transition with teleoconch marked by beginning of spiral sculpture. Teleoconch of six broad, sharply angular whorls, with broad, shallow, slightly concave sutural ramp, convex below shoulder to the suture. Suture superficial, undulating. Axial sculpture of ten weakly opisthocline, elevated, rounded ribs, weakening over sutural ramp towards adapical suture. Spiral sculpture of three narrow, elevated primary cords on spire whorls, adapical cord at shoulder angle, with numerous secondary threads on sutural ramp and one secondary cord in each interspace below shoulder. Last teleoconch whorl 63% of total height, with broad, shallow sutural ramp, sharply anguled at shoulder, central portion depressed, base strongly constricted. Aperture ovate, outer lip strongly thickened by labial varix, bearing strong, rounded adapical tooth internally and several weaker elongate denticles below. Anal sinus rounded, very deep, located against suture. Siphonal canal short, open, posteriorly recurved. Columella straight. Columellar and parietal calluses not thickened or expanded, sharply delimited, with one strong rounded parietal tooth.

Discussion – Clathurella pouweri nov. sp. is very similar to *Clathurella juliana* (Hörnes, 1854) from the middle Miocene Paratethys of Austria (Fig. 27). *Clathurella ju*- *liana* has not been figured since its original description, and we take the opportunity here to illustrate a syntype and a second specimen from the same locality. The new species differs from *C. juliana* in having a broader shell, with a wider sutural ramp, and in having slightly more numerous axial ribs (10 vs. 8 on the penultimate whorl). The protoconch of *C. pouweri* with its carina on the last two whorls and very delicate lattice-work microsculpture is fairly typical of the genus, as illustrated by della Bella & Scarponi (2007, figs 29, 33, 37, 41, 45, 49, 61). Unfortunately, the first protoconch whorl is missing on all specimens.



Figure 27. Clathurella juliana (Hörnes, 1856), Steinabrunn, Vienna Basin, Austria, Badenian, Middle Miocene. 1. Syntype NHMW 1846/0037/0347, height 22.3 mm; 2. Specimen NHMW 1846/0037/0347, height 22.7 mm

Clathurella fuchsi Bellardi, 1877 from the late Miocene Tortonian of Italy is also similar, but has even fewer axial ribs and its sutures are more constricted. Many other *Clathurella* species occur in the European Neogene, but they are all distinguished by their more rounded whorls and steeper sutural ramp, except *Clathurella scalaria* (de Cristofori & Jan, 1832) from the Mediterranean early Pliocene, which also has a broad, shallow sutural ramp, but differs in having a much sharper peripheral carina and quite different sculpture, consisting of narrow axial ribs and sharper, wider-spaced spiral cords.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Clathurella sp. Plate 43, fig. 9

Dimensions and material – Height 12.0 mm. Locality 13: NHMW 1847/0058/1158/1.

Discussion – This species is represented in the Karaman assemblages by a single specimen from the Akpınar deposits. The protoconch is incomplete, but consists of at least three whorls, the second whorl with some sculptural remnants including a medial cord; the last protoconch whorl is carinate. This type of protoconch would place it in the genus Clathurella Carpenter, 1857. Although Powell (1966, p. 116) in his generic description said the protoconch was unknown, at least in all the Italian Pliocene Clathurella species the protoconch is multispiral and highly ornate; protoconch I covered with micropustules, protoconch II bearing a central cord and axial riblets below the cord, the last whorl strongly carinate, in some species also with micropustules (see Scarponi & della Bella, 2007). The teleoconch consists of 6.5 strongly convex, biangulate whorls. The sculpture consists of eight very broad, prosocline, rounded axial ribs crossed by two prominent cords on the early whorls. A third cord forms adapically on the third teleoconch whorl and a single secondary cord appears in the interspaces abapically, the cords being swollen over the ribs. The sutural ramp is shallow, concave and smooth. The apertural characters are typical of the genus. This species is distinguished from most of its congeners by the absence of spiral sculpture on the sutural ramp. Unfortunately, the single Karaman shell is too worn to make a definitive identification, but it is closely similar to the early Pliocene Mediterranean species Clathurella sereventii (Pelosio, 1967), which also has weak sculpture on the sutural ramp, although in the Karaman shell it is even weaker.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Pleurotomoides Bronn, 1831

Type species – Defrancia pagoda Millet, 1827, by subsequent designation (Dall, 1908). Miocene, France.

Pleurotomoides aff. strombillus (Dujardin, 1837)

Plate 43, fig. 10; Plate 70, fig. 6

Dimensions and material – Maximum height 19.2 mm. Localities 7 & 8: NHMW 1847/0058/1159/2, RGM 783 241/1; locality 13: NHMW 1847/0058/1385/1.

Discussion – The beautifully preserved shell illustrated here has a teleoconch very similar to that of *Pleurotomides strombillus* (Dujardin, 1837) (see Glibert, 1954, pl. 7, fig.1). *Pleurotomides strombillus* is fairly widely distributed in the European Neogene, present in the Atlantic middle Miocene Langhian of France (Glibert, 1954), the middle Miocene Paratethys (Hörnes, 1854; Friedberg,

1912, 1928; Csepreghy-Meznerics, 1953, 1954; Strausz, 1966; Schultz, 1998; Bałuk, 2003) and the late Miocene Tortonian of Portugal (Pereira da Costa, 1867). The protoconch of P. strombillus was illustrated by Glibert (1954, pl. 1, fig. 20) showing a rather flattened paucispiral protoconch, with a strong carina on the second whorl. The protoconch in the Turkish specimen is also paucispiral, consisting of two whorls, but the first whorl is tall and bulbous, the second carinate (dp = 470 μ m, hp = 715 μ m, dp/hp = 0.66, dp1 = 360 μ m, dn = 145 μ m; Pl. 70, fig. 6). We have not seen any specimens of P. strombillus with a protoconch, but hesitate to say the Karaman specimen is are conspecific with Glibert's specimen when they show such clear differences in protoconch morphology. Further differences, at least when compared with specimens of *P. strombillus* from the Paratethys, is the shorter last whorl of the Karaman specimen, which is more constricted at the base, and the thicker outer lip, which bears distinct denticles.

Another closely similar species is *Clathurella densestriata* Boettger, 1906. However it has with fewer axial ribs and, judging from the small figure in Zilch (1934, pl. 21, fig. 91), a different, multispiral protoconch, and therefore *C. densestriata* should not be referred to *Pleurotomoides*.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Pleurotomoides isabelae nov. sp. Plate 44, figs 1; Plate 70, fig. 7.

Dimensions and type material – Holotype NHMW 1847/0058/1507, height 8.2 mm, width 3.4 mm.

Other material – Known only from the holotype.

Etymology – For Isabel Donders, enthusiastic naturalist and friend of the first author.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum –Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small to medium-sized species of *Pleurotomoides* with a paucispiral protoconch, a teleoconch with eight broad, rounded axial ribs crossed by fine spiral sculpture, a relatively small aperture with weak denticulation within and a short siphonal canal.

Description – Shell small to medium-sized, turriform, spire scalate. Protoconch paucispiral, of 1.75 convex whorls, with large, bulbous nucleus (dp = $600 \ \mu$ m, hp = 780 μ m, dp/hp = 0.77), nucleus bearing micropustules, last half-whorl bearing carina mid-whorl. Transition with teleoconch marked by deeply sinuous, prosocline scar. Teleoconch of six moderately angular whorls, with broad sutural ramp sloping at 45°, convex below, with periphery

mid-whorl. Suture superficial, undulating. Axial sculpture of eight elevated, broad, rounded ribs, each roughly equal in width to one interspace. Spiral sculpture, which overrides axial ribs, of three primary cords, adapical cord at shoulder angle. Several close-set, weaker spiral cords on sutural ramp. On fourth whorl, single secondary cord develops in each interspace below shoulder. Last whorl 54% of total height, moderately angled at shoulder, constricted at base, bearing eight broad axial ribs and fine spiral sculpture, primary and secondary spiral cords of almost equal strength. Aperture 39% of total height, small, ovate. Outer lip strongly thickened by varix, without denticles within. Anal canal well-developed, broad, moderately deep. Siphonal canal relatively short, open, slightly recurved. Columella smooth except for weak parietal tooth.

Discussion - The genus Pleurotomoides Bronn, 1831 is characterised by Glyphostoma-like shells, but without apertural processes. The protoconch is paucispiral, of 2-2.5 whorls, with a strong submedial carina developing on the second whorl (Powell, 1966, p. 119). Pleurotomoides isabelae nov. sp. is most closely similar to P. hordaceus (Millet, 1826) from the late Miocene Messinian of the Loire Basin, France, but differs in having a much larger first protoconch whorl. The teleoconch whorls in P. hordaceus have ten axial ribs, which are weaker than those of P. isabellae nov. sp., and the early whorls have only two primary cords below the shoulder, whereas in P. isabelae there are three. The sutural ramp in the French species is steeper and the spiral sculpture on the last teleoconch whorl is coarser, with a greater difference in strength between the primary and secondary cords and, finally, in *P. hordaceus* the cords on the base are deeply cut by growth lines, giving them a beaded appearance not seen in the Turkish shell.

The Atlantic middle and late Miocene French Loire Basin assemblages are rich in Pleurotomoides species. Pleurotomoides pagoda (Millet, 1827) and P. fascinellus (Dujardin, 1837) are immediately distinguished by their much coarser sculpture and strongly scalate whorls. Pleurotomoides milleti (Millet, 1827) is closer in shape to P. strombillus (Dujardin, 1837), with rounded whorls, a longer siphonal canal and reticulate sculpture mid-whorl on the last teleoconch whorl. Pleurotomoides variabilis (Millet, 1827) has more rounded ribs, a longer siphonal canal, narrower and closer-set axial ribs and coarser spiral sculpture. Pleurotomoides lecointrei Brébion, 1964 (unpublished name) is smaller, also with a short siphonal canal for the genus, but with coarser spiral sculpture. Pleurotomoides strombillus is larger, with much finer axial sculpture and quite a differently shaped aperture (see below).

Whilst common in the French Miocene deposits, apart from *Pleurotomoides strombillus*, all the Paratethyan shells with similar teleoconch characters have multispiral protoconchs and are here located in *Clathurella* Carpenter, 1857. Although we are aware that protoconch-type alone is not a valid generic character, the same holds true for the Mediterranean Pliocene species, which have been placed in *Pleurotomoides* by many authors (*i.e. Pleuro-toma scalaria* de Cristofori & Jan, 1832, *Pleurotomoides serventii* Pelosio, 1967, *Pleurotomoides littoralis* Vera-Peláez, 2002), as all have multispiral protoconchs.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Pleurotomoides sp.

Plate 44, fig. 2; Plate 71, fig. 1

Dimensions and material – Maximum height 6.2 mm. Locality 17: NHMW 1847/0058/1518/1, JvdV/5.

Discussion - Half a dozen small turrids occur in the Seyithasan assemblage representing a species with a paucispiral protoconch, which we have placed in the genus Pleurotomoides. We are uncertain whether the shells are fully grown, as they are very similar to the early whorls of Pleurotomoides isabelae nov. sp., but have a wider apical angle. These small shells may well represent juvenile specimens of P. isabelae, but without intermediate specimens we cannot be sure. They are also similar to early whorls of Pleurotomoides aff. strombillus (Dujardin, 1837) described above. However, the first teleoconch in P. aff. strombillus has a wide, steep sutural ramp followed by two primary spiral cords, whereas Pleurotomoides sp. has three spiral cords on the first teleoconch whorl. On subsequent whorls the sutural ramp in Pleurotomoides sp. becomes shallower, whereas in P. aff. strombillus it continues to be steep. Pleurotomoides sp. has fewer broader axial ribs than P. aff. strombillus and a proportionally broader last teleoconch whorl, which is far more constricted at the base.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Mangeliidae Fischer, 1883 Genus *Agathotoma* Cossmann, 1899

Type species – Mangelia angusta Bellardi, 1847, by monotypy. Neogene, Europe.

Agathotoma angusta (Bellardi, 1847)

Plate 44, fig. 3

- *1847 *Raphitoma angusta* Jan (*Pleurotoma*) Bellardi, p. 103, pl. 4, fig. 25.
- 1877 Mangelia (Ditoma) angusta (Jan) Bellardi, p. 295, pl. 8, fig. 40.
- 1896 Mangelia (Ditoma) angusta Jan Cossmann, p. 125, pl. 7, figs 29, 30.
- 1910 Mangilia [sic] (Agathotoma) angusta Jan Cerulli-Irelli, p. 248, pl. 5, figs 20, 21.
- 1914 Mangilia [sic] (Agathotoma) angusta Jan Cipolla, p. 148, pl. 13, fig. 19.
- 1937 Mangelia costata var. angusta (Jan) Montanaro,

p. 173, pl. 8, fig. 9.

- 1960b *Mangelia (Agathotoma) angusta* Jan Glibert, p. 27, pl. 5, fig. 11.
- 1966 Agathotoma angusta (Jan in Bellardi, 1848) Powell, p. 99, pl. 15, fig. 15.
- 1974 Agathotoma angusta (Jan, in Bellardi, 1848) Malatesta, p. 431, pl. 32, fig. 10.
- 1975 Agathotoma angusta (Jan) Pavia, p. 113, pl. 8, fig. 21.
- 1992 *Mangelia angusta* (Jan, 1842) Cavallo & Repetto, p. 142, fig. 385.
- 1997 Agathotoma angusta (Jan in Sismonda, 1842) Chirli, p. 58, pl. 16, figs 4-7.
- 2002 Agathotoma angusta (Jan in Sismonda, 1842) Vera-Peláez, p. 206, pl. 4, figs I, J.
- 2010 Agathotoma angusta (Jan, 1842) Sosso & dell'Angelo, p. 47, unnumbered fig. p. 63 top centre.
- 2010 Agathotoma angusta (Bellardi, 1847) Scarponi & della Bella, p. 81, figs 193-200.

Dimensions and material – Height 6.8 mm. Localities 2 & 3: NHMW 1847/0058/1160/1.

Discussion – There is little to add to the discussion by Scarponi & della Bella (2010, p. 82) on this very characteristic little turrid. The protoconch is damaged in the Turkish shell and only the last protoconch whorl remains, but it shows the very characteristic arcuate riblets typical of the species (see Scarponi & della Bella, figs 193, 197). *Raphitoma angusta* Jan *in* Sismonda, 1842 is a *nomen nudum* (Tucker, 2004).

Distribution - Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1877). Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic, Messinian, Loire Basin, France (Glibert, 1960b); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1877; Montanaro, 1937). Early Pliocene: western Mediterranean, Estepona Basin, Spain (Vera-Peláez, 2002); central Mediterranean, Italy (Bellardi, 1877; Pavia, 1975; Cavallo & Repetto, 1992; Chirli, 1997; Scarponi & della Bella, 2010). Early-late Pliocene: western Mediterranean, France (Cossmann, 1896); central Mediterranean, Italy (Sacco, 1904; Cipolla, 1914; Powell, 1966; Malatesta, 1974; Sosso & dell'Angelo, 2010; Scarponi & della Bella, 2010). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1910).

Agathotoma perforata (Brusina, 1877) Plate 71, fig. 2

- 1854 Pleurotoma caerulans Phil Hörnes, p. 377, pl. 40, fig. 19 (non Philippi 1844 = Mangelia striolata Risso, 1826).
- 1870 Mangilia Hörnesi Brusina, p. 213 (replacement name for Pleurotoma caerulans in Hörnes, 1854).
- *1877 Raphitoma (Mangelia) perforata Brusina, p. 377

(replacement name for *Pleurotoma caerulans* in Hörnes, 1854, but not *Pleurotoma coerulans* Philippi, 1844, and for *Mangilia hörnesi* Brusina, 1870, not *Pleurotoma hoernesi* Deshayes, 1865).

- 1902 Mangilia [sic] detmersiana Boettger, p. 69, no. 232.
- 1906 Mangilia [sic] detmersiana Bttgr. Boettger, p. 79, 294.
- 1912 Mangelia Monterosati Bell. Friedberg, p. 227, pl. 14, fig. 9 (non Bellardi, 1877).
- 1931 Mangelia perforata Brusina Peyrot, pl. 7, figs 47-49.
- 1932 Mangelia perforata Brusina Peyrot, p. 31.
- 1934 Cythara (Mangelia) detmersiana (Boettger) Zilch, p. 264, pl. 19, fig. 49.
- 2003 *Cythara (Mangelia) perforata* (Brusina, 1877) Bałuk, p. 59, pl. 20, figs 9.

Dimensions and material – Height 3.6 mm. Localities 17: NHMW 1847/0058/1343/1.

Discussion – The first available name for this species is *Mangilia hoernesi* Brusina, 1870. However, Brusina, 1877, seemed not to accept the validity of the name when he proposed *Raphitoma (Mangelia) perforata* Brusina, 1877. The name *hoernesi* has not been used as a valid name since its introduction, whereas *perforata* has been used on numerous occasions (Tucker, 2004). We therefore consider *Mangilia hoernesi* Brusina, 1870 a *nomen oblitum*.

This species belongs to Agathotoma, which differs from Mangelia in having a much heavier labial varix, a much deeper anal sinus and a much shorter siphonal canal. The Turkish shell is characterised by having few, widely spaced axial ribs (7 on the last whorl) and very fine, dense, microscopic spiral threads covering the whole whorl surface. The protoconch is not well-preserved, but consists of a least 3.5 convex whorls, the last whorl somewhat shouldered and bearing axial riblets towards the teleoconch boundary (Pl. 71, fig. 2c). This is quite similar to the protoconch illustrated by Scarponi & della Bella (2010, fig. 193) for Agathotoma angusta (Bellardi, 1847). The shell from the Karaman deposits is closely similar to that illustrated by Bałuk (2003, pl. 20, figs 9) from the middle Miocene of Kostej, Romania. Agathotoma paulae (Boettger, 1902), also from the Kostej deposits, is also closely similar, but seems to be rather more slender, with a greater number of axial ribs. The type species, A. angusta (Bellardi, 1847) from the middle Miocene to early Pleistocene of Italy differs in having a far greater number of axial ribs (14-15 on the last teleoconch whorl). Agathotoma pherousae (Glibert, 1960) from the Atlantic middle Miocene of the Loire Basin, France, has fewer axial ribs than A. angusta (9-10 on the last teleoconch whorl), but still a greater number than seen in the Turkish shell. Agathotoma brandenbergi (Boettger, 1902) and A. subreticulata (Boettger, 1902), both from the middle Miocene Paratethys of Romania, differ in having a more obvious spiral sculpture composed of cords rather than fine dense threads, and probably do not belong within the same A. angusta phylogenetic group.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Peyrot, 1931, 1932). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Peyrot, 1931, 1932); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1854), Poland (Friedberg, 1912; Bałuk, 2003), Romania (Boettger, 1902, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Bela Gray, 1847

Type species – Murex nebula Montagu, 1803, by subsequent designation (Gray, 1847). Recent, Europe.

Bela halavatsi (Boettger, 1902)

Plate 44, fig. 4; Plate 71, fig. 3

- *1902 *Rhaphitoma* [sic] (*Ginnania*) *halavatsi* Boettger, p. 80, no. 251.
- 1906 Rhaphitoma [sic] (Ginnania) halavatsi Bttgr. Boettger, p. 87, no. 319.
- 1934 *Cythara (Mangelia) halavatsi* (Boettger) Zilch, p. 268, pl. 20, fig. 69.
- 2003 Bela halavatsi (Boettger, 1901 [sic]) Bałuk, p. 61, pl. 24, figs 1-3.

Dimensions and material – Maximum height 4.3 mm. Locality 17: NHMW 1847/0058/1161/1, JvdV/5, RGM 784 079/2.

Discussion - This small species of Bela is characterised by its claviform shell shape, predominant, weakly flexuose axial ribs and short siphonal canal. The spiral sculpture is weak, overrunning the axial ribs, with the interspaces crowded with very fine spiral threads (Pl. 71, fig. 3e). The protoconch is flattened dome-shaped, of 2.5 smooth whorls with a medium-sized nucleus (dp = 420 μ m, hp = 340 μ m, dp/hp = 1.24, $dp1 = 180 \ \mu m$, $dn = 80 \ \mu m$; Pl. 71, fig. 3c-d). These specimens from Karaman are provisionally considered to be conspecific with those illustrated by Bałuk (2003, pl. 24, figs 1-3) as Bela halavatsi (Boettger, 1902). The Paratethyan shells illustrated by Bałuk (2003) are slightly more slender, with a slightly longer siphonal canal, but otherwise are a good match. It is unfortunate that no additional information regarding protoconch morphology is given in this work on the Polish assemblages, but as far as can be judged by the photographs the protoconch is of the same type.

Bela tumida (Boettger, 1906), described from the same middle Miocene assemblages in Romania, is very similar, and also has a claviform shell shape, but seems to differ in having a larger aperture and a more inflated last teleoconch whorl.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 2003), Romania (Boett-ger, 1902, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Bela hispidula (Bellardi, 1847) Plate 44, figs 5-6

- *1847 *Raphitoma hispidula* Jan (*Pleurotoma*) Bellardi, p. 92, pl. 4, fig. 17.
- ?1854 Pleurotoma plicatella Jan Hörnes, p. 374, pl. 40, fig. 5 [non Bela plicatella (Bellardi, 1847)].
- 1877 Raphitoma hispidula Jan Bellardi, p. 304, pl. 9, figs 17-18.
- 1904 Raphitoma hispidula var. pliocostatissima Sacc., Sacco, p. 55.
- 1904 *Raphitoma hispidula* var. *pliosubcancellata* Sacc., Sacco, p. 55, pl. 14, fig. 37.
- 1904 Raphitoma hispidula var. convexiuscula Sacc., Sacco, p. 56, pl. 14, fig. 38.
- 1904 *Raphitoma hispidula* var. *pliocostulatissima* Sacc., Sacco, p. 56, pl. 14, fig. 39.
- 1910 Raphitoma hispidula Jan Cerulli-Irelli, p. 256, pl. 6, fig. 13.
- 1910 Raphitoma hispidula var. pliocostatissima Sacco-Cerulli-Irelli, p. 256, pl. 6, fig. 14.
- 1912 Bela Zejszneri Friedb., Friedberg, p. 234, pl. 14, fig. 17.
- 1914 Daphnella (Raphitoma.) hispidula Jan Cipolla, p. 164, pl. 14, fig. 2.
- 1915 Raphitoma hispidula Bellardi Harmer, p. 260, pl. 29, fig. 27.
- 1928 Raphitoma hispidula Jan Friedberg, p. 572, pl. 37, figs 12. 13.
- ?1928 Raphitoma vulpecula Brocc. Friedberg, p. 573, pl. 37, fig. 17 [?non Bela vulpecula (Brocchi, 1814)].
- 1930 Raphitoma hispidula Jen [sic] Patrini, p. 37, pl. 3, fig. 18.
- 1937 Daphnella (Raphitoma) hispidula (Jan) in Bell. Montanaro, p. 182, pl. 8, fig. 42.
- 1955 *Raphitoma hispidula* Jan Malaroda, p. 54, pl. 1, fig. 5.
- 1960 Mangelia hispidula (Jan in Bellardi 1847) Kojumdgieva & Strachimirov, p. 206, pl. 48, fig. 21.
- ?1966 Mangelia vulpecula Brocchi, 1814 Strausz, p. 437, pl. 20, figs 18-21 [? non Bela vulpecula (Brocchi, 1814)].
- 1969 Raphitoma hispidula (Jan) Atanacković, p. 212, pl. 12, fig. 12.
- 1970 Bela hispidula (Bellardi, 1847) Greco, p. 291, pl. 1, figs 5, 9.
- 1971 Cythara (Mangelia) hispida Bellardi Csepreghy-Meznerics, p. 33, pl. 16, figs 34, 36 [non Bela hispida (Bellardi, 1877)].
- 1976 *Raphitoma* (*R*.) *hispidula* (Jan) Marasti & Raffi, p. 197, pl. 2, fig. 14.
- 1992 Neoguraleus hispidulus (Jan in Bellardi, 1847) Cavallo & Repetto, p. 144, fig. 399.
- Bela hispidula (Jan, 1847) González Delgado, p.
 39, pl. 4, figs 4, 5.
- 1997 *Raphitoma hispidula* Jan in Bellardi, 1847 Chirli, p. 80, pl. 23, figs 1-4.
- 1998 Neoguraleus hispidulus (Jan in Bellardi, 1847) Bogi & Cauli, p. 130, fig. 5.

- 1999 Bela hispidula (Bellardi, 1847) Vera-Peláez et al., p. 5, fig. 5.
- 2002 Bela hispidula (Bellardi, 1847) Vera-Peláez, p.
 208, pl. 4, figs V-W, pl. 13, fig. K.
- 2003 *Raphitoma plicatella* Jan in Bellardi, 1847 Bałuk, p. 69, pl. 21, figs 1-3 [*non Bela plicatella* (Bellardi, 1847)].
- 2008 Neoguraleus hispidulus (Jan in Bellardi, 1847) Chirli & Richard, p. 67, pl. 13, fig. 7.
- 2011 Bela hispidula (Bellardi, 1847) Landau et al., p. 34, pl. 17, fig. 10.
- non 1872 Pleurotoma hispidula Monterosato, p. 52 (nomen nudum = Raphitoma histrix Bellardi, 1847).
- non 1977 Raphitoma hystrix [sic] hispidula Monterosato Nordsieck, p. 50, fig. 119 (= Raphitoma histrix Bellardi, 1847).
- non 1980 Raphitoma hystrix [sic] hispidula (Monterosato) Bogi et al., p. 18, unnumbered fig. p. 19, top row second (= Raphitoma histrix Bellardi, 1847).

Dimensions and material – Maximum height 12.2 mm. Localities 2 & 3: JvdV/1; localities 7 & 8: NHMW 1847/0058/1163/1; locality 17: NHMW 1847/0058/1162/1, JvdV/7, YI 374/3.

Discussion - Three similar species of Bela occur in the European Neogene that have sometimes been ascribed incorrectly to the antipodean genus Neoguraleus Powell, 1939 (see Powell, 1966). These species of Bela all have a similar multispiral protoconch composed of about three whorls with axial riblets on the last whorl (see Vera-Peláez et al., 1999). Bela vulpecula (Brocchi, 1814) has the largest shell within the group, and has axial sculpture of about 12 sharp, narrow, slightly prosocline sinuous axial ribs and narrow flattened spiral cords. The sutural ramp is narrow and poorly delimited, the axial ribs rounded at the shoulder, subobsolete over the sutural ramp. Bela plicatella (Bellardi, 1847) has about 13 axial ribs that are slightly rounded, not as elevated as in *B. vulpecula*, and the spiral cords are narrow, rounded, less depressed than in B. vulpecula, and of alternating strength in many specimens. The sutural ramp is wider than in B. vulpecula, concave, more sharply delimited, with the axial ribs subnodulose at the shoulder and becoming obsolete on the sutural ramp. Bela hispidula (Bellardi, 1847) has more angular whorls than its congeners, more numerous axial ribs (about 16), which are narrow, elevated, sometimes sharp, the spiral sculpture is far more prominent, with the primary cords very narrow, elevated and the interspaces filled with secondary and tertiary spiral threads. The sutural ramp is broad, well delimited by an angular shoulder, the ribs weakenening over the ramp and disappearing only just before the suture. Cavallo & Repetto (1992) and Bogi & Cauli (1998) suggested that the Recent Mediterranean species Bela nuperrima (Tiberi, 1855) is a synonym of B. hispidula. The two are certainly similar, however, this suggestion has not been widely accepted (see Peñas et al., 2006).

Bela hispidula varies greatly in shell width and in the

prominence of the spiral cords (see Sacco, 1904, pl. 14, figs 37-39; Chirli, 1997, pl. 23, figs 1-4). The Turkish shells are intermediate in width, with the spiral sculpture somewhat more subdued than in many of the Italian Pliocene shells and 16 axial ribs on the last teleoconch whorl. The protoconch is similar to that seen in the Pliocene shells. Bałuk (2003, pl. 21, figs 1-3) figured some shells from the middle Miocene Paratethys of Poland under the name Raphitoma plicatella, discussing the difficulty of identifying these shells, which in the Paratethyan literature had been ascribed to B. plicatella or B. hispidula. They have shell characters intermediate between the two species; their sculpture and sutural ramp are similar to that of B. hispidula, but they have fewer axial ribs (9-13 vs. about 16), more in line with B. plicatella. We prefer to include these somewhat unusual Miocene Paratethian and Turkish forms in the synonymy of B. hispidula, as some of the Italian Pliocene shells also have fewer axial ribs and weaker spiral sculpture (see Chirli, pl. 23, figs 1-2).

Distribution - Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (?Strausz, 1966; Csepreghy-Meznerics, 1971), Poland (Friedberg, 1912, 1928; Bałuk, 2003), Bosnia (Atanackovič, 1969); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1877; Montanaro, 1937). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Gonzàlez Delgado, 1992; Landau et al., 2011); western Mediterranean, Estepona Basin (Vera-Peláez et al., 1999; Vera-Peláez, 2002), Roussillon Basin, France (Chirli & Richard, 2008); central Mediterranean, Italy (Bellardi, 1877; Sacco, 1904; Chirli, 1997). Early-late Pliocene: central Mediterranean, Italy (Bellardi, 1877; Sacco, 1904; Cipolla, 1914; Harmer, 1915; Patrini, 1930; Malaroda, 1955; Marasti & Raffi, 1976; Cavallo & Repetto, 1992; Bogi & Cauli, 1998). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1910).

Bela jeffreysi (Bellardi, 1877)

Plate 44 fig. 7; Plate 71, fig. 4

- *1877 *Raphitoma Jeffreysi* Bell., Bellardi, p. 303, pl. 9, fig. 13.
- ?1912 Raphitoma holubicensis Friedb., Friedberg, p. 236, pl. 14, fig. 19.
- 1937 Daphnella (Raphitoma) Jeffreysi Bell. Montanaro, p. 186, pl. 8, figs 59, 60.
- 1963 *Cythara (Mangelia) jeffreysi* (Bell.) Venzo & Pelosio, p. 127, pl. 41, figs 15-21.
- ?1997 Raphitoma jeffreysi Bellardi, 1877 Chirli, p. 82, pl. 23, fig. 8.
- 2003 Bela jeffreysi (Bellardi, 1877) Bałuk, p. 62, pl. 23, figs 1-3.

Dimensions and material - Maximum height 9.1 mm.

Localities 2 & 3: JvdV/3; locality 6: JvdV/5; localities 7 & 8: NHMW 1847/0058/1164/1, 1847/0058/1165/1; locality 13: JvdV/10; locality 17: NHMW 1847/0058/1167/3, RGM 784 082/3.

Discussion – This species is characterised by its fusiform shape, rather angular whorls, with a wide sutural ramp, about ten broad, rounded axial ribs, and narrow but prominent spiral cords, most strongly developed at the periphery. SEM imaging reveals numerous spiral threads of secondary strength in the interspaces between the spiral cords (Pl. 71, fig. 4c). The protoconch is multispiral, composed of about 2.75 whorls, the last half whorl bearing axial riblets (dp = 400 μ m, hp = 345 μ m, dp1 = 140 μ m, dn = 70 μ m; Pl. 71, fig 4a-b).

The Turkish shells are conspecific with those illustrated by Bałuk (2003, pl. 23, figs 1-3) from the middle Miocene Paratethys of Poland. Bałuk (2003) synonymised *Raphitoma holubicensis* Friedberg, 1912, with *Bela jeffreysi* (Bellardi, 1877). We follow his decision, as we assume he had type material at hand, although the original figure (Friedberg, 1912, pl. 14, fig. 19) is poor and could refer to any number of species of *Bela*. We also agree with Bałuk (2003) in including the Italian Pliocene reference of Chirli (1997, pl. 23, fig. 8) with some hesitation, as the photographs show a somewhat different shell with more widely-spaced spiral cords and the protoconch seems proportionally larger.

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1877). Middle Miocene: Paratethys (Langhian-Serravallian): Poland (Bałuk, 2003), ?Ukraine (Friedberg, 1912); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, Italy (Montanaro, 1937, Venzo & Pelosio, 1963). Early Pliocene: ?central Mediterranean, Italy (Chirli, 1997).

Bela scalariformis (Brugnone, 1862)

Plate 44, figs 8, 9; Plate 71, fig. 5

- *1862 *Pleurotoma scalariforme* Brugnone, p. 23, pl. 1, fig. 16.
- 1877 Raphitoma scalariformis (Brugn.) Bellardi, p. 319, pl. 9, fig. 33.
- 1902 *Rhaphitoma* [sic] subcylindrata Boettger, p. 75, no. 243.
- 1906 *Rhaphitoma* [*sic*] *subcylindrata* Bttgr Boettger, p. 83, no. 308.
- 1914 Daphnella (Raphitoma) scalariformis Brugnone Cipolla, p. 170, pl. 14, fig. 21.
- 1928 Raphitoma plicatella Jan Friedberg, p. 572, pl. 37, figs 14-16 [non Bela plicatella (Bellardi, 1847)].
- 1934 Cythara (Mangelia) subcylindrata (Boettger) Zilch, p. 267, pl. 19, fig. 31.
- 1938 Daphnella sp. an n. sp. Friedberg, p. 153, textfig. 49.

- 1958 Mangelia (Mangelia) subcylindrata Boettger Švagrovský, p. 28, pl. 8, figs 8, 9.
- 1963 Cythara (M.) scalariformis (Brugn.) Venzo & Pelosio, p. 128, pl. 11, fig. 23.
- 1975 *Bela* (*B.*) *scalariformis* (Brugnone) Pavia, p. 113, pl. 8, fig. 16.
- 1992 Bela (Bela) scalariformis (Brugnone, 1862) Cavallo & Repetto, p. 140, fig. 378.
- 1997 Bela scalariformis (Brugnone, 1862) Chirli, p. 54, pl. 15, figs 2-4.
- 2002 Bela scalariformis (Brugnone, 1862) Vera-Peláez, p. 210, pl. 4, figs C', D'.
- 2003 *Cythara (Mangelia) subcylindrata* (Boettger, 1901 [*sic*]) Bałuk, p. 60, pl. 22, figs 1-4.
- 2011 Bela scalariforme (Brugnone, 1862) Landau et al., p. 34, pl. 17, fig. 11.

Dimensions and material – Maximum height 5.6 mm. Locality 6: JvdV/50+; localities 7 & 8: NHMW 1847/0058/1166/1; locality 13: JvdV/13; locality 17: NHMW 1847/0058/1226-1847/0058/1227/2, NHMW 1847/0058/1228/6, JvdV/6, RGM 784 081/2, YI 375/3.

Discussion – We (BL) have compared the shells from Turkey with *Bela scalariformis* (Brugnone, 1862) from the Pliocene of Italy and Spain, and with *Bela subcylindrata* (Boettger, 1902) from the middle Miocene Paratethys of Romania. Apart from the larger size attained by the Pliocene populations, there are no differences in either protoconch or teleoconch characters. The protoconch of the Pliocene shells we have observed coincides with the description given by Chirli (1997, p. 54), who described it as composed of 2.5 whorls, the first 1.5 whorls smooth, the last whorl bearing four spiral rows of pearls, the adapical row weakest. This is similar to the protoconch illustrated here for the Turkish shells (Pl. 71, fig. 5).

Several tall, slender species of Bela occur in the European Neogene. Bałuk (2003) synonymised two French Atlantic species with B. subcylindrata: Daphnella (Raphitoma) helvetica Peyrot, 1932 from the middle Miocene Serravallian and D. (R.) girundica Peyrot, 1932 from the early Miocene Aquitanian and Burdigalian. These shells are certainly similar, but we have not been able to examine them and they are therefore excluded from the synonymy. Bela elegantissima (Degrange-Touzin, 1894) from the Atlantic Serravallian Aquitaine Basin of France is even more slender and elongate, with more rounded whorls and more sinuous axial ribs. The protoconch of B. elegantissima is larger, with an extra whorl and five gemmate spiral cords on the last whorl instead of four. Bela brachystoma (Philippi, 1844) from the Tortonian of Italy and the Mediterranean Pliocene is the squattest member of the group. The spiral sculpture is much sharper, more widely spaced and more prominent than in any of the preceding species. The protoconch is of a similar type to the preceding species, the last whorl bearing four gemmate spiral cords.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Friedberg, 1928, 1938; Bałuk,

2003), Slovakia (Švagrovský, 1958), Romania (Boettger, 1902, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Messinian): Po Basin, Italy (Venzo & Pelosio, 1963). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Landau *et al.*, 2011); western Mediterranean, Estepona Basin, Spain (Vera-Peláez, 2002), central Mediterranean, Italy (Pavia, 1975; Cavallo & Repetto, 1992; Chirli, 1997). Late Pliocene: central Mediterranean, Italy (Bellardi, 1877; Cipolla, 1914).

Bela trinacria Mariottini & Smriglio, 2009

Plate 44, fig. 10; Plate 71, fig. 6; Plate 72, fig. 1

- 1877 Raphitoma turgida (Forb.) Bellardi, p. 312, pl. 9, fig. 25 (non Reeve, 1844).
- 1904 Raphitoma turgida var. pliospiralata Sacc., Sacco, p. 56, pl. 14, figs 41-42.
- 1914 Daphnella (Raphitoma) turgida Forbes Cipolla,p. 168, pl. 14, figs 17, 18 (non Reeve, 1844).
- 1937 Daphnella (Raphitoma) turgida (Forb.) Montanaro, p. 189, pl. 8, fig. 71 (non Reeve, 1844).
- 1992 Bela turgida (Forbes, 1843 [sic]) González Delgado, p. 43, pl. 4, figs 11, 12 (non Reeve, 1844).
- 1992 Bela (Ichnusa?) turgida (Forbes in Reeve, 1844)
 Cavallo & Repetto, p. 140, fig. 383 (non Reeve, 1844).
- Bela turgida (Forbes in Reeve, 1843 [sic]) Chirli, p. 55, pl. 15, figs 9-12 (non Reeve, 1844).
- 2002 *Bela turgida* (Forbes, 1844) Vera-Peláez, p. 208, pl. 4, figs X-Z, pl. 13, figs G, H (*non* Reeve, 1844).
- *2009 *Bela trinacria* Mariottini & Smriglio *in* Mariottini *et al.*, p. 10, figs 17-25.
- 2011 Bela turgida (Reeve, 1844) Landau et al., p. 34, pl. 17, fig. 13 (non Reeve, 1844).

Dimensions and material – Maximum height 5.4 mm. Locality 17: NHMW 1847/0058/1517/1, RGM 784 080/1.

Discussion – This species of *Bela* is characterised by its biconic shape, elongate-fusiform solid shell and sculpture consisting of 7-8 broad ribs crossed by much finer, close-set spiral threads of primary and secondary strength. It belongs to the *Bela menkhorsti* species group. The name *Bela menkhorsti* was proposed by van Aartsen (1988a) to replace *Pleurotoma nana* Scacchi, 1836, not of Deshayes, 1835. Members of this species group have often been reported in the literature as *Pleurotoma turgida* Reeve, 1844, which van Aartsen (1988a, b) considered to be a *nomen dubium*.

The *Bela menkhorsti* group was revised recently by Mariottini *et al.* (2009), who recognised four species. All have very similar teleoconch morphology, but two have paucispiral protoconchs: *B. zenetouae* (van Aartsen, 1988) and *B. taprurensis* (Pallary, 1904), and two have multispiral protoconchs: *B. menkhorsti* and *B. trinacria.* The difference between the multispiral species was based on protoconch characters, as the protoconch is larger in *B.* *trinacria* (0.6-0.7 mm vs. 0.53-0.54 mm) than in *B. menkhorsti*, with a greater number of whorls in *B. trinacria* (2.7-2.8 vs. 2.0-2.2). Mariottini *et al.* (2009) considered *B. trinacria* to be a fossil species present in the Italian Pliocene, whereas *B. menkhorsti* is the Recent species.

The protoconch in the Turkish fossil shells is multispiral, consisting of about three whorls, the first two whorls smooth, the last whorl bearing axial riblets (dp = $580 \,\mu$ m, hp = $720 \,\mu$ m, dn = $80 \,\mu$ m, dp1 = $170 \,\mu$ m; Pl. 71, fig. 6, Pl. 72, fig. 1b), and we therefore consider them to be conspecific with the shells from the Italian Pliocene. The surface is covered with fine microsculpture of pustules (Pl. 72, fig. 1c), similar to that seen in Italian fossil shells (see Mariottini *et al.*, 2009, fig. 21b).

Although Mariottini et al. (2009) considered all the Italian Pliocene specimens attributed by most previous authors to B. turgida to belong to B. trinacria, the geographical and stratigraphical ranges of the fossil species are unclear. The early Pliocene shells from the Estepona Basin figured by Vera-Peláez (2002, pl. 4, figs X-Z, pl. 13, figs G-H) have a protoconch of just under three whorls with a diameter just above the upper range of that for B. menkhorsti. Specimens from the early Piacenzian Atlantic Pliocene of the Mondego Basin, Portugal also have a protoconch of just under three whorls. Unfortunately, none of the specimens from the Guadalquivir Basin have their protoconch preserved. We therefore consider all Miocene and Pliocene specimens to be B. trinacria. Vera-Peláez (2002, p. 208) included Raphitoma risii [sic] Bellardi, 1877 in his synonymy of B. turgida. The syntype of R. rissii from the late Miocene of Italy illustrated by Ferrero Mortara (1981, pl. 19, fig. 3) has axial ribs terminating abruptly at a narrow but clearly delimited concave sutural ramp. This character is not seen in any member of the B. menkhorsti species group. We consider Bela rissii to be a distinct species, which also occurs in the late Miocene Tortonian of southern Portugal (NHMW collection).

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Montanaro, 1937). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1992; Landau *et al.*, 2011); western Mediterranean, Estepona Basin (Vera Peláez, 2002), central Mediterranean, Italy (Chirli, 1997). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (BL collection); central Mediterranean, Italy (Bellardi, 1877; Sacco, 1904; Cipolla, 1914; Cavallo & Repetto, 1992).

Bela seyithasanensis nov. sp. Plate 45, figs 1, 2; Plate 72, fig. 2

Dimensions and material – Holotype NHMW 1847/-0058/1168/1, height 8.9 mm, locality 17; paratype 1 RGM 794 564 (ex JvdV collection), height 10.9 mm, localities 2 & 3; paratype 2 RGM 794 531 (ex JvdV collection), two specimens in YI 488, height 9.5 mm and YI 489, height 11.0 mm, locality 6.

Other material – Localities 2 & 3: JvdV/1, YI 419/1; locality 10: YI 419/1; locality 13: JvdV/1.

Etymology – Named from the type locality, Seyithasan.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum –Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small species of *Bela* with a multispiral protoconch, whorls rounded, with sutural ramp poorly delimited, with axial sculpture of 9-10 narrow ribs on the last two whorls, with inconspicuous spiral sculpture of narrow, flattened cords separated by even narrower grooves, and with an elongate aperture and relatively long siphonal canal.

Description - Shell small, relatively thin-shelled. Protoconch multispiral, of 3.5 strongly convex whorls with small nucleus, last half whorl bearing axial riblets (dp = 740 μ m, hp = 840 μ m, dp/hp = 0.88; Pl 72, fig. 2). Transition to teleoconch marked by sinuous scar. Teleoconch of five whorls, first two weakly angular at shoulder, rounded abapically. Whorls bearing convex sutural ramp, poorly delimited from rest of whorl. Suture linear, impressed. Axial sculpture of 8-9 ribs on early whorls, 9-10 on last two whorls; ribs narrow, elevated, weakly sinuous, opisthocline. Spiral sculpture inconspicuous, of narrow, flattened spiral cords separated by very narrow grooves. Last whorl 63% of total height, with narrow, slightly convex to flat sutural ramp, rounded at shoulder, weakly constricted at base. Aperture elongate, 45% of total height, outer lip simple, without varix. Anal sinus very shallow, apex placed just above shoulder. Columella weakly excavated at one third height, straight below, smooth. Siphonal canal long, open, slightly twisted to the left, weakly recurved at tip.

Discussion – Bela seyithasanensis nov. sp. differs from Bela vulpecula (Brocchi, 1814), from the Mediterranean Pliocene, in being smaller and more slender, in having fewer axial ribs (9-10 vs. about 12) and in having spiral cords slightly wider and more flattened. The protoconch (Pl. 72, fig. 2) is similar to that of the Pliocene shells, composed of about 3.5 convex whorls with axial riblets on the last protoconch whorl. Brébion (1964, p. 589) argued that the late Miocene Messinian (Redonian) species from the Loire Basin identified as Mangelia vulpecula by Glibert (1954, p. 49, pl. 6, fig. 9) differs from Italian Neogene shells in having less angular whorls, finer spiral ornament and fewer axial ribs on the last whorl. They were renamed Cythara (Mangelia) milleti by Brébion (1964), although this name was never published and therefore is not available. The Redonian species differs from B. seyithasanensis in being much broader, with a more scalate spire, and in having more numerous axial ribs and quite different spiral sculpture.

Bela submarginata (Bellardi, 1847), also from the Mediterranean Pliocene, differs in being more slender, with a slightly shorter siphonal canal, in having fewer axial ribs (8 *vs.* 9-10 on each of the last two whorls), which are straighter and weaken over the sutural ramp, whereas in *B. seyithasanensis* the ribs continue over the ramp to the suture.

Bela plicatella (Bellardi, 1847), another Mediterranean Pliocene species, is again much broader, with more angular whorls and the sutural ramp is clearly delimited at the shoulder. The spiral sculpture is again quite different; *B. plicatella* has a spiral sculpture composed of primary and secondary spirals cords, the primary cords relatively well developed and elevated, whereas in *S. seyithasanensis* all the spiral cords are of equal strength and flattened. For further discussion and comparison, see under *Bela hispidula*.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Mangelia Risso, 1826

Type species – Mangelia striolata Risso, 1826, by subsequent designation (Herrmannsen, 1852). Recent Mediterranean.

Mangelia gertrudae (Boettger, 1906)

Plate 45, fig. 3

- *1906 *Rhaphitoma* [*sic*] *gertrudae* Boettger, p. 83, no. 309.
- 1934 *Cythara (Mangelia) gertrudae* (Boettger) Zilch, p. 267, pl. 19, fig. 62.

Dimensions and material – Maximum height 7.3 mm. Locality 17: NHMW 1847/0058/1169/1, JvdV/2.

Discussion - Unfortunately the protoconch is worn in the Turkish shells, but it seems to be identical to that illustrated by Zilch (1934, pl. 19, fig. 62) as Mangelia gertrudae. Mangelia gertrudae (Boettger, 1906) belongs to the *M. costata* group of mangeliids, which are characterised by their tall, slender shells with sculpture composed of prominent axial ribs and subobsolete spiral cords. Mangelia coarctata (Forbes, 1840) from the Mediterranean Pliocene (Scarponi & della Bella, 2011) and adjacent Atlantic Pliocene (Landau et al., 2011) and widespread today on all European coasts is the most slender, with a conical spire rather than the scalate spire of *M. costata* (Pennant, 1777). The spiral sculpture of *M. coarctata* is also the weakest of the group. The Turkish shell has a spire similar to that of M. costata, although the shoulder is somewhat less prominent and it has slightly stronger spiral sculpture than either of the two Pliocene-Recent species. Moreover, the last teleoconch whorl is slightly shorter and more inflated than in *M. coarctata* and *M. costata*.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Boettger, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Mangelia subcostata Boettger, 1906

Plate 45, fig. 4; Plate 72, fig. 3

- 1856 Pleurotoma Vauquelini Payr. Hörnes, p. 378, pl. 40, fig. 18 [non Mangelia Vauquelini (Payraudeau, 1826)].
- *1906 Mangilia [sic] subcostata Boettger, p. 77, no. 288.
 1912 Mangilia [sic] rugulosa Phil. Friedberg, p. 225, pl. 14, fig. 7 [non Philippi, 1844 = Mangelia unifasciata (Deshayes, 1835)].
- 1934 *Cythara (Mangelia) subcostata* (Boettger) Zilch, p. 263, pl. 18, fig. 43.
- 1953 Cythara (Mangelia) rugulosa Phil. Csepreghy-Meznerics, p. 20, pl. 3, figs 11-12 [non Philippi, 1844 = Mangelia unifasciata (Deshayes, 1835)].
- ?1954 Cythara subcostata Boettg. Strausz, p. 34, pl. 5, fig. 107.
- 1958 Mangelia (Mangelia) rugulosa (Philippi) Švagrovský, p. 28, pl. 8, fig. 7 [non Philippi, 1844 = Mangelia unifasciata (Deshayes, 1835)].
- 2003 *Cythara (Mangelia) rugulosa* (Philippi, 1844) Bałuk, p. 60, pl. 22, figs 6-10 [*non* Philippi, 1844 *= Mangelia unifasciata* (Deshayes, 1835)].
- non 1966 Mangelia costata subcostata Boettger 1906 Strausz, p. 441, pl. 20, figs 8-11.

Dimensions and material – Maximum height 5.5 mm. Localities 2 & 3: JvdV/1; locality 13: JvdV/11, RGM 794 530/2; locality 17: NHMW 1847/0058/1170/1.

Discussion – We have several shells of a species of *Mangelia* from the Seyithasan assemblage that is characterised by a rather thin shell for the genus. The whorls are weakly convex, with a well-developed sutural ramp, the eight axial ribs per whorl are narrow, sharp, elevated and strongly fexuous, the spiral cords are very narrow, rounded, with every fourth or fifth cord slightly stronger than the others, and the anal sinus is broad and moderately shallow. The protoconch is multispiral, consisting of 3.5-4.0 whorls, with a small nucleus, with the last protoconch whorl bearing close-set axial riblets (Pl. 72, fig. 3).

This shell is probably conspecific with those illustrated by Bałuk (2003, pl. 22, figs 6-10) from the middle Miocene Paratethys of Poland under the name *Cythara* (*Mangelia*) *rugulosa* (Philippi, 1844) [a synonym of *Mangelia unifasciata* (Deshayes, 1835)]. However, they are not this species, which occurs in the Italian Pliocene and Recent Mediterranean. *Mangelia rugulosa* is thicker-shelled, has a less developed sutural ramp and has broader, less flexuous ribs (Scarponi & della Bella, 2010, figs 141-153).

The Turkish shell also seems identical to that described by Boettger (1906) from the middle Miocene Paratethys of Romania as *Mangilia* [*sic*] *subcostata*. Bałuk (2003, p. 60) considered this to be a synonym of *M. rugulosa*, which it is certainly not, and therefore *M. subcostata* is the first available name for this species. *Mangelia subaurea* (Boettger, 1902), also from the middle Miocene of Romania, is extremely similar, but differs in having a slightly more slender shell with more numerous axial ribs. It is difficult to tell from the small photographs in Zilch (1934), but *M. subaurea* seems to have a different protoconch from that of *M. subcostata*, without axial riblets on the last protoconch whorl.

Scarponi & della Bella (2010) highlighted the importance of the protoconch characters in identifying mangeliids. Indeed, the teleoconch of the Turkish shell is almost identical to that of the Italian Pliocene species *M. ceddaensis* della Bella *in* Scarponi & della Bella, 2010 and *M. imitatrix* Scarponi & della Bella, 2010. Consequently, it is impossible to evaluate the illustrations of related species given in the older literature. We therefore provisionally use the oldest name attributable to this species, pending a review using protoconch characters.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1856), Slovakia (Švagrovský, 1958), Hungary (?Strausz, 1954), Poland (Bałuk, 2003), Romania (Boettger, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Mangelia sp.

Plate 45, fig. 5; Plate 72, fig. 4

Dimensions and material – Maximum height 4.9 mm. Locality 17: JvdV/12, RGM 783 712/1, RGM 794 532/1.

Discussion - This species of Mangelia is unusual in having the last teleoconch whorl less inflated than usual for the genus and a relatively short aperture in relation to total shell height. The spire is tall, composed of convex whorls, weakly angled at the shoulder bordering a welldelimited, convex sutural ramp. The teleoconch sculpture consists of strongly flexuous axial ribs, ten on the penultimate whorl, eight on the last whorl and prominent narrow spiral cords with a single secondary thread in the interspaces on the last whorl. The anal sinus is broad and shallow. The protoconch is multispiral, of about 3.25 convex whorls, with a small nucleus, the last whorl bearing axial riblets and spiral cords (Pl. 72, fig. 4). Mangelia angulata (Peyrot, 1938) from the Atlantic middle Miocene Langhian of France is extremely similar (Glibert, 1954, pl. 6, fig. 8), but differs in having more acutely angled whorls, the axial ribs are straighter and the spiral cords are stronger and less numerous. Mangelia interrupta Scarponi & della Bella, 2010 from the Pliocene of Italy is also extremely similar, but differs in having more rounded whorls, the sutural ramp is slightly less strongly delimited and the spiral sculpture is finer and denser. The shell illustrated by Bałuk (2003) as Cythara (Mangelia) burdigalica (Peyrot, 1932) from the middle Miocene Paratethys of Poland also bears a close resemblance, but has a more angular shoulder and straighter, less sinuous ribs.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Raphitomidae Bellardi, 1875 Genus *Favriella* Hornung, 1920

Type species – Daphnella (Favriella) weberi Hornung, 1920, by monotypy. Pliocene, Italy.

Favriella dorae (Boettger, 1906)

Plate 45, fig. 6; Plate 72, fig. 5

- 1902 Drillia rotundicosta Boettger, p. 44, no. 184.
- *1906 Drillia dorae Bttgr. Boettger, p. 56, no. 224 (nov. nom. pro Drillia rotundicosta Boettger, 1902 non Bellardi, 1877).
- 1934 Drillia dorae Boettger Zilch, p. 260, pl. 17, fig.25.
- 2003 Daphnella (Favriella) dorae (Boettger, 1906) Bałuk, p. 68, pl. 27, figs 5-7.

Dimensions and material – Height 3.8 mm. Locality 13: NHMW 1847/0058/1509/1.

Discussion - We ascribe a single specimen from the Akpinar assemblage to Favriella dorae (Boettger, 1906), a species that was first described from the middle Miocene Paratethys of Romania. Judging by the series illustrated by Bałuk (2003, pl. 27, figs 5-7) the shell shape is quite variable, from slender to squat. The Turkish shell is of the squatter form. The protoconch is similar to that seen in the Polish shells; tall, conical, multispiral, and covered in the diagonal lattice-work pattern diagnostic of Raphitomidae (Pl. 72, fig. 5b). The sculpture of micropustules on the teleoconch whorls in the Turkish shell (Pl. 72, fig. 5b) seems to be a generic character, as it is also present in the type species Favriella weberi (Hornung, 1920). Favriella tenerrima (Boettger, 1902), also from the Romanian Paratethys, differs in having a wider, more inflated shell, especially the last teleoconch whorl, and in having more numerous axial ribs (9-12, vs. 7-8 in F. dorae).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 2003), Romania (Boett-ger, 1902, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Raphitoma Bellardi, 1847

Type species – Pleurotoma hystrix de Cristofori & Jan, 1832 (*nomen nudum*, validated by Bellardi, 1847 as '*Pleurotoma histrix* Jan'), by subsequent designation (Monterosato, 1872). Recent, Mediterranean.

Note – The species described in this section classically would have been placed in the genus *Philbertia* Monterosato, 1884 (type species: *Pleurotoma philberti* Michaud, 1829, by tautonomy. Recent, Mediterranean). However, this and numerous other poorly defined but closely similar generic groups were synonymised with *Raphitoma* Bellardi, 1847 by Pusateri *et al.* (2012, p. 43).

Raphitoma herminae (Boettger, 1902)

Plate 45, fig. 7; Plate 72, fig. 6

- *1902 Peratotoma herminae Boettger, p. 56, no. 211.
- 1906 Peratotoma herminae Bttgr. Boettger, p. 73, no. 271.
- 1934 Peratotoma herminae Boettger Zilch, p. 273, pl. 21, fig. 94.
- 2003 Peratotoma herminae Boettger, 1901 [sic] Bałuk, p. 73, pl. 29, figs 1-3.

Dimensions and material – Height 4.4 mm. Localities 7 & 8: RGM 794 533/1; locality 17: JvdV/1.

Discussion – One incomplete and one juvenile shell from the Seyithasan deposits are here assigned to *Raphitoma herminae* (Boettger, 1902). This species is characterised by its very open cancellate sculpture, and the Turkish shell is identical to that figured by Bałuk (2003, pl. 29, fig. 2). The protoconch in the Turkish juvenile shell is multispiral and highly ornate, as usual for the Raphitomidae, bearing a diagonal lattice-work sculpture. The last two protoconch whorls are carinate with a broad, flattened sutural ramp. Transition to the teleoconch is abrupt, with the disappearance of the central carina and the appearance of two spiral cords (Pl. 72, fig. 6).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 2003), Romania (Boett-ger, 1902, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Raphitoma leufroyi (Michaud, 1828)

Plate 45, fig. 8

- *1828 Pleurotoma Leufroyi Nob., Michaud, p. 121, pl. 1, figs 5, 6.
- 1836 Pleurotoma inflata Philippi, p. 197, pl. 11, fig. 24 [non Comarmondia inflata (de Cristofori & Jan, 1832)].
- 1854 Pleurotoma Leufroyi Mich. Hörnes, p. 373, pl. 40, fig. 16.
- 1904 Peratotoma (Leufroya [sic]) Leufroyi (Michd.) Sacco, p. 53, figs 52, 53.
- 1910 Peratotoma (Leufroyia) Leufroyi Michaud Cerulli-Irelli, p. 59, pl. 5, fig. 46.
- 1912 Mangilia [sic] Leufroyi Michd. Friedberg, p. 226, pl. 14, fig. 8.
- 1914 Peratotoma (Leufroyia) Leufroyi Michaud Cipolla, p. 174, pl. 14, fig. 24.
- Mangelia (Leufroyia) Leufroyi var. praecedens Dollfus et Dautzenberg – Peyrot, p. 285, pl. 5, figs 49, 56.
- 1954 Philbertia (Leufroyia) leufroyi f. praecedens Dollfus & Dautzenberg in Peyrot, 1938 – Glibert, p. 60, pl. 7, fig. 8.
- 1964 Raphitoma (Leufroyia) leufroyi Michelotti, 1827[sic] Brébion, p. 611, pl. 15, fig. 5.
- 1985 Raphitoma leufroyi (Michaud, 1828) Fretter &

Graham, p. 538, fig. 371.

1991	Raphitoma leufroyi (Michaud, 1828) - Poppe &
	Goto, p. 167, pl. 35, fig. 22.

- 1998 *Raphitoma leufroyi* (Michaud, 1828) Rolán *et al.*, p. 108, figs 26-28.
- 2003 *Peratotoma leufroyi* (Michaud, 1828) Bałuk, p. 73, pl. 29, fig. 12.
- non 1878 Pleurotoma leufroyi Michd. Nyst, pl. 3, fig. 14 [= Raphitoma pseudoleufroyi (Marquet, 1998)].
- non 1915 Clathurella Leufroyi (Michaud) Harmer, p. 235, pl. 28, figs 13-15 [= Raphitoma pseudoleufroyi (Marquet, 1998)].
- non 1960b Raphitoma (Leufroyia) leufroyi Michaud, 1828 Glibert, p. 17, pl. 4, fig. 19, pl. 5, fig. 7 [= Raphitoma pseudoleufroyi (Marquet, 1998)].
- non 1992 Raphitoma (Leufroyia) leufroyi (Michaud, 1828) Cavallo & Repetto, p. 146, fig. 404 [= Raphitoma linearis (Montagu, 1803).

Dimensions and material – Height 7.0 mm. Locality 17: NHMW 1847/0058/1171/1.

Discussion - Raphitoma leufroyi (Michaud, 1828) is represented in the Karaman assemblages by a single shell from the Seyithasan deposits. The specimen is not fully grown, with the outer lip not yet fully developed. Raphitoma leufroyi varies somewhat in slenderness and in the number and development of its axial ribs. Glibert (1954) considered the French Atlantic middle Miocene Langhian specimens to be a different 'forma', differing from Recent shells in being smaller, more slender, with straighter axial ribs. The rank of 'forma' is not recognised in the ICZN Code and we therefore consider these Miocene shells to be conspecific. The Turkish shell has 11 axial ribs, fewer than usual for Recent shells, but within the range given by Glibert (1954) for the French fossil shells. Marquet (1998b) correctly separated the Pliocene North Sea Basin records as Raphitoma pseudoleufroyi (Marquet, 1998), a species with very similar teleoconch characters, but a paucispiral protoconch as opposed to the multispiral one of R. leufroyi.

Distribution – Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France (Peyrot, 1938; Glibert, 1954); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1854), Poland (Bałuk, 2003), Ukraine (Friedberg, 1912); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (Brébion, 1964). Early Pliocene: central Mediterranean, Italy (Sacco, 1904). Early-late Pliocene: central Mediterranean, Italy (Cipolla, 1914). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1910). Recent: Atlantic, British Isles and Norway south into Mediterranean (Fretter & Graham, 1985; Poppe & Goto, 1992), south to Angola (Rolán *et al.*, 1998).

Raphitoma spinosissima nov. sp. Plate 45, fig. 9

Dimensions and type material – Holotype NHMW 1847/0058/1172, height 11.8 mm, width 5.0 mm.

Other material – Known only by the holotype.

Etymology – From Latin *spinosus*, *spinosissima*: extremely thorny or prickly, referring to the sculpture.

Locus typicus – Pinar Yaylasi, Akpınar, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A medium-sized species of *Raphitoma* with a multispiral protoconch covered in net-like sculpture, the last protoconch whorl keeled, with strongly convex teleoconch whorls, with a distinctly concave sutural ramp, densely reticulate spinous sculpture and a convex last teleoconch whorl strongly constricted at the base.

Description - Shell medium-sized, spire scalate, sculpture densely reticulate, spinous. Last protoconch whorl preserved, strongly carinate, surface covered with fine diagonal netting, transition to teleoconch sharply delimited by termination of median carina and appearance of three spiral cords. Teleoconch of six evenly convex whorls, with periphery mid-whorl, sutural ramp well delimited, strongly concave. Suture superficial, undulating. Axial sculpture of narrow, close-set, elevated, opisthocline ribs, 11 on first whorl, increasing in number abapically to 25 on last whorl. Spiral sculpture crossing axial ribs, of three narrow, elevated cords on each of first two teleoconch whorls, one secondary spiral cord developed in interspaces from third whorl. Number of primary cords increasing abapically to six on penultimate whorl, 12 on last whorl. Small, sharp spines developed at all sculptural intersections, giving surface a densely spinous appearance. Sutural ramp devoid of sculpture except for comma-shaped traces of anal sinus s. Last teleoconch whorl 60% of total height, strongly convex in profile, constricted at base. Aperture ovate, 40% of total height, outer lip damaged. Anal sinus shallow. Siphonal canal relatively short, open, slightly twisted. Columella straight, columellar callus narrow, appressed. Siphonal fasciole flattened, weakly defined, bearing nodular spiral cords.

Discussion – This very beautiful species of *Raphitoma* has the densest reticulate sculpture of any of its Neogene to Recent congeners. Unfortunately, the protoconch is incomplete, but the last protoconch whorl is preserved, and is carinate and covered with net-like sculpture. It strongly suggests a multispiral protoconch not unlike that of some of its congeners such as *R. linearis* (Montagu, 1803) and *R. purpurea* (Montagu, 1803) (see Rolán *et al.*, 1998). Numerous raphitomiids have been described from the

European Neogene and Recent faunas, some of which are currently under revision (Pusateri et al., 2012). The Recent Mediterranean species R. contigua (Monterosato, 1884), R. lineolata Bucquoy, Dautzenberg & Dollfus, 1884, R. oblonga (Jeffreys, 1867), R. purpurea, R. atropurpurea (Locard & Caziot, 1900) and R. spadiana Pusateri, Giannuzzi-Savelli & Oliverio, 2012 all differ in having a less clearly delimited and concave sutural ramp, and a more elongate last whorl, which is less convex and less strongly constricted at the base. Raphitoma cordieri (Payreaudeau, 1826) also has convex whorls, but does not have a concave sutural ramp and the sculpture is less dense. The Pliocene Mediterranean species R. histrix de Cristofori & Jan, 1832 and the Pliocene North Sea Basin species R. antonjanseni Marquet, 1998 have even more spinose sculpture than the Turkish shell, with a similar sutural ramp, but both are far more slender and elongate. They differ from each other mainly in the character of their protoconchs (see Marquet 1998b). We take the opportunity to point out that R. antonianseni was described honouring Mr Anton Janse and we therefore emend the name to Raphitoma antonjansei (ICZN Article 33.2.1).

The most closely similar species to *Raphitoma spinosis*sima nov. sp. is the Mediterranean Pliocene to Recent species *R. echinata* (Brocchi, 1814) (lectotype: Pinna & Spezia, 1978, pl. 44, fig. 1). This species also has a strongly spinous sculpture and a similar concave sutural ramp, but far fewer axial and spiral elements, resulting in a more open reticulate sculpture.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Raphitoma subpurpurea (Boettger, 1902)

Plate 45, fig. 10

- *1902 *Peratotoma (Philbertia) subpurpurea* Boettger, p. 57, no. 212.
- 1906 *Peratotoma (Philbertia) subpurpurea* Bttgr. Boettger, p. 73, no. 272.
- 1934 *Philbertia subpurpurea* (Boettger) Zilch, p. 269, pl. 20, fig. 75.
- 2003 *Philbertia subpurpurea* (Boettger, 1901 [sic]) Bałuk, p. 72, pl. 28, figs 11-13.

Dimensions and material – Height 4.7 mm. Locality 13: JvdV/4; locality 17: NHMW 1847/0058/1175/1, 1847/0058/1176/4, JvdV/2, YI 441/1.

Discussion – Several specimens from the Seyithasan deposits are here assigned to *Raphitoma subpurpurea* (Boettger, 1902). They are smaller than the maximum height recorded by Boettger (1902; 7 mm) for the Romanian specimens or Bałuk (2003; 8.4 mm) for the Polish shells. The protoconch in our Turkish shells is missing its apex, but it is tall, covered with fine diagonal lattice-work sculpture, and the last protoconch whorl is strongly carinate. This type of protoconch is also seen in the specimen illustrated by Bałuk (2003; pl. 28, fig. 11).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 2003), Romania (Boett-ger, 1902, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Raphitoma vandervoorti nov. sp.

Plate 45, fig. 11, Plate 46 fig. 1

Dimensions and material – Holotype NHMW 1847/-0058/1173, height 6.9 mm; paratype 1 NHMW 1847/-0058/1174, height 4.9 mm; paratype 2 RGM 783 999, height 6.2 mm; furthermore one specimen in YI 373, height 5.4 mm.

Etymology – Named after Jaap van der Voort, who collected much of the material for this work.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small species of *Raphitoma* with a standard raphitomid planktotrophic protoconch, last protoconch whorl strongly carinate, teleoconch spire whorls tall, weakly convex and scalate, sculpture of eight axial ribs and four elevated cords, last whorl elongate, and aperture elongate.

Description – Shell small, slender, spire weakly scalate. Protoconch multispiral, of four whorls with a small nucleus, the surface covered with fine diagonal netting, last protoconch whorl strongly carinate. Transition to teleoconch sharply delimited by termination of median carina and appearance of two spiral cords. Teleoconch of 5.5 weakly convex whorls, with periphery just above suture. Suture superficial, undulating. Axial sculpture of eight broad, rounded, weakly opisthocline ribs per whorl. Spiral sculpture of four narrow, sharp cords, crossing and thickened over axial ribs. Last teleoconch whorl 59% of total height, slender, elongate, constricted at base, bearing eight spiral cords. Aperture elongate, 40% of total height, outer lip damaged. Anal sinus well developed, rounded, shallow. Siphonal canal relatively long, open, twisted. Columella straight, columellar callus narrow, appressed. Siphonal fasciole weakly defined, bearing sharp spiral cords.

Discussion – Raphitoma vandervoorti nov. sp. has a tall, slender shape and a long, narrow aperture, characters distinguishing it from most of its congeners. However, it is closely similar to *Raphitoma linearis* (Montagu, 1803), which has a similar number of axial and spiral elements, but differs in having a far more slender, elongate shape and the siphonal canal in the new species is far longer than in *R. linearis.* The Recent West African species *R. kabuli* Rolán, Otero-Schmitt & Fernandes, 1998 is another similar species, but differs from *R. vandervoorti* nov. sp. in being slightly squatter, with an even shorter siphonal canal than *R. linearis*. The protoconch of all three species is of the standard raphitomid planktotrophic type.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Raphitoma sp.

Plate 46, fig. 2

Dimensions and material – Height 5.9 mm. Locality 17: RGM 776 936/1 (ex JvdV collection).

Discussion – This small species is characterised by its rather squat shape, its axial sculpture composed of eight broad, rounded, orthocline ribs with narrow interspaces, and its spiral sculpture of five sharp, narrow cords on the spire whorls. The last whorl is convex and weakly constricted at the base, covered with sculpture similar to that of the rest of the shell. The outer lip is not thickened and there are no denticles within the aperture. The protoconch is damaged, but the last protoconch whorl bears a sharp carina. The teleoconch sculpture is somewhat reminiscent of the Mediterranean Pliocene species *Raphitoma raynevali* (Bellardi, 1877), but the Karaman specimen has a wider sutural ramp and the last teleoconch whorl is far more constricted at the base than in *R. raynevali*.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Andonia Harris & Burrows, 1891

Type species – Fusus bonellii Bellardi & Michelotti, 1840, by original designation. Neogene, Italy.

Andonia transsylvanica (Hoernes & Auinger, 1890) Plate 46, fig. 3; Plate 72, fig. 7; Plate 73, fig. 1

- *1890 Fusus (Genea) Transsylvanicum Hoernes & Auinger, p. 261 (partim, pl. 32, fig. 9 only) (non fig. 11).
- 1995 Parvisipho (Andonia) transsylvanicus (Hoernes & Auinger, 1890) Bałuk, p. 239, pl. 33, fig. 7.
- non 1984a Andonia transsylvanica (Hoernes & Auinger, 1890) A.W. Janssen, p. 315, pl. 73, figs 10-11.
- non 2010 Andonia transsylvanica (R. Hoernes & Auinger, 1890) Moths et al., p. 67, pl. 20, fig. 3.

Dimensions and material – Maximum height 5.8 mm. Locality 6: JvdV/2, RGM 794 059/1 (ex JvdV collection), RGM 784 060/1; locality 17: RGM 776 863/1 (ex JvdV collection).

Discussion – The subfamily Andoniinae erected by Vera-Peláez (2002) was synonymised with Raphitominae Bellardi, 1875 by Bouchet & Rocroi (2005, p. 256). The specimen illustrated from the Karaman assemblages displays the tall multispiral protoconch covered with diagonal netting typical of Raphitomidae (Pl. 72, fig. 7b, c) (see Moroni & Ruggieri, 1981).

Hoernes & Auinger (1890, pl. 32, figs 9, 11) illustrated two specimens when introducing this species. A reinvestigation of the syntypes showed that the shells are not conspecific.

Their description is largely based on the extremely slender specimen with nearly flat-sided late teleoconch whorls illustrated as fig. 9. The second specimen, illustrated as fig. 11, differs in its 'normal' convex whorls, the less numerous but coarser spiral ribs and the much lower spire. Therefore, we designate the specimen illustrated by Hoernes & Auinger (1890, pl. 32, fig. 9) as lectotype of *Andonia transsylvanica*.

The Turkish shell and the Paratethyan Polish shell described by Bałuk (1995) are conspecific with the lectotype from Romania. In contrast, the specimens from the Miocene of the North Sea Basin identified as *Andonia transsylvanica* by A.W. Janssen (1984a) differ in their fusiform outline and convex whorls. This species is closer to but not identical with the probably unnamed species in fig. 11 of Hoernes & Auinger (1890) and possibly represents a new species.

Large adult specimens from Turkey are extremely rare and all are damaged, and are here ascribed to Andonia transsylvanica (Hoernes & Auinger, 1890). Judging from specimens illustrated in the literature, the shells shown here represent different growth stages of a single species. The smallest shell (Pl. 72, fig. 7a-b) is similar to those illustrated by A.W. Janssen (1984a, pl. 73, figs 10-11) from the middle Miocene North Sea Basin. Intermediate-sized shells (Pl. 46, fig. 3) have eight prominent, rounded, slightly opisthocline axial ribs and about 10 narrow spiral cords that cross over the ribs, similar to the lectotype and the specimen illustrated by Bałuk (1995, pl. 33, fig. 7). In the largest specimen (Pl. 73, fig. 1), in which only the last two teleoconch whorls are preserved, the axial ribs are obsolete on the last whorl. A similar change in sculpture with ontogeny was documented by Landau et al. (2011) in the Pliocene species Andonia bonellii (Bellardi & Michelotti, 1840).

The shell illustrated by Moroni & Ruggieri (1981, fig. 3) as *Andonia* cf. *transsylvanica* from the late Miocene Tortonian of Montegibbio, Italy is indeed very similar, but with fewer spiral cords. Until further material is available for comparison, this and other Italian records (*i.e.* Cavallo & Repetto, 1992, p. 138, fig. 370; Sosso & dell'Angelo, 2010, p. 47, unnumbered fig. p. 63) are excluded from the synonymy.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Hoernes & Auinger, 1890), Poland (Bałuk, 1995); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Teretia Monterosato, 1890

Type species – Pleurotoma anceps Eichwald, 1830, by original designation. Middle Miocene, Paratethys.

Teretia anceps (Eichwald, 1830)

Plate 73, fig. 2

- *1830 Pleurotoma anceps Eichwald, p. 225.
- 1853 Pleurotoma anceps m. Eichwald, p. 186, pl. 8, fig. 7.
- 1854 Pleurotoma anceps Eichw. Hörnes, p. 368, pl. 40, fig. 11.
- 1896 Teretia anceps Eichw. Cossmann, p. 130, pl. 7, figs 3, 4.
- 1904 *Teres* [*sic*] *anceps* (Eichw.) Sacco, p. 54, pl. 14, figs 15-17.
- 1912 Teres [sic] anceps Eichw. Friedberg, p. 232, pl. 14, fig. 15.
- 1914 Daphnella (Teretia) teres Forbes Cipolla, p. 158, pl. 14, fig. 5 [non Teretia teres (Reeve, 1844)].
- 1925 Daphnella (Teres (sic]) anceps Eichw. Kautsky, p. 191, pl. 12, fig. 20.
- 1953 Daphnella anceps (Eichw.) Csepreghy-Meznerics, p. 18, pl. 2, figs 19, 20.
- 1964 Teretia anceps (Eichwald 1830) Anderson, p. 314, pl. 43, fig. 271.
- 1966 Teretia anceps Eichwald (1830) 1853 Strausz, p. 435, pl. 18, fig. 16.
- 1966 Teretia anceps (Eichwald, 1830) Powell, p. 126, pl. 20, fig. 9.
- 1972a Teretia anceps (Eichwald, 1830) Nordsieck, p. 115, fig. 190.
- 1975 *Teretia anceps* (Eichwald) Pavia, p. 114, pl. 8, figs 25, 26.
- 1977 *Teretia anceps* (Eichwald, 1830) Jakubowski, p. 113, pl. 16, figs 5, 6.
- 1982 Teretia anceps (Eichwald, 1830) Švagrovský, p. 422, pl. 11, fig. 5.
- 1984a *Teretia anceps* (Von Eichwald, 1830) A.W. Janssen, p. 326, pl. 75, fig. 2, pl. 80, fig. 2.
- 1992 Teretia teres (Forbes in Reeve, 1844) Cavallo & Repetto, p. 146, fig. 408 [non Teretia teres (Reeve, 1844)].
- 1997 Teretia teres (Revee [sic], 1844) Chirli, p. 96, pl.
 27, figs 11, 12 [non Teretia teres (Reeve, 1844)].
- 2002 Teretia anceps (Eichwald, 1830) Vera-Peláez, p.
 223, pl. 14, figs K-L.
- 2003 *Teretia anceps* (Eichwald, 1830) Brunetti & Vecchi, p. 52, pl. 2, figs 1, 2, pl. 3, figs 1, 6.
- 2003 *Teretia anceps* (Eichwald, 1853) Bałuk, p. 67, pl. 27, figs 1-3.
- 2007 Teretia anceps (Eichwald, 1830) R. Janssen & Wienrich in Wienrich, p. 715, pl. 115, figs 6, 7, pl. 154, figs 1-3.
- 2010 *Teretia anceps* (Eichwald, 1830) Moths *et al.*, p. 68, pl. 42, fig. 7.
- 2010 Teretia teres (Forbes in Reeve, 1844) Sosso & dell'Angelo, p. 48, unnumbered fig. p. 64 second row centre [non Teretia teres (Reeve, 1844)].
- 2011 Teretia anceps (Eichwald, 1830) Landau et al.,
 p. 35, pl. 18, fig. 7.
- non 1910 Daphnella (Teres (sic]) anceps Eichw. Cerulli-Irelli, p. 63, pl. 6, figs 6-10 [= Teretia teres (Reeve,

1844)].

- non 1958 Teretia anceps (Eichwald) Sorgenfrei, p. 287, pl. 62, fig. 206 (Teretia fusianceps Nordsieck, 1972).
- non 1969 Teres [sic] anceps (Eichwald) Atanacković, p. 213, pl. 12, fig. 6.
- non 1977 Teretia anceps (Eichwald, 1830) Nordsieck, p. 61, pl. 19, fig. 161 [= Teretia teres (Reeve, 1844)].

Dimensions and material – Maximum height 6.1 mm. Locality 13: NHMW 1847/0058/1391/3, JvdV/3, RGM 783 712/1, 784 049/1.

Discussion - The European species of Teretia can be separated into two groups; those with prominently carinate whorls, such as T. elegantissima (Foresti, 1868), T. monterosatoi (Cipolla, 1914) and T. turritelloides (Bellardi, 1847) and those without a prominent carina, including T. anceps (Eichwald, 1830), T. fusianceps Nordsieck, 1972 and T. teres (Reeve, 1844). The new species introduced by Vera Peláez (2002, pl. 6, figs G-J, pl. 17, V-Y) from the early Pliocene of Estepona, southern Spain are difficult to evaluate due to the extremely poor figures, and are excluded from the discussion. The specimen from Turkey falls within the second group. The fossil species T. anceps differs from the Recent northeastern Atlantic and Mediterranean species T. teres in having 4-5 rounded spiral cords per whorls as opposed to 3-4 somewhat lamellar cords in T. teres and in the absence of secondary spiral sculpture, whereas T. teres has 4-6 secondary cords per whorl (Brunetti & Vecchi, 2003). The surface of both these species is covered with micropustules and not smooth as described by Brunetti & Vecchi (2003). This can be seen in their own figures (Brunetti & Vecchi, 2003, pl. 3, figs 1-2). The micropustules seem to be a generic character. Bałuk (2003, p. 67) synonymised the Miocene North Sea Basin species T. anceps and T. fusianceps. However, as pointed out by A.W. Janssen (1984a, p. 328) there are constant differences in their shape and sculpture as well as in their microsculpture and they are here considered to be a distinct species.

Distribution - Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Germany (Kautsky, 1925; Anderson, 1964; R. Janssen & Wienrich in Wienrich, 2007; Moths et al., 2010), Netherlands (Nordsieck, 1972a; A.W. Janssen, 1984a). Middle Miocene: Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1854), Hungary (Csepreghy-Meznerics, 1953; Strausz, 1966), Poland (Friedberg, 1912; Jakubowski, 1977; Bałuk, 2003), Slovakia (Švagrovský, 1982); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (BL collection). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (Vera-Peláez, 2002); central Mediterranean, Italy (Pavia, 1975; Cavallo & Repetto, 1992; Chirli, 1997). Early-late Pliocene: central Mediterranean, Italy (Sacco, 1904; Cipolla, 1914; Brunetti & Vecchi, 2003; Sosso & dell'Angelo, 2010).

Family Cochlespiridae Powell, 1942 Genus *Cochlespira* Conrad, 1865 (= *Ancistrosyrinx* Dall, 1881)

Type species – Pleurotoma cristata Conrad, 1848, by monotypy. Eocene, southeastern United States

Cochlespira protomediterranea nov. sp. Plate 46, fig. 4

1847/0058/1178, height 13.8 mm

Dimensions and type material – Holotype NHMW 1847/0058/1177, height 15.6 mm; paratype 1 NHMW

Other material – Known only by the type material.

Etymology – Name reflecting the origin in the middle Miocene Proto-Mediterranean Sea.

Locus typicus – Pinar Yaylasi, Akpınar, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A medium-sized species of *Cochlespira* with a multispiral protoconch bearing axial riblets on last half whorl, a relatively slender teleoconch, with a strongly scalate spire, a steep sutural ramp delimited by a weakly coronate peripheral crest, and sculpture reduced to a few axial ridges on the sutural ramp, ending in small spines at the peripheral crest.

Description - Shell medium-sized, fusiform, relatively slender, with strongly scalate spire. Protoconch damaged, but multispiral, 2.5 convex whorls preserved, last half whorl bearing axial riblets. Transition to teleoconch delimited by sinuous scar. Teleoconch of six strongly angular whorls, with broad, weakly concave sutural ramp, becoming steeper abapically, sharply delimited by elevated, weakly coronate peripheral crest, whorl profile straight-sided below, tapering inwards to abapical suture. Suture linear, superficial. Axial sculpture restricted to very low, widely-spaced, inconspicuous prosocline ridges on sutural ramp, each forming small spine at peripheral ridge. Spiral sculpture absent. Last whorl 61% of total height, with steeply sloping sutural ramp, elevated coronate shoulder, weakly convex below, constricted at base. Aperture 47% of total height, sharply angled at periphery. Outer lip simple, not thickened. Siphonal canal long, open. Columella obscured by matrix. Columellar callus not developed.

Discussion – Cochlespira protomediterranea nov. sp. is closely similar to *Cochlespira corneti* (von Koenen, 1872), which is widely reported from the middle Miocene North Sea Basin (Kautsky, 1925; Glibert, 1954; A.W. Janssen, 1984a; Moths, 1990; R. Janssen & Wienrich *in* Wienrich, 2007). However, the Turkish species differs

from C. corneti in having a more slender shell, in which the sutural ramp becomes steeper abapically, whereas in C. corneti the ramp becomes shallower abapically, and is almost horizontal on the last teleoconch whorl. Furthermore, the peripheral crest delimiting the sutural ramp is far more elevated and more strongly coronate from C. corneti, making the suture deeply canaliculate, with more numerous and more pointed spines on the crest than in C. protomediterranea. The protoconch of the North Sea Basin specimens is multispiral, consisiting of possibly up to three whorls, with a central carina appearing at the beginning of the teleoconch (A.W. Janssen, 1984a, pl. 10, fig. 11; R. Janssen & Wienrich in Wienrich, 2007, pl. 108, fig. 8). The protoconch in the Karaman specimens is damaged, but consists of at least three whorls, delimited from the teleoconch by a prosocline scar and the beginning of the carinate teleoconch. The last half whorl bears weak axial riblets, which are not present in the drawings of the protoconch in the North Sea Basin specimens. Schnetler (2001) erected the genus Pseudocochlespira for cochlespirids in which the terminal protoconch bears axial riblets. However, the riblets in the Karaman shell are very weak and not clearly visible without magnification, whereas they are more clearly visible in the species discussed by Schnetler.

Cochlespira serrata (Bellardi, 1877) introduced as a *nomen novum pro Pleurotoma subterebralis* of Hörnes (1854, pl. 39, fig. 16; *non Pleurotoma subterebralis* Michelotti, 1847) from the middle Miocene Paratethys of the Vienna Basin differs in having a more slender shell, with stronger spiral sculpture and a far more finely coronate carina. *Cochlespira subserrata* (Boettger, 1906) from the middle Miocene Paratethys of Romania differs in having a very prominent coronate carina, which in this species is horizontal rather than reflected adapically as in *C. protomediterranea* or *C. corneti*. As in the new Turkish species, the spiral sculpture seems to be absent in *C. subserrata*, except for a sharp basal carina, not present in *C. protomediterranea* or *C. serrata*.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Drilliidae Olsson, 1964 Genus *Crassopleura* Monterosato, 1884

Type species – Pleurotoma maravignae Bivona, 1838, by monotypy. Recent, Pliocene, Italy.

'Crassopleura' sigmoidea (Bronn, 1831) Plate 46, fig. 5

- *1831 Pleurotoma sigmoidea Brn., Bronn, p. 47.
- 1847 *Raphitoma sigmoidea* Bronn Bellardi, p. 109, pl. 4, fig. 29.
- 1877 Drillia sigmoidea (Bronn) Bellardi, p. 144, pl. 5, fig. 4.
- 1904 Drillia (Cymatosyrinx) sigmoidea var. pliomagna Sacc., Sacco, p. 47, pl. 12, figs 49-50.

- 1914 Drillia (Cymatosyrinx) sigmoidea Bronn Cipolla, p. 124, pl. 12, fig. 14.
- 1915 *Drillia sigmoidea* (Bronn) Harmer, p. 225, pl. 27, figs 24, 25.
- 1937 Drillia (Cymatosyrinx) sigmoidea Brn. Montanaro, p. 158, pl. 7, figs 37-40.
- 1953 Drillia incrassata Duj. Csepreghy-Meznerics, p. 8, pl. 1, figs 5, 6 [non Sowerby, 1833; non Dujardin, 1837 = Crassopleura maravignae (Bivona, 1838)].
- 1954 Clavus (Elaeocyma) sigmoidea (Bronn) Glibert,p. 34, pl. 5, fig. 5.
- 1955 Drillia (Cymatosyrinx) sigmoidea (Bronn 1831) Rossi Ronchetti, p. 327, fig. 176.
- 1962 Drillia sigmoidea Bronn Strausz, p. 69, pl. 19, fig. 11.
- 1966 *Drillia sigmoidea* Bronn, 1831 Strausz, p. 426, pl. 19, fig. 11.
- 1967 Clavus (Cymatosyrinx) sigmoideus (Bronn) Pelosio, p. 158, pl. 45, figs 15, 16.
- 1973 *Clavus (Cymatosyrinx) sigmoideus* (Bronn) Caprotti & Vescovi, p. 177, pl. 2, figs 23, 24.
- 1974 *Elaeocyma sigmoidea* (Bronn, 1831) Malatesta, p. 420, pl. 31, fig. 3.
- 1976 Clavus sigmoideus (Bronn) Caprotti, p. 12, pl. 16, fig. 23.
- 1978 Pleurotoma sigmoidea Bronn, 1831 Pinna & Spezia, p. 158, pl. 46, fig. 3.
- 1984 *Crassopleura sigmoidea* (Bronn, 1831) Bernasconi & Robba, p. 272, pl. 2, figs 2, 3.
- 1990 Cerodrillia (C.) sigmoidea (Bronn, 1831) della Bella & Tabanelli, p. 267, figs 1, 2.
- 1997 Crassopleura sigmoidea (Bronn, 1831) Chirli, p. 44, pl. 12, figs 6-9.
- 2002 Crassopleura sigmoidea (Bronn, 1831) Vera-Peláez, p. 197, pl. 3, figs A-C, pl. 11, figs K-L.
- 2003 'Crassopleura' sigmoidea (Bronn, 1831) Scarponi & della Bella, p. 23, figs 4, 5, 15.
- 2010 'Crassopleura' sigmoidea (Bronn, 1831) Sosso & dell'Angelo, p. 44, unnumbered fig. p. 60 bottom row centre.
- 2011 *'Crassopleura' sigmoidea* (Bronn, 1831) Landau *et al.*, p. 36, pl. 18, fig. 13.

Dimensions and material – Maximum height 7.4 mm. Localities 7 & 8: NHMW 1847/0058/1692/1; locality 13: NHMW 1847/0058/1508/2.

Discussion – As pointed out by Scarponi & della Bella (2003, p. 24) the anal sinus in this species is not typical of the genus, and it is therefore attributed to the genus *Crassopleura* with some hesitation. *Crassopleura' sigmoidea* is extremely rare in the Karaman assemblages. The low, rounded, smooth, axially aligned axial ribs and absence of spiral sculpture are distinctive. One slightly worn specimen is present from the clayey Pinarlar Yaylasi deposits. For discussion see Bernasconi & Robba (1984, p. 272) and Scarponi & della Bella (p. 24).

Distribution - Middle Miocene: Paratethys (Langhian-Serravallian): Hungary (Csepreghy-Meznerics, 1953; Strausz, 1962, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (BL collection); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1877; Montanaro, 1937). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (Vera-Peláez, 2002); central Mediterranean, Italy (Bellardi, 1877; Pelosio, 1967; Bernasconi & Robba, 1984; della Bella & Tabanelli, 1990; Chirli, 2008). Early-late Pliocene: central Mediterranean, Italy (Bellardi, 1877; Sacco, 1904; Cipolla, 1914; Glibert, 1954; Caprotti & Vescovi, 1973; Caprotti, 1976; Malatesta, 1974; Scarponi & della Bella, 2003; Sosso & dell'Angelo, 2010). Late Pliocene: North Sea Basin, England (Harmer, 1915). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1910).

Genus Fusiturris Thiele, 1929

Type species – Pleurotoma undatiruga Bivona, 1838, by monotypy. Recent, West Africa.

Fusiturris plicatula (Grateloup, 1832) Plate 46, fig. 6

- *1832 Pleurotoma plicatula Grateloup, p. 327.
- 1846 *Pleurotoma plicatula* Grat. Grateloup, pl. 20, fig. 31.
- 1931 *Pleurotoma plicatula* Grateloup Peyrot, p. 81, no. 1242, pl. 8, figs 65, 73.
- 1958 *Turris (Turris) plicatula* (Grateloup) Erünal-Erentöz, p. 105, pl. 16, figs 11, 12.
- 2004 *Pleurotoma plicatula* Grateloup, 1832 Tucker, p. 771.

Dimensions and material – Maximum height 39.5 mm. Localities 2 & 3: JvdV/27, RGM 783 925/5, YI 387/9; locality 6: RGM 783 868/2; localities 7 & 8: NHMW 1847/0058/1695/1, JvdV/13, RGM 783 894/5; locality 9: JvdV/11, RGM 783 840/16, YI 370/5; locality 10: YI 388/4; locality 12: JvdV/50+; locality 13: NHMW 1847/0058/1179/1, 1847/0058/1180/50+, JvdV/50+, RGM 783 709/50+, MTA 2013/080/10, YI 369/50+; locality 17: JvdV/10, YI 371/18 + 1 juvenile. Exact locality unknown: AÜ-LE-K-245/8.

Discussion – Fusiturris plicatula (Grateloup, 1832) is found in most of the Karaman assemblages, although it is particularly common in the clayey deposits. It is closely similar to *Fusiturris aquensis* (Grateloup, 1832), but differs in having more numerous axial ribs and in having the last whorl more convex at the base. The protoconch is not well-preserved in any of the numerous shells seen, however, it is tall, slender, multispiral, consisting of about 3.5 whorls, the last protoconch whorl bearing axial riblets. *Distribution* – **Middle Miocene**: northeastern Atlantic (Langhian): Aquitaine Basin, France (Peyrot, 1931); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Genus Spirotropis G.O. Sars, 1878

Type species – Pleurotoma carinata 'Philippi' (? = Bivona, 1838) *non* 'Defrance' Deshayes, 1834 *nec* Gray, 1834 = *Drillia confusa* Seguenza, 1880, by monotypy. Pliocene. Italy.

Spirotropis karamanensis R. Janssen, 1993

Plate 46, fig. 7; Plate 73, fig. 3

*1993 Spirotropis karamanensis R. Janssen, p. 244, pl. 2, figs 6-8.

Dimensions and material – Maximum height 13.6 mm. Locality 6: 1 paratype RGM 229 971/1; localities 7 & 8: NHMW 1847/0058/1183/15, RGM 783 893/5, YI 389/3; locality 13: NHMW 1847/0058/1181/1, 1847/0058/1182/50+, JvdV/5, 2 paratypes RGM 229 972/2, RGM 784 050/1, YI 390/33.

Discussion - 'This species is known only from the Miocene of the Karaman Basin. In some characters it holds an intermediate position between S. badensis [R. Janssen, 1993] and S. tortonica [R. Janssen, 1993] and probably it represents an intermediate evolutionary stage between these two species. The species is distinguished from S. badensis by its small size, a different growth ratio (H/n wh, t = 11.877 [H = height, n wh = number of whorls, t = Students t-test where values of t > 3 indicate a significant difference]), the smooth and glossy shell, the smaller protoconch (dprot, t = 14.158), the more or less missing denticulation on the first teleoconch whorl, and by the position of the bulge of the last whorl. From S. tor*tonica* it is distinguished by its smooth shell, the smaller dimensions of the protoconch (dnuc, t = 16.757; dprot, t =12.952) and again by the position of the bulge' (R. Janssen, 1993, p. 245).

There is little to add to these comments. The parameters of the protoconch we figure (dp = $615 \ \mu m$, hp = $770 \ \mu m$, dp/hp = 0.80, dP1 = $480 \ \mu m$, dn = $250 \ \mu m$; Pl. 73, fig. 3) are similar to those given by R. Janssen (1993). The species is common in the clayey assemblages of the Karaman Basin.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (R. Janssen, 1993).

Genus Stenodrillia Korobkov, 1955

Type species – Pleurotoma allionii Foresti, 1876, by original designation. Miocene-Pliocene, Europe.

Stenodrillia sp.

Plate 46, fig. 8; Plate 73, fig. 4

Dimensions and material – Maximum height 42.0 mm. Localities 2 & 3: JvdV/32, RGM 783 926/2, YI 382/18; locality 6: JvdV/1, RGM 783 867/1; localities 7 & 8: JvdV/4, RGM 783 895/3; locality 9: JvdV/9; locality 10: YI 381/5; locality 12: JvdV/23; locality 13: NHMW 1847/0058/1186/20, 1847/0058/1184/1, JvdV/31, RGM 783 710/34, RGM 794 534/3, YI 386/50+; locality 17: NHMW 1847/0058/1185/11. Exact locality unknown: AÜ-LE-K-235/8.

Discussion – This Turkish species of Stenodrillia is characterised by its tall multispiral protoconch, consisting of about three whorls (dp = 900 μ m, hp = 1140 μ m, dp/hp = 0.79; Pl. 73, fig. 4), the last protoconch whorl bearing a few comma-shaped riblets. The teleoconch sculpture is of intermediate strength, with 9-11 axial ribs and one or two secondary threads between the primary spiral cords. The sutural ramp is rather narrow, concave, with the axial sculpture crossing the ramp, weakening towards the suture.

Two similar European Neogene species, *Stenodrillia allionii* (Foresti, 1876) and *Stenodrillia bellardii* (Desmoulins, 1842), have long been confused in the literature, however, the two are quite distinct (Scarponi & della Bella, 2003). *Stenodrillia allionii* has a wide, well-developed sutural ramp, devoid of axial sculpture, a wider and more prominent anal sinus, less robust axial ribs and finer spiral threads, and a protoconch with three instead of four whorls with a larger nucleus than *S. bellardii. Stenodrillia bellardii* has much coarser sculpture, the sutural ramp is very narrow indeed, with the axial ribs strongly developed across the ramp. Moreover, *S. bellardii* is an exclusively Miocene species, whereas *S. allionii* has a middle Miocene to Piacenzian stratigraphic range.

Stenodrillia victoriae (Hoernes & Auinger, 1891) is a another closely similar species from the middle Miocene Paratethys of Romania, differing in having an even more slender shell shape and fine, close-set spiral cords, similar to *S. allionii*, but with a narrower sutural ramp. *Steno-drillia moulinsii* (Grateoup, 1846) from the Atlantic middle Miocene Langhian of the Aquitaine Basin is closely similar to *S. allionii* in the character of its sculpture and sutural ramp, but seems to have the axial ribs obsolescent towards the sutures (see Glibert, 1954).

Paratethyan shells erroneously referred to as *Stenodrillia allionii/obeliscus* by Hörnes (1853) and Hoernes & Auinger (1891) are also very similar, but differ from the species compared above in their axial ribs, which terminate rather abruptly adapically below the sutural band. Moreover, they differ in the less pronounced separation into primary and secondary spiral threads.

The Turkish shells are intermediate in form between *S. allionii* and *S. bellardii*. The sculpture is stronger than that of *S. allionii*, but weaker than of *S. bellardii*. The sutural ramp is intermediate in width, with the axial ribs crossing the ramp as in *S. bellardii*, but more weakly developed. Therefore, we do not assign these specimens to

a species, but await a wider revision of European species of *Stenodrillia*.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Stenodrillia cf. *obeliscus* (Desmoulins, 1842) Plate 46, fig. 9

- cf. *1842 Pleurotoma obeliscus Desmoulins, p. 176, no. 59.
- cf. 1931 *Drillia (Crassispira) obeliscus* Desmoulins Peyrot, p. 94, no. 1250, pl. 7, figs 59-61.
 - 1958 *Crassispira* aff. *obeliscus* (Desmoulins) Erünal-Erentöz, p. 91, pl. 14, figs 5, 6.
 - 2003 Crassispira obeliscus (Desmoulins, 1842) Bałuk, p. 47, pl. 13, figs 6-10.

Dimensions and material – Maximum height 25.8 mm. Localities 2 & 3: JvdV/40, YI 383/30; localities 7 & 8: JvdV/18; locality 12: JvdV/17; locality 13: NHMW 1847/0058/1187/1, 1847/0058/1188/50+, JvdV/37, RGM 783 711/39, YI 385/50+; locality 17: YI 384/7.

Discussion – There is huge confusion in the literature on the status of the Paratethyan shells, variously referred to as Stenodrillia allionii or S. obeliscus. It seems that several different species might be lumped together, which is also indicated by their different palaeoecological settings ranging from seagrass environments to offshore clays (personal observation MH). Bałuk (2003) illustrated shells from the Badenian of Poland, which are very similar to the Turkish shells and might be conspecific. Other specimens from Romania and Austria in the NHM collections [including the shells illustrated by Hörnes (1853) and Hoernes & Auinger (1891)] are more slender and have more numerous axial ribs than the Turkish shells. These Paratethyan shells could indeed be conspecific with Stenodrillia obeliscus (Desmoulins, 1842) as defined by Peyrot (1931), although the anal sinus of the Turkish shells is far deeper than that illustrated by Peyrot (1931) for the French shells.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): ?Poland (Bałuk, 2003); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Genus Turriclavus Bernasconi & Robba, 1984

Type species – Murex harpula Brocchi, 1814, by original designation. Pliocene, Italy.

Turriclavus harpulus (Brocchi, 1814)

Plate 46, fig. 10

*1814 *Murex harpula* nob., Brocchi, p. 421, pl. 8, fig. 12.
1840 *Pleurotoma Philippii* Bell. et Michel., Bellardi &

Michelotti, p. 102, pl. 1, fig. 8.

- 1862 Pleurotoma harpula (Br.) var. B Brugnone, p. 26, pl. 1, fig. 19.
- 1882 *Pleurotoma harpula* Brocchi S.V. Wood, p. 5, pl. 1, fig. 4.
- 1904 *Raphitoma? harpula* (Br.) Sacco, p. 56, pl. 14, figs 45-47.
- 1914 *Peratotoma (Amblyacrum) harpula* Brocchi Cipolla, p. 172, pl. 14, fig. 23.
- 1915 *Raphitoma harpula* (Brocchi) Harmer, p. 255, pl. 30, figs 1-2.
- 1937 Daphnella (Raphitoma) harpula (Br.) Montanaro, p. 187, pl. 8, figs 63, 64.
- 1937 Daphnella (Raphitoma) harpula var. peracutecostata Montanaro, p. 189, pl. 8, figs 68-70.
- 1955 *Cythara (Mangelia) (Mangelia) harpula* (Brocchi 1814) Rossi Ronchetti, p. 300, fig. 160.
- 1966 Cythara (Mangelia) harpula (Brocchi) Pelosio, p. 165, pl. 46, figs 4-7.
- 1974 Bela harpula (Brocchi, 1814) Malatesta, p. 426, pl. 31, fig. 21.
- 1978 Murex harpula Brocchi, 1814 Pinna & Spezia, p. 149, pl. 38, fig. 3.
- 1984 *Turriclavus harpula* (Brocchi, 1814) Bernasconi & Robba, p. 282, pl. 3, figs 3-5.
- 1992 *Turriclavus harpula* (Brocchi, 1814) Cavallo & Repetto, p. 132, fig. 352.
- 1997 *Raphitoma harpula* (Brocchi, 1814) Chirli, p. 78, pl. 22, figs 7-10.
- 2002 *Turriclavus harpula* (Brocchi, 1814) Vera-Peláez, p. 198, pl. 3, figs I, J, pl. 12, figs A-B.
- 2003 *Turriclavus harpula* (Brocchi, 1814) Scarponi & della Bella, p. 26, figs 9-11, 18.
- 2010 *Turriclavus harpula* (Brocchi, 1814) Sosso & dell'Angelo, p. 44, unnumbered fig. p. 60 bottom right.
- ?non 1831 Fusus (Murex) harpula Broc. Dubois de Montpéreux, p. 31, pl. 1, figs 47, 48.
- ?non 1853 Pleurotoma harpula Brocc. Hörnes, p. 376, pl. 40, fig. 12.
- non 1937 Daphnella (Raphitoma) harpula var. mutabilis May. – Montanaro, p. 188, pl. 8, fig. 65.
- non 1937 Daphnella (Raphitoma) harpula var. brachystoma (Phil.) – Montanaro, p. 188, pl. 8, fig. 66-67.
- non 1963 Cythara (Mangelia) harpula (Br.) Venzo & Pelosio, p. 128, pl. 46, figs 24, 26.
- non 1963 Cythara (Mangelia) harpula f. turricolata Venzo & Pelosio, p. 129, pl. 46, fig. 25.
- non 1963 Cythara (Mangelia) harpula f. tumida Venzo & Pelosio, p. 129, pl. 46, fig. 31.

Dimensions and material – Height 17.8 mm. Locality 13: NHMW 1847/0058/1189/1; YI 416/3.

Discussion – The derivation of the genus *Turriclavus* Bernasconi & Robba, 1984 is "*clavus*", a masculine noun meaning nail, spike or rivet. Therefore the correct name for the type species is *Turriclavus harpulus* (Brocchi, 1814). These tall, slender, fusiform shells from the Akpinar assemblages are here ascribed to *Turriclavus harpulus*. The spiral sculpture is finer than usual for this species, although such 'smooth' forms also occur in the Italian Pliocene (see Scarponi & della Bella, 2003, pl. 2, fig. 9). Unfortunately, the protoconch is missing from the Turkish shells, but it is described as composed of 2.25-2.75 whorls, with micropustules on the early whorls (Bernasconi & Robba, 1984, p. 283, pl. 3, figs 4-5).

As pointed out by Bernasconi & Robba (1984), the shells illustrated by Hörnes (1853, pl. 40, fig. 12) and Venzo & Pelosio (1963, pl. 8, figs 24-26, 31) are unlikely to be conspecific, or to belong to the genus *Turriclavus* Bernasconi & Robba, 1984. The shell illustrated by Dubois de Montpéreux (1831, pl. 1, figs 47-48) from the middle Miocene Paratethys is too poorly preserved to identify, but seems far too small to be *T. harpulus*.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Poland (Friedberg, 1912); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1904; Montanaro, 1937). Early Pliocene: North Sea Basin, England (Harmer, 1915); western Mediterranean, Estepona Basin, Spain (Vera-Peláez, 2002), central Mediterranean, Italy (Pelosio, 1966; Bernasconi & Robba, 1984; Chirli, 1997; Scarponi & della Bella, 2003). Early-late Pliocene: North Sea Basin, England (Wood, 1882; Harmer, 1915); central Mediterranean, Italy (Sacco, 1904; Cipolla, 1914; Malatesta, 1974; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010).

Family Pseudomelatomidae Morrison, 1965 Genus Crassispira Swainson, 1840

Type species – Pleurotoma bottae Kiener, 1840a, by subsequent designation (Herrmannsen, 1847). Recent, tropical western America.

Crassispira pustulata (Brocchi, 1814)

Plate 46, fig. 11; Plate 73, fig. 5; Pl. 82, fig. 10

- *1814 Murex pustulatus Brocchi, p. 430, pl. 9, fig. 5.
- 1847 *Pleurotoma pustulata* Brocch. Bellardi, p. 76, pl. 4, fig. 4.
- 1877 Pleurotoma pustulata (Brocch.) Bellardi, p. 104, pl. 3, fig. 31.
- 1904 Drillia (Crassispira) pustulata var. plurisulcata Sacco, p. 45, pl. 12, fig. 19.
- 1904 Drillia (Crassispira) pustulata var. bifidocostata Sacco, p. 45, pl. 12, figs 20, 21.
- 1931 Drillia (Crassispira) pustulata Brocchi Peyrot, no. 1256, pl. 7, figs 92, 94.
- 1937 *Drillia*?? (*Crassispira*) *pustulata* (Br.) Montanaro, p. 153, pl. 7, figs 18-21, 24, 25.
- ?1937 Drillia?? (Crassispira) pustulata var. bifidocostata Sacco – Montanaro, p. 155, pl. 10, figs 26-27.
- 1954 Pleurotoma pustulata (Brocchi, 1814) Glibert,

p. 27, pl. 1, fig. 10.

- 1955 *Turris (Crassipira) pustulata* (Brocchi 1814) Rossi Ronchetti, p. 324, fig. 174.
- 1956 Drillia (Crassispira) pustulata bifidocostata (Sacco, 1904) – Moroni, p. 117, pl. 6, fig. 33 (not seen).
- 1958 Drillia (Crassispira) pustulata var. plurisulcata Sacco – Erünal-Erentöz, p. 90, pl. 14, figs 3-4.
- 1963 *Crassispira* (*C.*) *pustulata* (Br.) Venzo & Pelosio, p. 123, pl. 39, figs 9-13.
- 1963 Crassispira (C.) pustulata f. sanmarinensis Venzo & Pelosio, p. 124, pl. 39, figs 14-15.
- 1963 Crassispira (C.) pustulata var. bifidocostata (Sacco) Venzo & Pelosio, p. 124, pl. 39, figs 20-23.
- 1968 Crassispira (Crassispira) pustulata bifidocostata (Sacco, 1904) – Robba, p. 592, pl. 45, fig. 7.
- 1978 Murex pustulatus Brocchi, 1814 Pinna & Spezia,
 p. 152, pl. 41, fig. 3.
- 1984 Crassispira (Crassispira) pustulata (Brocchi) Ruggieri & Davoli, p. 69, pl. 5, figs 5-9.
- 1990 *Crassispira* (*Crassispira*) *pustulata* (Brocchi, 1814) Davoli, p. 91, pl. 8, figs 22, 23, pl. 9, figs 2-7.
- 2003 Crassispira pustulata (Brocchi, 1814) Scarponi & della Bella, p. 52, figs 68, 79.
- non 1854 Pleurotoma pustulata Brocch. Hörnes, p. 369, pl. 39, fig. 21 [= Crassispira enzesfeldensis (Handmann, 1882)].
- ?non 1891 Pleurotoma (h. Drillia) pustulata Brocc. var. Hoernes & Auinger, p. 319, pl. 40, figs 1-12 [= Crassispira enzesfeldensis (Handmann, 1882)].
- ?non 1912 Drillia pustulata Brocc. Friedberg, p. 215, pl. 13, fig. 17 [= Crassispira enzesfeldensis (Handmann, 1882)].
- non 1912 Pleurotoma (Drillia) pustulata Brocchi (var?) Schaffer, p. 134, pl. 49, fig. 8.
- ?non 1917 Drillia pustulata (Brocchi) Stefanini, p. 54, pl. 1, figs 20, 21.
- non 1938 Drillia (Crassispira) pustulata (Brocchi) Peyrot, p. 270, pl. 4, fig. 60 (= Crassispira powelli Glibert, 1954).
- ?non 1954 Drillia pustulata Brocchi Csepreghy-Meznerics, p. 50, pl. 6, figs 22, 23, 28, 29 [= Crassispira enzesfeldensis (Handmann, 1882)].
- ?non 1958 Clavus (Crassipira) pustulatus (Brocchi) Švagrovský, p. 23, pl. 7, figs 6-13 [= Crassispira enzesfeldensis (Handmann, 1882)].
- non 1958 Clavus (Crassipira) pustulatus (Brocchi) Hölzl, p. 273, pl. 21, fig. 21.
- ?non 1960 Drillia pustulata (Brocchi 1814) Kojumdgieva & Strachimirov, p. 202, pl. 48, fig. 10 [= Crassispira enzesfeldensis (Handmann, 1882)?].
- ?non 1962 Drillia pustulata Brocchi Strausz, p. 68, pl. 19, fig. 9 [= Crassispira enzesfeldensis (Handmann, 1882) ?].
- ?non 1966 Drillia pustulata Brocchi, 1814 Strausz, p. 424, pl. 19, fig. 9 [= Crassispira enzesfeldensis (Handmann, 1882) ?].
- ?non 1968 Drillia pustulata (Brocchi, 1814) Zelinskaya et al., p. 222, pl. 50, figs 26, 27 [= Crassispira

enzesfeldensis (Handmann, 1882) ?].

- ?non 1970 Clavus (Crassipira) pustulatus (Brocchi) Bałuk, p. 119, pl. 13, fig. 10 [= Crassispira enzesfeldensis (Handmann, 1882) ?].
- ?non 1973 Clavus pustulatus (Brocchi) 1814 Bohn Havas, p. 1065, pl. 6, fig. 6 [= Crassispira enzesfeldensis (Handmann, 1882) ?].
- ?non 1985 Drillia (Crassispira) pustulata (Brocchi, 1814) Atanacković, p. 170, pl. 37, figs 16-17 [= Crassispira enzesfeldensis (Handmann, 1882) ?].
- ?non 2003 Crassispira pustulata (Brocchi, 1814) Bałuk, p. 48, pl. 13, figs 1-5 [= Crassispira enzesfeldensis (Handmann, 1882) ?].
- non 2009 Clavus (Drillia) pustulatus (Brocchi, 1814) Schultz, p. 74, pl. 30, fig. 10 [= Crassispira enzesfeldensis (Handmann, 1882)].
- ?non 2009 Clavus (Drillia) pustulatus (Brocchi, 1814) Mikuž, p. 29, pl. 9, fig. 128 [= ? Crassispira enzesfeldensis (Handmann, 1882) ?].

Dimensions and material – Maximum height 27.8 mm. Localities 2 & 3: JvdV/3, RGM 783 927/1, YI 379/2; localities 7 & 8: NHMW 1847/0058/1191/17, JvdV/4; locality 13: YI 380/1; locality 17: NHMW 1847/0058/1190/1, 1847/0058/1191/50+, JvdV/30, RGM 777 900/1 (ex JvdV collection), RGM 784 024/1,783 972/7, MTA 2013/081/17, YI 378/42.

Discussion - Glibert (1954, pl. 1, fig. 10) illustrated the protoconch of Crassispira pustulata (Brocchi, 1814), showing a bulbous paucispiral protoconch, similar to that seen in the shells from the Karaman Basin (dp = $730 \,\mu m$, hp = 620 μ m, dp/hp = 1.2, dn = 495 μ m, dV1 = 615 μ m; Pl. 73, fig. 5). The specimen illustrated by Peyrot (1938, pl. 4, fig 60) as C. pustulata from the middle Miocene Langhian of the Loire Basin of France were shown by Glibert (1954) to be a separate species, Crassipira powelli Glibert, 1954, differing from C. pustulata in sculptural details, and in having a multispiral protoconch. The shells described by Peyrot (1931) from the Aquitain Basin do, however, seem to be C. pustulata, as Peyrot described them as having a paucispiral protoconch. Interestingly, Glibert (1954) ascribed the middle Miocene Paratethyan shells to C. powelli, based on remnants of coloration.

Other authors, such as Bellardi (1877) and Hoernes & Auinger (1891), had also recognised that the middle Miocene shells from the Vienna Basin identified as Pleurotoma pustulata by Hörnes (1854) were not conspecific with Brocchi's species. Handmann (1882) was the first to propose Pleurotoma enzesfeldensis as a new name for this species, referring explicitely to the specimen illustrated by Hörnes (1854). This rarely cited paper was probably overlooked by Glibert (1954), who suggested that the Paratethyan shells represent his species Crassispira powelli. Later, Glibert (1960b) corrected his identification and separated the Paratethyan shells from Austria and Romania that he had at hand as Crassispira cf. enzesfeldensis (Handmann) from C. powelli based on differences in sculpture. He described the protoconch of C. enzesfeldensis as identical to that of C. powelli, with a conical multispiral protoconch. We did not find any protoconchs on shells from the Vienna Basin but those from Lapugiu de Sus in Romania in the NHM collection confirm Glibert's description.

Unfortunately, the story is even more complex as we (BL) have examined the protoconch of a Paratethyan shell from Várparlota in Hungary with a well-preserved protoconch, and it is paucispiral with a bulbous nucleus, similar to that illustrated here (Pl. 73, Fig. 5). The colour pattern seen with UV light in the Turkish shells is similar to that seen in Paratethyan specimen of *C. enzesfeldensis*, consisting of a subsutural band and a mid-whorl band on the last whorl (Pl. 82, fig. 10). This suggests that *C. pustulata* and *C. enzesfeldensis* co-occurred in the middle Miocene Paratethys. Thus, without information on the protoconch it is difficult to interpret the Paratethyan literature and we have tentatively removed it from the synonymy.

Numerous other *Crassispira* species occur in the European Neogene, but they are all separated by their more slender shells with taller spires. The small, poorly preserved shells from the early Burdigalian (Eggenburgian) of the Paratethys described by Schaffer (1912) and Hölzl (1958) are not this species.

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1877). Middle Miocene: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Peyrot, 1931); Paratethys (Langhian-Serravallian): Hungary (NHMW collection); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, Italy (Bellardi, 1877; Sacco, 1904; Montanaro, 1937; Venzo & Pelosio, 1963; Robba, 1968; Davoli, 1990). Early Pliocene: Central Mediterranean, Italy (Ruggieri & Davoli, 1984; Scarponi & della Bella, 2003).

Genus Miraclathurella Woodring, 1928

Type species – Miraclathurella vittata Woodring, 1928, by original designation. Pliocene, Jamaica.

Miraclathurella bittneri (Boettger, 1902) Plate 46, fig. 12

- *1902 Mangilia [sic] bittneri Boettger, p. 67, no. 229.
- 1906 Mangilia [sic] bittneri Bttgr. Boettger, p. 78, no.291.
- 1934 Cythara (Mangelia) bittneri (Boettger) Zilch, p. 266, pl. 18, fig. 46.
- 2003 *Cythara (Mangelia) bittneri* (Boettger, 1901 [*sic*]) – Bałuk, p. 57, pl. 20, figs 5, 6.

Dimensions and material – Height 10.9 mm. Locality 13: NHMW 1847/0058/1193/1.

Discussion – Unfortunately, the protoconch is missing, but the teleoconch has a very characteristic tall, slender shape,

the spire is composed of tall, weakly convex whorls and the sculpture is subdued, consisting of weak, flattened, prosocline axial ribs and narrow spiral threads starting below a broad, smooth, steep sutural ramp. The shoulder is hardly developed. The aperture is long and narrow and the anal sinus very deep. The lectotype of *Miraclathurella bittneri* (Boettger, 1902), illustrated by Zilch (pl. 18, fig. 46), differs in having fewer spiral cords and stronger nodes at the shoulder, but the very worn specimens from Poland illustrated by Bałuk (2003; pl. 28, figs 11) have more numerous cords like the Turkish specimen. Unfortunately, we have insufficient Turkish or Paratethyan specimens to understand the intraspecific variability, but despite these small differences the Akpınar shell is provisionally assigned to *M. bittneri*.

Miraclathurella bittneri is not similar to any other European turrid, but is very similar indeed to certain Caribbean Neogene species such as *M. entemna* Woodring, 1928 from the Pliocene Bowden Formation of Jamaica and *M. eucharis* Woodring, 1970 from the late Miocene Gatun Formation of Panama.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 2003), Romania (Boett-ger, 1902, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Miraclathurella granaria (Dujardin, 1837)

Plate 46, fig. 13

- *1837 *Pleurotoma granaria* Duj., Dujardin, p. 292, pl. 20, fig. 29.
- 1854 Pleurotoma granaria Duj. Hörnes, p. 382, pl. 40, fig. 10.
- ?1877 Drilla Matheroni Bellardi, p. 117, pl. 4, fig. 5.
- 1891 Pleurotoma (l. Drillia) granaria Duj. Hoernes & Auinger, p. 321, pl. 41, figs 14-20.
- 1912 Drillia granaria Duj. Friedberg, p. 217, pl. 13, figs 18-19.
- 1931 Drillia (Crassispira) granaria Dujardin Peyrot, no. 1261, pl. 9, fig. 33, pl. 10, figs 45-47.
- 1953 *Drillia granaria szobensis* Csepreghy-Meznerics, p. 8, pl. 1, figs 15, 16.
- 1954 *Clavus (Crassispira) granaria* Dujardin, 1837 Glibert, p. 31, pl. 5, fig. 1.
- 1955 Drillia (Stenodrillia) granaria Duj. Korobkov, p. 392, pl. 104, figs 16, 17.
- 1960 Drillia (Stenodrillia) granaria (Dujardin 1837) Kojumdgieva & Strachimirov, p. 201, pl. 48, figs 8-9.
- 1962 Drillia granaria szobensis Csepreghy-Meznerics
 Strausz, p. 68, pl. 19, fig. 10.
- 1966 Drillia granaria szobensis Csepreghy-Meznerics, 1953 – Strausz, p. 425, pl. 19, fig. 10.
- 1966 Drillia (Stenodrillia) granaria (Duj) Kókay, p. 134 (plate caption only), pl. 9, fig. 13.
- ?1981 Drilla matheroni Bellardi, 1877 Ferrero Mortara et al., p. 71, pl. 11, fig. 11.
- 2003 Miraclathurella granaria (Dujardin, 1837) -

Bałuk, p. 49, pl. 11, figs 5-8.

Dimensions and material – Maximum height 10.2 mm. Localities 2 & 3: JvdV/1; locality 6: JvdV/1; localities 7 & 8: NHMW 1847/0058/1196/1, JvdV/1; locality 13: YI 452/1; locality 17: NHMW 1847/0058/1194/1, 1847/0058/1195/2, JvdV/2.

Discussion - Bałuk (2003, p. 49) synonymised Drillia matheroni Bellardi, 1877 with Pleurotoma granaria Dujardin, 1837 and and said that they were identical in both protoconch and teleoconch characteristics. When interpreting Bellardi's species, Bałuk referred to Pliocene specimens illustrated by Bernasconi & Robba (1984, pl. 8, figs 4-5) and Chirli (1997, pl. 10, figs 8-10), whereas D. matheroni actually was described from the early Miocene Burdigalian deposits of Italy. A syntype of D. matheroni from the Turin Hills was illustrated by Ferrero Mortara et al. (1981, pl. 11, fig. 11), but the illustration is too small to recognise any protoconch characters. Unfortunately, none of the Turkish shells have the nucleus preserved, but there are clear differences between their protoconchs and that of the Pliocene shells illustrated by Bernasconi & Robba (1984, pl. 8, fig. 4) and Scarponi & della Bella (2003, fig. 101). The protoconch of the Italian Pliocene shells is rather slender and tall, composed of 3.5 weakly convex whorls, with close-set axial riblets on the last whorl. The protoconch in the Turkish shells is low domeshaped, with strongly convex whorls, probably also consisting of 3-3.5 whorls, with fewer, more elevated riblets on the last whorl. The teleoconch is indeed very similar in the Turkish and Italian Pliocene shells. However, all the Pliocene specimens seen in the literature and in collections (BL) are taller and more slender. Therefore, we do not consider the Italian Pliocene shells reported as D. matheroni to be conspecific with the Turkish shells. The illustration given by Ferrero Mortara et al. (1981, pl. 11, fig. 11) of the early Miocene Italian species D. matheroni is more similar to the squatter Turkish shells, and from the very small photograph, the protoconch seems to be intact and composed of strongly convex whorls, more like the Turkish shell. However, in order to be certain a detailed comparison is required. The illustrations by Bałuk (2003, pl. 11, figs 5-8) from the middle Miocene Paratethys of Poland show a low protoconch similar to that described for the Turkish shells and Bałuk's specimens are here considered to represent the same species. Direct comparison with French specimens of M. granaria was not possible, as none are preserved in our collections with the protoconch intact. Bernasconi & Robba (1984) commented that the early teleoconch whorls of the French species have only one spiral cord, whereas the first teleoconch whorl of the both the Turkish and Italian Pliocene shells starts with two cords.

We note that Scarponi & della Bella (2003, p. 64) did not include *D. matheroni* in synonymy with *Pleurotoma granaria*, but merely commented that they are very similar. These authors placed both species in the genus *Compsodrillia* Woodring, 1928. The latter is a typically Caribbean genus, characterised by shells with more strongly convex whorls than *Miraclathurella*, the base is far more quickly constricted and the primary spiral cords are more strongly developed than in *Miraclathurella*.

To summarise, we provisionally consider the Turkish middle Miocene, Paratethyan middle Miocene and probably the Italian early Miocene shells conspecific with those from the early and middle Miocene of France, pending confirmation. We further consider the Italian Pliocene shells reported as *D. matheroni* to be a distinct species (or chronosubspecies), which at present is unnamed.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Peyrot, 1931); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1877). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Peyrot, 1931), Loire Basin, France (Glibert, 1954); Paratethys (Langhian-Serravallian): Vienna Basin, Austria (Hörnes, 1854; Hoernes & Auinger, 1891), Bulgaria (Kojumdgieva & Strachimirov, 1960), Poland (Friedberg, 1912; Bałuk, 2003), Hungary (Strausz, 1962, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: Central Mediterranean, Italy (Bernasconi & Robba, 1984; Chirli, 1997).

Family Clavatulidae Gray, 1853 Genus *Clavatula* Lamarck, 1810

Type species – Clavatula coronata Lamarck, 1801, by monotypy. Recent, West Africa.

Clavatula ernesti (Toula, 1901)

Plate 47, figs 1-3; Plate 50, fig. 3; Plate 73, fig. 6

- *1901 Pleurotoma (Clavatula) Ernesti Toula, p. 261, pl. 8, fig. 11.
- 1958 *Clavatula (Clavatula) asperulata* var. *ernesti* Toula – Erünal-Erentöz, p. 96, pl. 15, figs 3-4.

Dimensions and material – Maximum height 82.2 mm. Localities 2 & 3: JvdV/50+, RGM 783 929/50+, MTA 2013/082/28, YI 398/50+; locality 6: NHMW 1847/0058/1490/8, JvdV/5, RGM 783 869/40; localities 7 & 8: NHMW 1847/0058/1201/8, JvdV/42, RGM 783 900/23; locality 9: JvdV/14, YI 402/4; locality 10: YI 400/28; locality 12: JvdV/50+, RGM 783 617/50+; locality 13: NHMW 1847/0058/1199/1, 1847/0058/1200/20, JvdV/50+, RGM 783 713-783 715/50+, RGM 794 535/1, YI 399/44; locality 17: NHMW 1847/0058/1197/1, 1847/0058/1198/14, JvdV/50+, RGM 783 810/35, YI 401/15. Exact locality unknown: RGM 17 044/1, height 56.7 mm, holotype of *Pleurotoma (Clavatula) ernesti* Toula, 1901 (Pl. 47, fig. 3); AÜ-LE-K-240/4.

Revised description – Shell large, early whorls relatively slender, later whorls widening, with spinous sculpture. Protoconch paucispiral, consisting of just over two smooth whorls with medium-sized nucleus. Teleoconch

boundary marked by beginning of comma-shaped axial ribs (Pl 73, fig. 6b, c). First teleoconch whorl with four spiral cords separated by narrow grooves. Abapically, upper cord becomes nodular, second cord weakens and divides, and lower two cords become nodular, elevated and coalescent (Pl. 73, fig. 6a). On later whorls upper cord producing strong, laterally compressed, erect spines, lower cord forms short weak spine at abapical suture; sculpture in between of narrow, very weak, irregular spiral cords. Last whorl squat, convex, regularly constricted at base, bearing 3-4 rows of short primary spines on spiral cords, cords most prominent at shoulder, bearing 14-15 spines, rest of last whorl covered with weak irregular spiral cordlets. Aperture ovate, anal sinus subsutural (Plate 50, fig. 3), moderately deep. Siphonal canal moderately long, twisted.

Discussion - Clavatula ernesti (Toula, 1901) resembles the middle Miocene Paratethyan species Clavatula polonica (Pusch, 1837), which has been confused frequently with Clavatula asperulata (Lamarck, 1822) from the Atlantic early Miocene of France (see Bałuk, 2003 for discussion). The Turkish shells are likely to be closely related to both these species, as indicated by Erünal-Erentöz (1958) who treated the Turkish specimens as a variety of C. asperulata. However, a comparison between Clavatula polonica shells from the type locality in Korytnica, Poland, as well as numerous additional localities from Austria and Romania, and the Turkish shells reveals constant differences in sculpture and outline. As already emphasised by Friedberg (1938), the last whorls of C. polonica are devoid of spiral sculpture, whereas the Turkish shells have obvious spiral sculpture on the last teleoconch whorl. Moreover, the growth lines are more prominent in most specimens of C. polonica. Another less constant difference is the deeper adapical concavity of the whorls in the area below the subsutural band in many specimens of C. polonica whereas C. ernesti has nearly flat whorls. In view of the differences in the character of the spiral sculpture and whorl profile, we consider the Turkish shells to be a separate species, *Clavatula ernesti* (Toula, 1901).

Bałuk (2003) discussed the great variability seen in *Clavatula polonica*. Unfortunately, it is not easy to verify whether all of the forms figured by Bałuk are conspecific, as no information is given on the protoconch and early whorls. The Turkish population is also variable, but not as extremely so as the Polish shells. *Clavatula asperulata* (Lamarck, 1822) from the Atlantic early Miocene of France differs in being much smaller and more slender, in having a greater number of spines or tubercles, which are not as strongly developed as in *C. polonica*, and the siphonal canal is shorter. Unfortunately, none of the specimens from France at hand have their protoconchs preserved.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Toula, 1901; Erünal-Erentöz, 1958).

Clavatula gracilis Erünal-Erentöz, 1958

Plate 47, fig. 4; Plate 50, fig. 4; Plate 73, fig. 7

*1958 Clavatula (Clavatula) asperulata var. gracilis Erünal-Erentöz, p. 95, pl. 14, figs 20-23, pl. 15, figs 12.

Dimensions and material – Maximum height 94.5 mm. Localities 2 & 3: JvdV/12, RGM 783 930/2, YI 408/22; localities 7 & 8: NHMW 1847/0058/1203/10, JvdV/5, RGM 783 901/6; locality 12: JvdV/4, RGM 783 618/34; locality 13: NHMW 1847/0058/1202/20, JvdV/50+), RGM 783 716/50+, RGM 794 536/1, YI 409/25; locality 17: NHMW 1847/0058/1204/1, 1847/0058/1205/6, JvdV/10, RGM 783 811/5, YI 407/12. Exact locality unknown: AÜ-LE-K-241/5.

Revised description - Shell large, very slender, weakly spinous. Protoconch multispiral, of three smooth whorls with small nucleus (Pl. 73, fig. 7b). Teleoconch boundary marked by series of axial ribs. Early teleoconch whorls bearing one nodular cord below adapical suture and one strongly nodular cord above abapical suture, smooth and concave between cords, except for weak sinus scars (Pl. 73, fig. 7a). Abapically, on intermediate whorls, nodules at sutures strengthen. On later spire whorls nodules at adapical suture become more widely spaced and spinous, nodules at abapical suture weaken, whorl surface covered with fine spiral cords. Last whorl bearing one row of small spines below adapical suture, concave to shoulder, convex below, whorl side below sutural ramp bearing two sets of rows of 14-20 spinous tubercles, the upper of each set more strongly developed; base strongly constricted. Aperture small, ovate, anal sinus subsutural, moderately deep (Plate 50, fig. 4); siphonal canal very long, straight.

Discussion – Erünal-Erentöz (1958) originally described this as a variety of *Clavatula asperulata* (Lamarck, 1822). However, the Turkish shells are quite different from this early Miocene French Atlantic species, which has a much smaller shell and a much shorter siphonal canal. Indeed, *Clavatula gracilis* Erünal-Erentöz, 1958 has the longest siphonal canal of any European *Clavatula* species we have seen, and seems to be endemic to the Karaman Basin. Two syntypes are present in the Muséum National d'Histoire Naturelle in Paris (MNHN.F.A26720; not seen) from the Pinarlar Yaylası deposits.

Clavatula gracilis differs from *Clavatula polonica* (Pusch, 1837) and *C. ernesti* (Toula, 1901) in being more slender, having a more elongate spire and a longer, straighter siphonal canal. Their protoconch and early teleoconch characters are quite different. Whilst *C. gracilis* has a multispiral protoconch, *C. ernesti* has a paucispiral protoconch (the protoconch of *C. polonica* is not known). The three species also differ in sculptural details; the spines are more strongly developed in *C. polonica* and *C. ernesti*, and the rows of tubercles on the last teleoconch whorl are arranged in pairs in *C. gracilis*, whereas they are rather irregularly placed in *C. polonica* and *C. ernesti*.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Clavatula francisci (Toula, 1901)

Plate 47, figs 5-6; Plate 50, fig. 5; Plate 73, figs 8-9

- *1901 Pleurotoma (Clavatula) Francisci Toula, p. 260, pl. 8, fig. 10.
- 1958 *Clavatula* (*Clavatula*) *calcarata* var. *francisci* Toula – Erünal-Erentöz, p. 91, pl. 14, figs 7-9.
- 2004 *Clavatula (Clavatula) calcarata francisci* Toula İslamoğlu, p. 161, pl. 4, fig. 4.

Dimensions and material – Maximum height 68.8 mm. Holotype RGM 17 045, village of Larenda (= Karaman), Cilicien, Karaman Basin, Turkey, height 54.8 mm (Pl. 47, fig. 5); localities 2 & 3: JvdV/50+, RGM 783 928/50+, MTA 2013/083/6, YI 403/50+; locality 6: NHMW 1847/0058/1487/15, JvdV/1, RGM 783 870/31; localities 7 & 8: NHMW 1847/0058/1208/15, JvdV/19, RGM 783 899/50+); locality 9: JvdV/4; locality 10: YI 404/19; locality 12: RGM 783 620/2; locality 13: JvdV/3, RGM 783 717/4, YI 405/6; locality 17: NHMW 1847/0058/1206/1, 1847/0058/1207/18, JvdV/50+, RGM 776 908/1, RGM 776 909/1, RGM 783 809/32, YI 406/32. Exact locality unknown: AÜ-LE-K-236/2.

Revised description - Shell large, relatively slender. Protoconch consisting of 2-2.25 smooth whorls with medium-sized nucleus (Plate 73, fig. 8). Teleoconch boundary marked by comma-shaped scar. Early spire whorls concave, first three whorls with rounded subsutural band; sinuous, close-set axial ribs below, slightly swollen above abapical suture; axial ribs stop abruptly on 4-5th whorl, where subsutural band persists and whorl surface covered with indistinct, narrow spiral cords (Pl. 73, fig. 9). Broad, widelyspaced, vertically compressed, rounded spines appear on subsutural band on seventh whorl; spiral sculpture becoming obsolete. Late whorls bearing crown of tubercles below carina, straight-sided and smooth below. Last whorl bearing 10-11 tubercles below carina, weakly convex below to periphery, marked by weak, subobsolete carina, more strongly angular at base, concave below. Aperture ovate, anal sinus subsutural, moderately broad and deep (Pl. 50, fig. 5). Siphonal canal long, slightly curved, bearing 1-3 spiral cords.

Discussion – *Clavatula francisci* (Toula, 1901) was originally described as a variety of *Clavatula calcarata* (Grateloup, 1832), a species from the Atlantic middle Miocene of France. The two species belong to the same group of *Clavatula* species characterised by rather subobsolete sculpture apart from a prominent crown of tubercles below the suture. However, *C. calcarata* is smaller and has a marked, sudden inflation of the late teleoconch whorls, giving the shell a rather squat appearance, whereas the spire growth is more regular in *C. francisci*. The spire whorls are also more scalate in *C. calcarata* and

the spines sharper, whereas the spines in *C. francisci* are rounded. Furthermore, the last teleoconch whorl in *C. calcarata* is shorter, more strongly bicarinate and the siphonal canal is much shorter.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Langhian): Antalya Basin, Turkey (İslamoğlu, 2004), Karaman Basin, Turkey (Toula, 1901; Erünal-Erentöz, 1958).

Clavatula theodori (Toula, 1901)

Plate 47, figs 7-9; Plate 50, fig. 6; Plate 74, fig. 1; Plate 78, figs 9, 10

- *1901 Pleurotoma (Clavatula) Theodori Toula, p. 259, pl. 8, fig. 9.
- 1958 *Clavatula (Clavatula) theodori* (Toula) Erünal-Erentöz, p. 93, pl. 14, figs 10-12.
- 1958 Clavatula (Clavatula) theodori var. calcaratiformis Erünal-Erentöz, p. 94, pl. 14, figs 13-14.

Dimensions and material – Maximum height 38.5 mm. Holotype RGM 17 049, village of Larenda (= Karaman), Cilicien, Karaman Basin, Turkey, height 39.7 mm (Pl. 47, fig. 7); locality 9: JvdV/3, YI 415/1; locality 10: 414/1 juvenile; locality 12: JvdV/50+, RGM 783 619/4; locality 13: NHMW 1847/0058/1209/1, 1847/0058/1210/27, JvdV/25, RGM 783 718/8, RGM 794 537/1, YI 413/7; locality 17: NHMW 1847/0058/1211/1, 1847/0058/1212/2. Exact locality unknown: AÜ-LE-K-237/3, AÜ-LE-K-238/3.

Revised description - Shell medium-sized, broad, weakly spinous. Protoconch paucispiral, bulbous, consisting of two smooth whorls with large nucleus. Teleoconch boundary marked by series of comma-shaped scars (Plate 74, fig. 1). Teleoconch spire whorls slightly concave, somewhat swollen above abapical suture, bearing comma-shaped axial ribs on first whorl, ribs disappearing on second whorl of most specimens, but persist onto third whorl of a few. On fourth whorl, swelling placed at adapical suture rather than abapical, bearing small spines; fine, weak, indistinct spiral cords throughout. Last whorl bicarinate, upper portion concave to upper, more prominent carina, which bears 17 spines; concave between carinae, strongly constricted and concave on base. Aperture small, ovate; anal sinus subsutural (Plate 50, fig. 6), moderately broad and deep; siphonal canal long, slightly curved.

Discussion – Bałuk (2003) figured a number of shells from the middle Miocene Paratethys of Poland, characterised by their concave spire whorls, weak sculpture, short spines on the subsutural band and bicarinate last teleoconch whorl under the names *Clavatula juliae* (Hoernes & Auinger, 1891), *Clavatula laevigata* (Eichwald, 1853) and *Clavatula suturalis* (Andrzejowski, 1830). It is almost impossible to separate these species without a description of their protoconch and early teleoconch whorl morphology. Nevertheless, *C. juliae* seems to have a wider apical angle than the other species, and the axial sculpture persists longer than in C. theodori. The shells illustrated by Bałuk (2003, pl. 7, figs 7-10) as C. laevigata show some variability as to the length of the siphonal canal. Figures 8-10 are most like the type illustrated by Eichwald (1830, pl. 8, fig. 3), whereas figure 7 has a slightly longer siphonal canal and is quite similar to the Karaman shells. Clavatula suturalis as illustrated by Bałuk (2003, pl. 8, figs 1-8), of which he considered Pleurotoma (Clavatula) susannae, P. (C.) clarae and P. (C.) rosaliae, all Hoernes & Auinger, 1891 all to be junior subjective synonyms, is larger, more solid, the last teleoconch whorl is less constricted at the base and the siphonal canal is broader and shorter than in C. juliae and C. theodori. How many species are present in the Paratethyan Miocene can only be clarified by a more detailed analysis. We provisionally consider the Turkish species distinct from all Paratethyan species, differing mainly in having axial sculpture that disappears early on the spire whorls and a narrower, longer siphonal canal. We use the name erected by Toula (1901) for these Karaman shells. We have examined shells in the Erünal-Erentöz collection in Ankara labelled Clavatula (Clavatula) theodori var. calcaratiformis (Pl. 78, fig. 10) and consider these to constitute a form of the nominal species with the spines more strongly developed below the suture. Five syntypes

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Toula, 1901; Erünal-Erentöz, 1958).

are present in the Muséum National d'Histoire Naturelle

Clavatula gradata (Defrance, 1826)

in Paris (MNHN.F.A26721; not seen).

Plate 48, fig. 1; Plate 50, fig. 7

- *1826 Pleurotoma gradata Def., Defrance, p. 393.
- 1847 Pleurotoma interrupta var. A (Br.) Bellardi, p. 32, pl. 1, fig. 11 [non Clavatula interrupta (Brocchi, 1814)].
- 1877 Clavatula gradata (Defr.) Bellardi, p. 175, pl. 5, fig. 39.
- 1984 *Clavatula (Clavatula) gradata* (Defrance) Ruggieri & Davoli, p. 65, pl. 3, figs 10-13.
- 1984 Clavatula (Clavatula) cfr. geniculata Bellardi Ruggieri & Davoli, p. 66, pl. 3, figs 9, 17, 18.
- 1990 *Clavatula (Clavatula) gradata* (Defrance, 1826) –Davoli, p. 84, pl. 8, figs 11-14.
- ?2003 Clavatula aff. gradata (Defrance, 1826) Scarponi & della Bella, p. 32, figs 19, 20, 46.

Dimensions and material – Maximum height 47.4 mm. Locality 13: RGM 783 719/1; locality 17: NHMW 1847/0058/1213/1, 1847/0058/1214/16, JvdV/8, RGM 783 807/1, YI 421/1.

Revised description – Shell medium-sized, slender, tallspired. Protoconch not preserved. Early spire whorls with raised subsutural band bearing fine spiral cords, with close-set sinuous ribs extending between sutures, swollen abapically. Later spire whorls tripartite, subsutural band weakly nodulose, mid-portion deeply channelled, smooth except for comma-shaped traces of anal sinus; lower portion nodulose, bearing 2-4 weak spiral cords. Last whorl with subsutural band weakly nodulose, withsmall open spines developed in some specimens, deeply concave below, sharply rounded at shoulder, convex below, bearing 4-5 irregular primary spiral cords below shoulder, crossed by axial cords of slightly weaker strength, producing somewhat reticulate pattern with small nodules developed at intersections. Aperture small, ovate; anal sinus subsutural, narrow and deep (Plate 50, fig. 7). Siphonal canal relatively short, straight; siphonal fasciole bearing spiral cords.

Discussion - Glibert (1954, p. 19) noted that Defrance (1826) had identified numerous different 'Pleurotoma' species from different localities as *Pleurotoma gradata*, and suggested that as Siena was the first locality designated, the shell illustrated by Bellardi (1877) should be considered the true Clavatula gradata. This species from the late Miocene Tortonian and possibly Pliocene of Italy is extremely variable, as illustrated by Ruggieri & Davoli (1984) and Davoli (1990). The Pliocene shells illustrated by Scarponi & della Bella (2003) seem to fit within the range of variability of the species. Unfortunately the protoconch is not preserved in the Karaman shells, which also show a wide range of variability, but basically show the characters of C. gradata. Clavatula ruida (Bellardi, 1877), also from the late Miocene Tortonian of Italy is closely similar in shape and also has a short siphonal canal, but differs in being more strongly sculptured and in having spiral cords with a beaded appearance, not seen in C. gradata. Clavatula neogradata Glibert, 1954 from the middle Miocene Langhian of the Loire Basin, France, differs in having weaker sculpture and fewer spiral cords, with no axial sculpture below the shoulder on the last teleoconch whorl.

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Bellardi, 1877; Ruggieri & Davoli, 1984; Davoli, 1990). Early-late Pliocene: ?central Mediterranean: Italy (Scarponi & della Bella, 2003).

Clavatula olgae (Hoernes & Auinger, 1891) Plate 48, figs 2-6; Plate 50, fig. 8

- *1891 Pleurotoma (Clavatula) Olgae Hoernes & Auinger, p. 337, pl. 43, figs 5-7.
- 1938 Clavatula Olgae R. Hoern. U. Auing. Friedberg, p. 143, fig. 46.
- ?1954 Clavatula olgae Hoernes et Auinger aff. Csepreghy-Meznerics, p. 51, pl. 7, fig. 14.
- 1958 Clavatula (Trachelochetus) olgae R. Hoernes et Auinger – Švagrovský, p. 22, pl. 7, figs 2-5.
- 1960 Clavatula (Clavatula) olgae (Hoernes und

Auinger 1891) – Kojumdgieva & Strachimirov, p. 199, pl. 48, fig. 1.

- 1982 Clavatula (Clavatula) olgae (R. Hoernes & Auinger, 1891) Švagrovský, p. 413, pl. 8, fig. 3.
- 1998 Clavatula olgae (Hoernes R. & Auinger, 1891) Mikuž, p. 74, pl. 4, figs 3, 4.
- 2009 *Clavatula olgae* (R. Hoernes & Auinger, 1891) Mikuž, p. 32, pl. 10, fig. 142.

Dimensions and material – Maximum height 45.5 mm. Locality 6: YI 410/2; localities 7 & 8: RGM 783 902/2; locality 13: NHMW 1847/0058/1220/1 1847/0058/1221/1, 1847/0058/1219/2, RGM 783 720/1, YI 411/1; locality 17: NHMW 1847/0058/1215-1847/0058/1217/3, 1847/-0058/1218/30, JvdV/19, YI 420/50+.

Revised description - Shell medium-sized, solid, slender to relatively broad. Protoconch not preserved. Teleoconch spire whorls slightly concave, with tripartite sculpture, adapically subsutural band bearing 2-3 spiral cords, midsection canaliculate, bearing comma-shaped axial ribs, abapical portion somewhat elevated, tuberculate, bearing 1-2 obscure spiral cords; sculpture weakens abapically. Last whorl with subsutural band poorly delimited, midportion concave to shoulder, smooth or with very weak comma-shaped ribs, shoulder roundly angular, convex below, weakly angular at base, slightly concave below; sculpture below shoulder of 4-5 primary cords of irregular strength, uppermost cord nodular, and irregular secondary spiral sculpture in some specimens, very irregular weak axial sculpture extends abapically from nodules beading spiral cords. Aperture small, ovate, anal sinus subsutural, narrow and deep (Plate 50, fig. 8). Siphonal canal moderately long, slightly curved.

Discussion – *Clavatula olgae* (Hoernes & Auinger, 1891) belongs to a group of European Neogene *Clavatula* species characterised by a tripartite sculpture on the spire whorls, consisting of an elevated subsutural band, a canaliculate mid-portion bearing comma-shaped ribs, and a lower elevated tuberculate portion and all have a relatively deep subsutural sinus. The specimens from Karaman are extremely variable in width, and the most slender and broadest forms look quite unlike. However, there is a transition between the two extreme forms (Plate 48, figs 2-6). The sculpture is similar in all specimens, although in some there is a suggestion of weak spines on the subsutural band on the last teleoconch whorl.

Clavatula interrupta (Brocchi, 1814) present in the European Miocene and Pliocene, differs from *C. olgae* in having the lower tuberculate portion on the spire whorls wider and bearing more numerous spiral cords. *Clavatula ruida* (Bellardi, 1877) from the late Miocene Tortonian of Italy differs in having stronger sculpture, especially in the mid-portion, and having a shorter siphonal canal. *Clavatula modesta* (Pecchioli, 1864) from the early Pliocene Zanclean of Italy differs in not having the subsutural band developed. *Clavatula gradata* (Defrance, 1826) from the late Miocene Tortonian of Italy

is extremely similar to *C. olgae*. From the illustrations seen *C. gradata* is very variable, but seems consistently smaller, the subsutural band is more strongly developed and the siphonal canal is shorter. *Clavatula saubrigiana* (Grateloup, 1846) from the Atlantic middle Miocene of France is more slender than the extreme slender form of *C. olgae*, with a much taller spire and the subsutural band is hardly developed.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Bulgaria (Kojumdgieva & Strachimirov, 1960), Poland (Friedberg, 1938), Slovenia (Švagrovský, 1958, 1982; Mikuž, 1998, 2009); Romania (Hoernes & Auinger, 1879); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Clavatula sotterii (Michelotti, 1847)

Pl. 48, figs 7-12

- *1847 Pleurotoma Sotterii mihi., Michelotti, p. 302.
- 1877 Clavatula turbinata Bell., Bellardi, p. 156, pl. 5, fig. 11.
- 1877 *Clavatula vigolenenesis* (May.), Bellardi, p. 156, pl. 5, fig. 12.
- 1877 Clavatula Sotterii (Michtti.) Bellardi, p. 157, pl. 5, fig. 15.
- 1877 Clavatula turgidula Bell., Bellardi, p. 159, pl. 5, fig. 17.
- 1877 Clavatula Curionii (Michtti.), Bellardi, p. 160, pl. 5, fig. 18.
- 1937 *Clavatula Sotterii* Michti Montanaro, p. 117, pl. 5, figs 2-18.
- 1937 Clavatula Sotterii Michti forma turgidula Bell.
 Em. Montan. Montanaro, p. 118, pl. 5, figs 19, 20.
- 1958 *Clavatula (Clavatula) contorta* Švagrovský, p. 15, pl. 4 figs 3-7.
- 1960 Clavatula (Clavatula) contorta Švagrovský Švagrovský, p. 147, pl. 13, figs 2-5.
- 1963 Clavatula (Clavatula) sotterii (Micht.) Venzo & Pelosio, p. 118, pl. 40 figs 18-23.
- 1963 Clavatula (Clavatula) sotterii var. turgidula (Bell.) – Venzo & Pelosio, p. 118, pl. 40 figs 24, 25.
- 1963 Clavatula (Clavatula) sotterii var. curionii (Micht.) – Venzo & Pelosio, p. 118, pl. 40 figs 26-33.
- 1963 Clavatula (Clavatula) sotterii var. turbinata (Bell.) – Venzo & Pelosio, p. 119, pl. 40 figs 34-38.
- 1963 Clavatula (Clavatula) sotterii var. vigolenensis (May.) – Venzo & Pelosio, p. 119, pl. 40 figs 39-42.
- 1981 *Clavatula turgidula* Bellardi, 1877 Ferrero-Mortara *et al.*, p. 75, pl. 14, fig. 2.
- 1984 Clavatula (Clavatula) sotterii (Michelotti) Ruggieri & Davoli, p. 66, pl. 4, figs 1, 6, 13, 14, 18, 19.

- ?non 1854 Pleurotoma Sotterii Micht. Hörnes, p. 338, pl. 36, fig. 16.
- ?non 1954 Clavatula sotterii (Michelotti) Papp, p. 57, pl. 9, figs 6, 7.
- ?non 1959 Clavatula sotterii (Michelotti) Boda, p. 627, pl. 29, fig. 12.

Dimensions and material – Maximum height 21.6 mm. Localities 2 & 3: JvdV/1, localities 7 & 8: NHMW 1847/0058/1503/1, 1847/0058/1504/1; locality 11: RGM 794 567/1, JvdV/7, RGM 776 905/1 (ex JvdV collection), RGM 776 906/1 (ex JvdV collection), RGM 776 907/1 (ex JvdV collection); locality 17: JvdV/3; locality 17a: NHMW 1847/0058/1588/30; YI 396/50+.

Revised description – Shell small, with early spire whorls tall, flat-sided, later whorls squat. Spire conical to scalate in profile. Protoconch worn, but probably paucispiral (Pl. 48, fig. 11c). Early teleoconch spire whorls elevated, with close-set, sinuous axial ribs, fourth teleoconch whorl rapidly broadening, becoming squatter, tripartite, with broad subsutural collar. In some specimens subsutural collar swollen, making spire scalate. Last teleoconch whorl barrel-shaped, with flattened or swollen subsutural collar, bearing close-set, narrow cords and prosocline growth lines. Mid-portion narrow, bearing close-set, narrow cords and comma-shaped sinus scars, lower portion bearing broader cords of primary to tertiary strength, cut by axial growth lines, giving surface a somewhat quadrately tuberculate appearance. Aperture ovate; anal sinus subsutural, shallow. Siphonal canal short, relatively broad. Columella smooth.

Discussion – As noted by Montanaro (1937) and Venzo & Pelosio (1963), *Clavatula sotterii* (Michelotti, 1847) has a very variable shell, which accounts for the numerous nominal taxa proposed by Bellardi (1877). The Turkish specimens are very squat, with a short siphonal canal, and have more secondary spiral sculpture than seen in most of the Italian Miocene shells. Moreover, the middle set of granules is absent or poorly developed compared with the Italian shells. Nevertheless, considering the great variability illustrated in the Italian populations we provisionally consider them to be conspecific.

Clavatula sotterii is rare in the Turkish fully marine assemblages, and almost always poorly preserved. It is mostly found in the brackish deposits of Gödet Creek near Tilkikaya (locality 11) and the brackish levels at Sevithasan (locality 17a). Its small squat shape makes it impossible to confuse with any of its Turkish congeners. Clavatula sotterii has frequently been recorded from the largely endemic Sarmatian assemblages of the Paratethys (e.g.: Hörnes, 1854; Jekelius, 1944; Boda, 1959; Švagrovský, 1971; Papp, 1974). We are not convinced that these Sarmatian shells are conspecific with the Italian species C. sotterii. The ovoid, fusiform Sarmatian species is characterised by two very regular, prominent spiral rows of nodes along the lower and upper suture, separated by a deeply incised band with a single row of granules. It also has a shorter and more inflated last whorl, lacking the delicate secondary threads of typical *C. sotterii*. Therefore, until the Sarmatian specimens are revised, we prefer to exclude these Paratethyan references from the synonymy. This misconception was probably the reason for Švagrovský (1958) introducing *Clavatula contorta* as a new species for Badenian (middle Miocene) shells from Slovakia, which in fact seem to represent 'true' *C. sotterii*, but indeed differ from the Sarmatian specimens that Švagrovský understood as *C. sotterii*.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Slovenia (Švagrovský, 1958, 1971); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean (Tortonian): Po Basin, Italy (Michelotti, 1847; Bellardi, 1877; Montanaro, 1937; Venzo & Pelosio, 1963; Ruggieri & Davoli, 1984).

Clavatula sp.

Plate 48, figs 13, 14; Plate 50, fig. 9

Dimensions and material – Maximum height 31.2 mm. Localities 2 & 3: RGM 794 057/1 (ex JvdV collection); locality 17: NHMW 1847/0058/1223/3, RGM 783 806/3.

Description – Shell medium-sized. Protoconch not preserved. Teleoconch spire whorls tripartite, with broad mid-portion almost entirely filled by wide spiral cord, abapical band equal in width to subsutural band, prosocline axial ribs nodular over central cord and abapical band; abapical band with 2-3 spiral cords on later spire whorls. Subsutural band wide on last whorl, bearing subobsolete spines, mid-portion narrow, broadly rounded at shoulder, evenly convex at base, bearing seven low primary cords below shoulder, with secondary cords in interspaces, cut by very weak axial ribs, slightly nodulose at intersections, giving gemmate appearance. Aperture ovate, small; anal sinus subsutural, very narrow and deep; siphonal canal short.

Discussion – The shells from Karaman described above are closely similar to *Clavatula ligeriana* Peyrot, 1938 from the middle Miocene of the Loire Basin, France, but differ in lacking the strong central cord in the mid-portion on spire whorls and in having an angular base, as well as differing in other sculptural details. They possibly also represent a subadult form of *Clavatula rustica* (Brocchi, 1814), as the shells illustrated are similar to that figured by Scarponi & della Bella (2003, fig. 27). None of the shells so far found in Turkey has a complete aperture and we reserve final judgement on their identification until better material is available.

Among the middle Miocene Paratethyan faunas, the most closely similar species is *Clavatula vialisi* (Strausz, 1955), which is known so far from a single Hungarian specimen. The holotype of *C. vitalisi* develops near-identical sculpture but differs from the Turkish species in its broader, somewhat angulated last whorl and in its slightly broader apical angle.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Note: The next two species have a lirate inner lip, differing from more typical *Clavatula* species, and possibly represent a separate species group.

Clavatula labiolirata nov. sp.

Plate 49, figs 1, 2; Plate 50, fig. 10

Dimensions and type material – Holotype NHMW 1847/0058/1224, height 31.4 mm; paratype 1 NHMW 1847/0058/1225, height 26.8 mm; paratype 2 NHMW 1847/0058/1229, height 23.8 mm; paratype 3 NHMW 1847/0058/1230, height 24.3 mm; paratype 4 NHMW 1847/0058/1231, height 23.3 mm, paratype 5 NHMW 1847/0058/1232, height 23.2 mm.

Other material – Maximum height 23.8 mm. Locality 17: NHMW 1874/0058/1233/10.

Etymology – Name reflecting the presence of lirae within the outer lip.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A medium-sized species of *Clavatula* with fusiform shape, tripartite nodular sculpture on spire whorls, squarely gemmate sculpture on last whorl, short siphonal canal, and lirae within the outer lip.

Description - Shell medium sized, solid. Protoconch not preserved. Teleoconch spire whorls tripartite, with broad subsutural and adapical bands, lower band broadest, narrower canaliculate mid-portion, sinuous prosocline ribs swollen in all three sections giving sculpture a nodulose appearance on bands and beaded appearance in mid-portion. Spiral sculpture of narrow flattened cords of variable strength and number. Last whorl roundly shouldered, weakly constricted at base, bearing about seven primary spiral cords, cut by weaker close-set axial ribs, giving surface a squarely gemmate appearance; three adapical cords fused in some specimens to form elongate shoulder nodule. Aperture ovate, small, outer lip lirate within, lirae close-set, extending deep within the aperture; anal sinus subsutural, narrow and deep; siphonal canal short; siphonal fasciole weakly developed, rounded, bearing spiral cords, bordering small umbilical chink.

Discussion – Clavatula labiolirata nov. sp. and Clavatula seyithasanensis nov. sp. belong to a group of Clavatula species with a rather buccinoid shape, and with lirae within the aperture. Powell (1966) discussed the genus Trachelochetus Cossmann, 1889 (type species: Pleurotoma desmia Edwards, 1857, by original designation, middle-
late Eocene, Europe), which differs from *Clavatula* in having an unnotched siphonal canal and lirae within the outer lip. One Mediterranean Pliocene species has been attributed to that genus: *Trachelochetus romanus* (Defrance, 1826). The species from Karaman described here have a lirate outer lip, but do not have a long siphonal canal and therefore cannot be placed in the genus *Trachelochetus*. They are similar to the Paratethyan species *Clavatula granulatocincta* (Goldfuss, 1841) and *Clavatula schreibersi* (Hörnes, 1854), both in shape and in having lirate outer lips. We note that some of the Recent West African species such as *Clavatula muricata* (Lamarck, 1822) also have a lirate outer lip. Whether these species form a single monophyletic group is unclear.

Clavatula labiolirata is quite unlike any of its congeners. It can be distinguished from most *Clavatula* species by the presence of lirae within the outer lip. It is distinguished from the lirate Paratethian species *Clavatula granulatocincta* (Goldfuss, 1841) and *Clavatula schreibersi* (Hörnes, 1854) by being smaller and by its sculpture, which is tubercular rather than spinous as in the two Paratethyan species.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Clavatula seyithasanensis nov. sp. Plate 49, figs 3-5; Plate 50, fig. 11

Dimensions and material – Holotype NHMW 1847/-0058/1234, height 56.6 mm; paratype 1 NHMW 1847/0058/1235, height 56.6 mm; paratype 2 NHMW 1847/0058/1236, height 39.2 mm, paratype 3 RGM 783 806; furthermore one specimen in YI 423, height 50.0 mm.

Etymology - Named after type locality.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A large species of *Clavatula* with fusiform shape, tripartite sculpture consisting of a broad subsutural band, weakly spinose on the last whorl, a canaliculate mid-portion bearing a strong central spiral cord and comma-shaped axial ribs, and a tuberculose lower part, a weakly constricted last whorl, lirae within the outer lip, and a short siphonal canal.

Description – Shell large, solid. Protoconch not preserved. Teleoconch spire whorls tripartite, with broad subsutural band, mid-portion canaliculate bearing prominent central spiral cord and comma-shaped axial ribs, lower band tuberculate, upper and lower bands bearing inconspicuous spiral cords; abapically subsutural band weakly spinose. Subsutural band on last whorl bearing weak spines, concave below, broadly rounded at shoulder, weakly constricted at base, bearing seven low primary spiral cords below shoulder, with 1-2 secondary cords in each interspace, upper cord finely nodular, cut by weak, close-set axial ribs. Aperture ovate, small, outer lip lirate within; anal sinus subsutural, very narrow and deep; siphonal canal short; siphonal fasciole weakly developed, rounded, bearing spiral cords, bordering small umbilical chink.

Discussion – Clavatula seyithasanensis nov. sp. resembles the Paratethyan species Clavatula granulatocincta (Goldfuss, 1841), but differs in being less buccinoid in shape, in not having a scalate spire and in having coarser spiral sculpture. The spines on the subsutural band are larger and are tubercular in C. granulatocincta and C. seyithasanensis nov. sp.lacks the typical granular surface of C. granulatocincta. Clavatula seyithasanensis is more similar in shape to Clavatula schreibersi (Hörnes, 1854), but this Paratethyian middle Miocene species differs in having a weakly scalate spire, the spines on the subsutural band are stronger, and the mid-portion of the whorl is different, lacking the strong central spiral cord and the comma-shaped axial ribs.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Perrona Schumacher, 1817

Type species – Perrona tritonium Schumacher, 1817 (*= Murex perron* Gmelin, 1791 *= Pleurotoma perronii* Reeve, 1843b), by monotypy. Recent, West Africa.

Perrona robustocarinifera nov. sp.

Plate 49, figs 6, 7; Plate 50, fig. 12; Pl. 82, fig. 11

Dimensions and type material – Holotype NHMW 1847/0058/1237, height 42.3 mm; paratype 1 RGM 794 090 (ex JvdV collection), height 41.5 mm; paratype 2 NHMW 1847/0058/1673, height 38.2 mm; paratype 3 NHMW 1847/0058/1607, height 43.6 mm; paratype 4 NHMW 1847/0058/1608, height 45.8 mm (incomplete), paratype 5 NHMW 1847/0058/1609, height 23.2 mm.

Other material – Maximum height 53.2 mm. Locality 17: NHMW 1847/0058/1238/9, JvdV/5, YI 412/3 + 2 juveniles.

Etymology – Named compound Latin '*robustus*' solid, robust and '*carinifera*' carinate, reflecting the very robust nature of the shoulder carena.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tirtar Formation, Serravallian, middle Miocene.

Diagnosis - A species of Perrona with a robust shell,

a relatively short, strongly scalate spire composed of whorls with a narrow, subhorizontal sutural platform, which is sharply delimited from the rest of the whorl by a subsutural band that is obsoletely tuberculate on early teleoconch whorls, and a barrel-shaped last whorl with well-developed subsutural and basal bands, the whorl sides concave and subparallel between the bands.

Description - Shell medium-sized, robust, fusiform, with relatively short, strongly scalate spire, last whorl barrel-shaped. Protoconch damaged. Teleoconch of seven strongly angular whorls, with narrow, sub-horizontal sutural ramp, sharply delimited by adapical edge of subsutural band, whorl profile vertical below, concave to abapical suture. Subsutural band weakly and irregularly nodular on early whorls. Suture superficial, linear. Axial and spiral sculpture absent. Last teleoconch whorl 68-69% of total height, with horizontal sutural ramp, delimited by sharp upper edge of subsutural band; whorl sides below subparallel and concave down to weakly elevated basal band,; whorl strongly concave and constricted at base. Aperture 49% of total height, angled at subsutural and basal bands. Outer lip simple, damaged in all specimens. Siphonal canal long, straight, open. Columella straight, smooth. Columellar callus hardly developed. Colour patternunder UV light consisting of large spots on subsutural and basal bands (Pl. 82, fig. 11).

Discussion – Perrona robustocarinifera nov. sp. is most similar to *Perrona carinifera* (Grateloup, 1832), from the early Miocene Aquitaine Basin of France. It differs from the French shells in its distinctly lower spire, the strongly gradate outline, and the barrel-shaped last whorl with subparallel flanks. Moreover, the subsutural and basal bands are broader than in the French species and are distinctly tuberculate on the early teleoconch whorls, a character not seen in the French Aquitanian shells compared (NHMW collection).

The Italian shell described as *Perrona carinifera* by Bellardi (1877) agrees in the shape of the last whorl but has a much higher spire. Even the rather gradate subpecies *Clavatula carinifera scalata* (Grateloup) *sensu* Peyrot (1931) has a less gradate spire, a conical (not barrel-shaped) last whorl, and develops a longer siphonal canal. The middle Miocene Paratethyan shells from Austria illustrated by Hoernes & Auinger (1891, pl. 48, figs 14, 15) as *Pleurotoma (Clavatula) carinifera* are not conspecific with the French Aquitanian shells. They have strong spiral sculpture and the spire is hardly scalate. The middle Miocene Paratethyan shell from Slovenia illustrated by Mikuž (2009, pl. 11, fig. 148) as *P. carinifera* represent, in our opinion, *Perrona descendens* (Hilber, 1879).

Perrona robustocarinifera is also closely similar to the shells from the late Miocene Tortonian of Montegibbio, Italy, figured by Montanaro (1937, pl. 6, figs 4-15) as *Clavatula jouanneti* Desmoulins, 1842, which in the text he describes as variety *italica* (Montanaro, 1937, p. 136). These Italian Tortonian shells are not conspecific with *P. jouanneti* and should be separated at full species level. We have compared the Turkish shells with speci-

mens of *Perrona italica* from Montegibbio (NHMW collection), and *P. robustocarinifera* differs in being larger, the subsutural band on the early teleoconch whorls is not nodulose in *P. italica* as it is in *robustocarinifera*, the last whorl is more strongly constricted at the base in *P. italica*, and the siphonal canal is much longer in *P. robustocarinifera*.

Another closely allied species from the middle Miocene Serravallian of the Aquitaine Basin is illustrated by Peyrot (1931, pl. 8, figs 34, 43) as *Clavatula (Perrona) jouanneti* mut. *helvetica*. We have not seen any specimens of this species, but judging from Peyrot's figures it is closely similar, if not conspecific with, *P. italica*. It differs from *P. robustocarinifera* in the same characters as discussed above; in not having tubercles on the subsutural band on the early teleoconch whorls and in having a shorter siphonal canal.

Perrona robustocarinifera is uncommon in the Turkish assemblages, and found only in the fully marine Sevithasan deposits. Interestingly, none of the specimens collected are in perfect condition, and most show clear signs of crab predation. Perrona descendens, with which it is found in the sandy deposits at Seyithasan, is easily distinguished by its smaller shell and much weaker and more rounded shoulder carina, and its rounded rather than angular base. The two *Perrona* species found in the clayey deposits at Pinarlar Yaylasi, P. inedita (Bellardi, 1877) and P. taurinensis (Bellardi, 1877), both differ in being larger and having quite different sculpture. Perrona jouannetii (Desmoulins, 1842) from the early and middle Miocene and early Pliocene Atlantic differs in being smaller and in lacking the basal carina. Perrona semimarginata (Lamarck, 1822), also from the early and middle Miocene Atlantic, is of similar size, but differs in having almost no shoulder carina.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Perrona descendens (Hilber, 1879) Plate 49, figs 8-9; Plate 50, fig. 13

- 1854 Pleurotoma Jouannettii Desm. Hörnes, p. 346 (partim, pl. 38, figs 1-6 only).
- *1879 *Pleurotoma (Clavatula) descendens* Hilb., Hilber, p. 434, pl. 3, fig. 5.
- 1891 Pleurotoma (Clavatula) descendens Hilb. Hoernes & Auinger, p. 355, pl. 48, figs 7-9.
- 1891 Pleurotoma (Clavatula) Sabinae Hoernes & Auinger, p. 356, pl. 48, figs 10, 11.
- 1912 Clavatula Jouanneti [sic] Desm. Friedberg,
 p. 201, pl. 13, fig. 1 [non Perrona jouannettii (Desmoulins, 1842)].
- 1931 Clavatula (Perrona) Jouanneti [sic] Des Moulins Peyrot, p. 55, no. 1221 (partim, pl. 8, fig. 34 only) [figs 43, 61-62, 66, 71, ?99 = Perrona jouannettii (Desmoulins, 1842)].
- 1958 Clavatula (Perrona) Jouanneti [sic] (Desmoulins)

- Erünal-Erentöz, p. 100, pl. 15, figs 15-17.

- 1960 Clavatula (Perrona) emmae Hoernes und Auinger 1891 – Kojumdgieva & Strachimirov, p. 199, pl. 48, fig. 2 [non Perrona emmae (Hoernes & Auinger, 1891)].
- 1960 Clavatula (Perrona) emmae var. sabinae (Hoernes und Auinger 1891) – Kojumdgieva & Strachimirov, p. 199, pl. 48, figs 3, 4.
- 1962 Clavatula jouanneti [sic] descendens Hilber Strausz, p. 62, pl. 14, figs 15, 16.
- 1966 *Clavatula jouanneti* [*sic*] *descendens* Hilber, 1879 – Strausz, p. 401, pl. 14, figs 15, 16.
- 1966 Clavatula (Perrona) descendens Hilb. Kókay, p. 134 (only figure caption), pl. 9, fig. 19.
- 1972 Clavatula (Perrona) jouannettii descendens Hilber, 1879 Csepreghy-Meznerics, p. 32, pl. 16, figs 2, 3.
- 1973 *Clavatula (Perrona) jouannettii descendens* (Hilber) Bohn-Havas, p. 1063, 1118, pl. 6, fig. 10.
- 1994 Perrona (Perrona) vindobonensis (Partsch in Hörnes) – Nikolov, p. 59, pl. 6, figs 9, 10.
- 1998 Perrona (Perrona) jouanneti [sic] descendens (Hilber) – Schultz, p. 74, pl. 30, fig. 4.
- 1998 Perrona carinifera (Grateloup, 1832) Mikuž, p. 78, pl. 5, fig. 4.
- 1998 Perrona (Perrona) jouanneti [sic] (Des Moulins, 1842) Mikuž, p. 78, pl. 5, fig. 8.
- 1998 *Perrona* cf. *descendens* (Hilber, 1879) Mikuž, p. 79, pl. 5, fig. 9.
- 1998 Perrona (Perrona) sabinae (Hoernes R. & Auinger, 1891) Mikuž, p. 81, pl. 6, fig. 3.
- 2003 Perrona (Perrona) descendens (Hilber, 1879) Bałuk, p. 40, pl. 9, figs 1-7.
- 2009 Perrona carinifera (Grateloup, 1832) Mikuž, p.
 33, pl. 11, fig. 148.
- 2009 *Perrona jouanneti* [*sic*] (Des Moulins, 1842) Mikuž, p. 33, pl. 11, fig. 149.
- 2009 *Perrona* cf. *descendens* (Hilber, 1879) Mikuž, p. 34, pl. 11, fig. 150.
- 2009 Perrona sabinae (R. Hoernes & Auinger, 1891) Mikuž, p. 34, pl. 11, fig. 153.

Dimensions and material – Maximum height 29.5 mm. Localities 2 & 3: JvdV/5, YI 412/3; localities 7 & 8: JvdV/1; locality 17: NHMW 1847/0058/1239-1847/0058/1240/2, 1847/0058/1241/30, JvdV/50+, RGM 783 787/8, 783 802/1, MTA 2013/084/8, YI 377/50+.

Discussion – Perrona descendens (Hilber, 1879) is the smallest species of *Perrona* in the Karaman assemblages. It is quite variable, especially in the character of the subsutural band, which can be almost completely smooth to relatively strongly nodular in different specimens. The most similar congener is *P. jouannetii* (Desmoulins, 1842) from the early and middle Miocene and early Pliocene Atlantic, which differs in being more slender, in having the subsutural band always smooth and in having a longer and narrower siphonal canal.

Distribution - Middle Miocene: northeastern Atlantic

(Serravallian): Aquitaine Basin, France (Peyrot, 1931); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854; Hoernes & Auinger, 1891), Romania (Hoernes & Auinger, 1891), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (?Csepreghy-Meznerics, 1954; Strausz, 1962, 1966; Bohn-Havas, 1973), Poland (Friedberg, 1912; Bałuk, 2003), Slovenia (Mikuž, 1998, 2009); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Perrona inedita (Bellardi, 1877)

Plate 49, figs 10, 11; Plate 50, fig. 14; Plate 74, fig. 2; Plate 82, fig. 12

- *1877 Clavatula inedita Bellardi, p. 203, pl. 6, fig. 28.
- 1958 *Clavatula (Perrona) inedita* Bellardi Erünal-Erentöz, p. 98, pl. 15, figs 10-12.
- 1981 *Clavatula inedita* Bellardi, 1877 Ferrero Mortara *et al.*, p. 80, pl. 15, fig. 8.

Dimensions and material – Maximum height 72.5 mm. Localities 7 & 8: JvdV/3, RGM 783 898/1; locality 9: JvdV/1; locality 12: JvdV/25, RGM 783 621/50+; locality 13: NHMW 1847/0058/1242-1847/0058/1243/2, 1847/0058/1244/22, JvdV/44, RGM 777 901/1 (ex JvdV collection), RGM 783 721/25, RGM 794 538/1, MTA 2013/085/2, YI 409/3. Exact locality unknown: AÜ-LE-K-242/3.

Discussion – Perrona inedita (Bellardi, 1877) is a very distinctive species with narrow subsutural and abapical bands on the spire whorls, and the whorl surface in between is strongly concave. The abapical band, which on the last teleoconch whorl extends around the shoulder, bears somewhat nodular prosocline ribs. The base is angular and the siphonal canal is narrow, long and straight. The protoconch is not well-preserved, but consists of about three whorls, with the protoconch/teleoconch boundary delimited by a sinuous scar (Pl. 74, fig. 2). A colour pattern is seen under UV light, consisting of comma shaped blotches on the sutural ramp (Pl. 82, fig. 12).

Distribution – **Early Miocene**: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1877); **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Perrona taurinensis (Bellardi, 1877)

Plate 50, figs 1, 2, 15; Plate 82, fig. 13

- 1847 Pleurotoma vulgatissima Grat. Bellardi, 1847, p.
 35, pl. 2, fig. 9 [non Perrona vulgatissima (Grateloup, 1832)].
- *1877 Clavatula taurinensis (May.), Bellardi, p. 187, pl. 6, fig. 10.
- 1958 *Clavatula* (*Perrona*) *taurinensis* (Mayer) Erünal-Erentöz, p. 99, pl. 15, figs 13, 14.

- ?1962 Clavatula taurinensis Mayer Strausz, p. 61, pl. 14, figs 20-23.
- ?1966 Clavatula taurinensis Mayer, Bellardi Strausz, p. 403, pl. 14, figs 20-23.

Dimensions and material – Maximum height 59.7 mm. Localities 2 & 3: JvdV/4; locality 9: JvdV/2; locality 12: JvdV/50+; locality 13: NHMW 1847/0058/1245-1246/2, 1847/0058/1247/5, JvdV/11, RGM 777 902/1 (ex JvdV collection); locality 17: JvdV/3. Exact locality unknown: AÜ-LE-K-243/2.

Discussion - The shells from Karaman are characterised by their spire whorls, which are channelled in the mid-portion, although not as strongly as in Perrona inedita (Bellardi, 1877). The early teleoconch whorls have a row of small tubercles at the abapical suture crossed by narrow spiral cords, persisting to the 6th to 8th whorl, whereas in *P. inedita* the early whorls are unbeaded, the tubercles appearing on the abapical band only on the last three whorls. The last teleoconch whorl in P. taurnensis has a weakly concave upper portion, rounded mid-whorl, weakly carinate at the base and concave below. The midportion of the last whorl of some specimens bears one or two subobsolete to four relatively well-defined, weakly nodular spiral cords. In P. inedita the last teleoconch whorl has no subsutural band, but has a strongly concave portion below the suture to the shoulder, which is nodular, and the last teleoconch whorl is more strongly angled at the base. The siphonal canal is long in both species, but in P. taurinensis it bears 1-3 stronger spiral bands. They also differ in colour pattern seen under UV light; P. taurinensis has a narrow mid-whorl band on the spire whorls and on the adapical half of the sutural ramp on the last whorl (Pl. 82, fig. 13), whereas in P. inedita the blotches are comma-shaped and extend across the sutural ramp. The Karaman specimens of P. taurinensis differ from the holotype figured by Bellardi (1877, pl. 6, fig. 10) in being less slender and in having a longer siphonal canal. However, we judge these differences to be due to intraspecific variation.

Distribution – **Early Miocene**: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1847, 1877). **Middle Miocene**: Paratethys (Langhian-Serravallian): ?Hungary (Strausz, 1962, 1966), Croacia (Pavlovsky, 1957); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958).

Genus Comitas Finlay, 1926

Type species – Surcula oamarutica Suter, 1917 (= *Drillia fusiformis* Hutton, 1877), by original designation. Miocene, New Zealand.

Comitas korytnicensis (Bałuk, 2003)

Plate 50, figs 16-17; Plate 74, fig. 3



*2003 *Turricula (Surcula) korytnicensis* Bałuk, p. 44, pl. 10, fig. 8.

Dimensions and material – Maximum height 36.1 mm. Localities 2 & 3: JvdV/2, YI 391/6; localities 7 & 8: JvdV/1; locality 9: JvdV/11, RGM 783 839/6; locality 12: JvdV/23; locality 13: NHMW 1847/0058/1248/1, 1847/0058/1249/1, 1847/0058/1250/30, JvdV/50+, RGM 783 683/23, RGM 794 539/1, MTA TN83/10, YI 392/50+.

Discussion – Some European members of this group with the anal sinus placed low on the sutural ramp in contact with the carina have been placed within the genus *Comitas* Finlay, 1926, whereas those with the anal sinus entirely on the sutural ramp, placed equidistant between the suture and the shoulder carina are placed in *Turricula* Schumacher, 1817 (Malatesta, 1974; Scarponi & della Bella, 2003). We follow this position, although it is unclear if this European Neogene group is monophyletic with *Comitas*, as described by Powell (1966), which is mainly an antipodean genus.

Apart from the position of the sinus, *Comitas korytnicensis* (Bałuk, 2003) differs from *T. lamarcki* (Bellardi, 1847) in having a much narrower sutural ramp and in having more rounded whorls, whereas the whorls of *T. lamarcki* are distinctly angular, with a nodular carina. The Miocene-Pliocene Proto-Mediterranean and Paratethyan species *Turricula coquandi* (Bellardi, 1847) again has a wide sutural ramp and carinate whorls. It is very similar to *T. lamarcki*, but differs in having less strongly carinate whorls, weaker spiral sculpture and a more regularly ovate aperture. All three species have a protoconch consisting of about two whorls with a large nucleus (see Scarponi & della Bella, 2003 and Pl. 73, fig. 3).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 2003), Romania (Hoernes & Auinger, 1891); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Horaiclavidae Bouchet, Kantor, Sysoev & Puillandre, 2011

Genus *Haedropleura* Bucquoy, Dautzenberg & Dollfus, 1883

Type species – Pleurotoma septangularis Montagu, 1803, by original designation. Recent, Mediterranean.

Haedropleura avenacea Boettger, 1906

Plate 51, figs 1, 2; Plate 74, fig. 4

- *1906 Haedropleura avenacea Boettger, p. 60, no. 233.
- 1934 *Haedropleura avenacea* Boettger Zilch, p. 262, pl. 18, fig. 35.
- 2003 Haedropleura avenacea Boettger, 1906 Bałuk, p. 50, pl. 14, figs 4-6.

¹⁸⁹¹ Pleurotoma (Surcula) Lamarcki Bell. – Hoernes &

Dimensions and material – Maximum height 7.0 mm. Localities 7 & 8: NHMW 1847/0058/1254/2; locality 13: NHMW 1847/0058/1251/1, 1847/0058/1252/1, 1847/0058/1253/12, JvdV/7, RGM 784 010/2, YI 448/4; locality 17: YI 449/4.

Discussion - Haedropleura avenacea Boettger, 1906 is characterised by its small size, claviform shape, 7-8 flexuous, prosocline axial ribs, intercalated on early whorls but placed above each other (axially aligned) on the last two teleoconch whorls, and by spiral sculpture of weak, narrow, flattened, densely packed cords. The protoconch is dome-shaped, consisting of 3.25 whorls with a small nucleus (dp = 680 μ m, hp 0 670 μ m, dV1 = 240 μ m, dn = 105 μ m; Pl. 74, fig. 4). These shells are probably conspecific with those illustrated by Bałuk (2003, pl. 14, figs 4-6) as Haedropleura avenacea, although we note that the lectotype figured by Zilch (1934, pl. 18, fig. 35) is somewhat broader. Zilch (1934) and Bałuk (2003) recognised several small species of Haedropleura from the middle Miocene Paratethys. Haedropleura etelkae (Boettger, 1902) has stronger spiral sculpture composed of elements of primary and secondary strength. Haedropleura cristallina Boettger 1906 and H. adami (Friedberg, 1912) are similar to each other and rather variable in shape, although most specimens are squatter than H. avenacea. Their spiral sculpture is similar to that of H. avenacea and it is possible that they all represent extreme forms of a single species. A revision of these, including protoconch morphology, is required. Bałuk (2003, p. 51) placed Drillia (Haedropleura) pseudosigmoidea Boettger, 1902 in the genus Haedropleura, however, this species has no spiral sculpture, which is a generic character. This species is probably better placed in the genus Nitidiclavus Bernasconi & Robba, 1984.

The Italian Pliocene *Haedropleura* species revised by Scarponi & della Bella (2004) are all larger than the Turkish species. *Haedropleura bucciniformis* (Bellardi, 1847) is easily separated by virtue of its bucciniform shell, as the name implies. *Haedropleura secalina* (Philippi, 1844) has more numerous axial ribs (9-11 vs. 7-8). Its protoconch also consists of 3.5 whorls. *Haedropleura septangularis* (Montagu, 1803) has the same number of axial ribs, but a protoconch of only 2.5 whorls.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk, 2003), Romania (Boettger, 1906; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Turridae H. Adams & A. Adams, 1853 Genus *Gemmula* Weinkauff, 1875

Type species – Pleurotoma gemmata Reeve, 1843b (*non* Conrad, 1835) (= *G. hindsiana* Berry, 1958), by subsequent designation (Cossmann, 1896). Recent, tropical West America.

Gemmula badensis (R. Hoernes, 1875) Plate 51, fig. 3

- 1854 Pleurotoma monilis Brocc. Hörnes, p. 353, pl.
 38, figs 14-16 [non Gemmula monile (Brocchi, 1814)].
- 1875 Pleurotoma Badensis R. Hoernes, p. 217 (nov. nom. pro Pleurotoma monilis Brocc. in Hörnes, pl. 38, figs 14-16; non Brocchi, 1814)
- 1891 Pleurotoma Badensis R. Hoernes Hoernes & Auinger, p. 294.
- 1962 Pleurotoma badensis R. Hoernes Strausz, p. 66, pl. 18, figs 1, 2.
- 1966 *Pleurotoma badensis* R. Hoernes, 1875 Strausz, p. 420, pl. 18, figs 1, 2.
- 1998 Turris (Turris) badenis (Hoernes & Auinger) Schultz, p. 76, pl. 31, fig. 2.
- non 1958 Gemmula badensis (Hörnes) Sorgenfrei, p. 252, pl. 52, fig. 173 [= Gemmula schafferi (Kautsky, 1925)].
- non 1972a Gemmula badensis (R. Hoernes, 1875) Nordsieck, p. 91, pl. 22, fig. 140.
- non 1984a Gemmula (Gemmula) badensis (Hoernes & Auinger, 1891 [sic]) A.W. Janssen, p. 275, pl. 11, fig. 1, pl. 68, fig. 1 [= Gemmula schafferi (Kautsky, 1925)].

Dimensions and material – Maximum height 37.5 mm. Locality 9: JvdV/1; locality 12: JvdV/1; locality 13: NHMW 1847/0058/1255/1, 1847/0058/1511/1, 1847/0058/1256/2, JvdV/7, RGM 783 722/1.

Discussion – We provisionally identify the Turkish shells as *Gemmula badensis* (R. Hoernes, 1875), although typical *G. badensis* from the middle Miocene of the Vienna Basin has a higher spire and therefore has a more slender appearance.

This species was confused by Hörnes (1854) with the late Miocene and early Pliocene Italian species *Gemmula monile* (Brocchi, 1814), from which it differs in having a wider shell, more numerous tubercles on the peripheral spiral cord, and more gemmate sculpture. We agree with R. Janssen & Wienrich (2007) in excluding the North Sea Basin species from the synonymy. Scarponi & della Bella (2003) included the Paratethys in the distribution of *G. monile*, listing Hörnes (1854) as the only Paratethyan record. This is probably a '*lapsus*' by Scarponi & della Bella, as the figure of the Pliocene shell they illustrated is clearly different from the Paratethyan shell.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1854; Hoernes & Auinger, 1891), Hungary (Strausz, 1962, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1904).

Gemmula coronata (Münster *in* Goldfuss, 1841) Plate 51, fig. 4

*1841	Pleurotoma coronata Münster – Münster in Gold-
	fuss, p. 21, pl. 171, fig. 8.
1856	Pleurotoma coronata Münster - Hörnes, p. 683,

- pl. 52, fig. 9.
 1891 *Pleurotoma coronata Lapugyensis* Hoernes & Auinger, p. 295, pl. 37, figs 11-13.
- 1904 Pleurotoma coronata Münst. Sacco, p. 41, pl. 11, figs 27-28.
- 1904 Pleurotoma coronata var. rugulosa Sacc., Sacco, p. 41, pl. 11, fig. 29.
- 1904 Pleurotoma coronata var. perdenticulata Sacc., Sacco, p. 41, pl. 11, figs 30, 31.
- 1904 *Pleurotoma coronata* var. *longospirata* Sacc., Sacco, p. 41, pl. 11, fig. 32.
- 1904 *Pleurotoma coronata* var. *profundesuturata* Sacc., Sacco, p. 41, pl. 11, fig. 33.
- 1928 Pleurotoma coronata Münst. Friedberg, p. 567, pl. 37, figs 5, 6.
- 1953 *Clavatula* (*Surcula*) *coronata* (Münster) Csepreghy-Meznerics, p. 10, pl. 2, figs 9-12.
- 1954 Pleurotoma coronata Münst. Friedberg, p. 577, pl. 37, figs 5, 6.
- 1954 *Turris (Gemmula) coronata* Münster sp. 1844 Glibert, p. 7, pl. 2, fig. 4.
- 1960 Pleurotoma (Pleurotoma) coronata Münster in Goldfuss, 1843 – Kojumdgieva & Strachimirov, p. 193, pl. 46, fig. 10.
- 1974 Pleurotoma coronata Münst. Urbaniak, p. 38, pl. 12, fig. 1.
- 2003 Gemmula coronata (Münster in Goldfuss, 1843) Bałuk, p. 46, pl. 12, figs 1-4.
- 2004 *Pleurotoma coronata* Goldfuss, 1841 Tucker, p. 246.
- non 1964 Gemmula (Gemmula) coronata (Münster in Goldfuss, 1844) – Anderson, p. 282, pl. 32, fig. 227 [= Gemmula schafferi (Kautsky, 1925)].
- non 1972a Gemmula coronata (Münster, 1844) Nordsieck, p. 90, pl. 22, fig. 137 [= Gemmula schafferi (Kautsky, 1925)].
- ?non 1984a Gemmula (Gemmula) coronata (Von Münster, 1844) – A.W. Janssen, p. 277, pl. 11, fig. 2, pl. 68, fig. 5.

Dimensions and material – Height 19.9 mm (incomplete). Locality 13: NHMW 1847/0058/1257/1 (NHMW collection).

Discussion – Gemmula coronata (Münster *in* Goldfuss, 1841) is characterised by having two narrow spiral cords forming the carina. The species was described from the middle Miocene Paratethyan Vienna Basin assemblages (Münster *in* Goldfuss, 1841). The protoconch in the Turkish shells is multispiral, but too worn to describe.

We agree with Bałuk (1984, p. 46) and R. Janssen & Wienrich (2007, p. 662) in provisionally excluding the reference to the Miocene of Miste, Netherlands (A.W.

Janssen, 1984a) from the synonymy. The Miste specimen illustrated by A.W. Janssen has a taller spire, is slightly more constricted at the base and has less well-developed tubercles at the periphery. The Miste shell is probably the same as that recorded by R. Janssen & Wienrich (2007, p. 662, pl. 109, fig. 2, pl. 139, fig. 2) as *Gemmula* (*Gemmula*) n. sp. However, we do not agree with Bałuk (1984, p. 46) in including *Gemmula denticulata borealis* (Glibert, 1954) from the same deposits in the synonymy of *G. coronata*, as the two have quite different protoconchs (see A.W. Janssen, 1984a).

Distribution – Middle Miocene: northeastern Atlantic (Langhian): Loire Basin, France (Glibert, 1954); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856), Bulgaria (Kojumdgieva & Strachimirov, 1960), Poland (Friedberg, 1928; Bałuk, 2003), Romania (Hoernes & Auinger, 1891); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1904).

Genus Unedogemmula MacNeill, 1960

Type species – Pleurotoma unedo Kiener, 1940a, by original designation. Recent, Pacific.

Type species – Pleurotoma gemmata Reeve, 1843 (*non* Conrad, 1835) (= *G. hindsiana* Berry, 1958), by subsequent designation (Cossmann, 1896). Recent, tropical West America.

Unedogemmula galvanii (Bellardi, 1877) Plate 51, fig. 5

- *1877 *Pleurotoma Galvanii* Bell., Bellardi, p. 44, pl. 1, fig. 26.
- 1894 Pleurotoma Giebeli Bellardi Degrange-Touzin, p. 349 (non Bellardi, 1877).
- 1896 *Pleurotoma Giebeli* Bell. Cossmann, p. 78, pl. 5, figs 20, 21 (*non* Bellardi, 1877).
- 1931 *Pleurotoma (Hemipleurotoma) Cosmanni [sic]* Peyrot, p. 91, no. 1248, pl. 8, figs 11, 12, 22.
- 1954 Turris (α-Gemmula) cossmanni Peyrot Glibert, p. 8, pl. 2, fig. 5.
- 1981 *Pleurotoma galvanii* Bellardi, 1877 Ferrero-Mortara *et al.*, p. 62, pl. 8, fig. 5.
- 1993 *Gemmula galvanii* (Bellardi, 1877) Gatto, p. 30, pl. 1, figs 1-10, text-fig. 3.

Dimensions and material – Height 24.5 mm. Locality 13: NHMW 1847/0058/1510/1, JvdV/1.

Discussion – This species was discussed in detail by Gatto (1993). In the Turkish assemblages it is very rare, represented by two shells, both from the clayey deposits of Pınarlar Yaylası. The colour pattern enhanced by UV light is identical to that illustrated by Gatto (1993, text-fig. 1, pl. 1, figs 5b, 6c, 7b, 10c). Although the

protoconch is not preserved, its teleoconch features are closely similar to those of the following species *Pleurotoma giebeli* Bellardi, 1877 and we have placed both in the genus *Unedogemmula* MacNeill, 1960.

Distribution – **Early Miocene**: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1877; Gatto, 1993). **Middle Miocene**: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Degrange-Touzin, 1894; Cossmann, 1896; Peyrot, 1928; Glibert, 1954; Gatto, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Unedogemmula giebeli (Bellardi, 1877)

Plate 51, fig. 6; Plate 74, fig. 5.

- *1877 *Pleurotoma Giebeli* Bell., Bellardi, p. 38, pl. 1, fig. 24.
- 1981 *Pleurotoma giebeli* Bellardi, 1877 Ferrero-Mortara *et al.*, p. 62, pl. 8, fig. 6.
- non 1894 Pleurotoma Giebeli Bellardi Degrange-Touzin, p. 349 [= Gemmula galvanii (Bellardi, 1877)].
- non 1896 Pleurotoma Giebeli Bell. Cossmann, p. 78, pl. 5, figs 20, 21 (non Bellardi, 1877) [= Gemmula galvanii (Bellardi, 1877)].

Dimensions and material – Maximum height 29.2 mm. Localities 2 & 3: JvdV/6; locality 6: JvdV/1, YI 394/2; locality 9: RGM 783 841/4, YI 397/1; locality 10: YI 395/1; locality 12: JvdV/1; locality 13: NHMW 1847/0058/1258/12, JvdV/9, RGM 794 561/1 (ex JvdV collection), RGM 794 023/11, YI 393/5.

Discussion – We have placed this species in the genus *Unedogemmula* McNeill, 1960, as the protoconch is tall, multispiral, and composed of about 3.5 smooth convex whorls (Pl. 74, fig. 5). The protoconch of species of *Gemmula* Weinkauff, 1875 is axially ornate. *Unedogemmula giebeli* (Bellardi, 1877) is characterised by its extremely slender shell, the base is hardly constricted and the sculpture is relatively prominent. *Unedogemmula annae* (Hoernes & Auinger, 1891), which is widespread in the middle Miocene Paratethys, is also a slender species, but differs in having the base more strongly constricted and having its spiral cords narrower and not gemmate as in *U. giebeli*. The protoconch of the Paratethyan species also seems to be multispiral and smooth (Bałuk, 2003, pl. 12, fig. 5).

As seen in the synonymy, this species has been confused with *Unedogemmula galvanii* (Bellardi, 1877), with which it co-occurs in the clayey Pinarlar Yaylasi deposits. *Unedogemmula galvanii* is distinguished by its wider shell, which is much more constricted at the base, and by its much stronger tuberculate cord mid-whorl. The protoconch of this species seems to be axially striate (Gatto, 1993, pl. 1, fig 8).

The Pliocene species *Unedogemmula contigua* (Brocchi, 1814) from the northeastern Atlantic and Mediterranean

and *Unedogemmula antwerpiensis* (Vincent, 1890) from the North Sea Basin differ in having practically smooth spiral sculpture.

Distribution – **Early Miocene**: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Bellardi, 1877). **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Terebridae Mörch, 1852 Subfamily Terebrinae Mörch, 1852 Genus *Subula* Schumacher, 1817

Type species – Buccinum dimidiatum Linnaeus, 1758, by original designation. Recent, Indo-West Pacific.

Subula buiturica Moisescu, 1955

Plate 51, fig. 7; Plate 82, fig. 14

- 1880 Terebra (Acus) fuscata Brocc. var. Hoernes & Auinger, p. 106, pl. 12, fig. 17 [non Subula fuscata (Brocchi, 1814)].
- *1955 *Terebra fuscata* var. *buiturica* Moisescu, p. 172, pl. 15, figs 10-12.

Dimensions and material – Maximum height 50.4 mm. Locality 17: NHMW 1847/0058/1259/5, JvdV/13, RGM 794 080/1 (ex JvdV collection), RGM 777 903/1 (ex JvdV collection), YI 463/33.

Discussion - A number of shells from the Seyithasan assemblages represent a species of Subula closely matching the figures given by Hoernes & Auinger (1880, pl. 12, fig. 17), which Moisescu (1955, p. 172) named Terebra fuscata var. buiturica. It is unlikely that it represents a form of Subula plicaria (de Basterot, 1825) based on specimens from the early and middle Atlantic Miocene of France, as at the same size Subula buiturica shows no tendency for the later whorls to become inflated. Moreover, in S. plicaria the inflated adult whorls lose their axial sculpture, whereas there is no such tendency in S. buiturica, in which the axial ribs are very close-set and remain strong to the aperture. Finally, a colour pattern is enhanced under UV light in both species. In S. buiturica it consists of a spiral row of blotches on the infrasutural band (Pl. 82, fig. 14), whereas in S. plicaria a row of blotches is present just above the suture (Pl. 82, fig. 15). We also note that the groove delimiting the subsutural band is more prominent in the Turkish shells than in the Paratethyan population.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Hoernes & Auinger, 1880; Moisescu, 1955); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subula plicaria (de Basterot, 1825)

Plate 51, figs 8-9; Plate 82, fig. 15

- *1825 Terebra plicaria de Basterot, p. 52, pl. 3, fig. 4.
- 1829 *Terebra modesta* Tristan *in* Defrance, p. 288 (not seen).
- 1846 *Terebra plicaria* Bast. Grateloup, pl. 35, figs 21, 22, 28.
- 1852 Terebra fuscata Brocc. Hörnes, p. 128, pl. 11, figs 15-18, 26 [non Subula fuscata (Brocchi, 1814)].
- 1866 Terebra fuscata Brocc. Pereira da Costa, p. 78, pl. 12, figs 14-16, pl. 13, figs 1-2 [non Subula fuscata (Brocchi, 1814)].
- 1880 Terebra (Acus) Hochstetteri Hoernes & Auinger, p. 106, pl. 12, figs 18, 19.
- 1891b Subula plicaria var. laevisulcata Sacc., Sacco, p. 12, pl. 1, fig. 14.
- 1891b Subula plicaria var. conicogigantea Sacc., Sacco, p. 12, pl. 1, fig. 15.
- 1891b Subula plicaria var. fuscatoides Sacc., Sacco, p. 13, pl. 1, fig. 16.
- 1891b Subula plicaria? var. scalariolonga Sacc., Sacco, p. 13, pl. 1, fig. 17.
- 1891b Subula plicaria? var. vermicularis Sacc., Sacco, p. 13, pl. 1, fig. 18.
- 1891b Subula plicaria? var. subHochstetteri Sacc., Sacco, p. 14, pl. 1, fig. 19.
- 1891b Subula plicaria? var. cerithinoidea Sacc., Sacco, p. 14, pl. 1, fig. 20.
- 1891b Subula plicaria? var. fusco-modesta Sacc., Sacco, p. 14, pl. 1, fig. 21.
- 1891b Subula plicaria? var. laevicolligens Sacc., Sacco, p. 14, pl. 1, fig. 22.
- 1891b Subula conicoplicaria Sacc., Sacco, p. 15, pl. 1, fig. 23.
- 1891b Subula modesta (Tristan) Sacco, p. 15, pl. 1, fig. 24.
- 1891b Subula modesta var. plano-clavata Sacc., Sacco, p. 16, pl. 1, fig. 25.
- 1891b Subula modesta var. perinflata Sacc., Sacco, p. 16, pl. 1, fig. 26.
- 1891b Subula modesta var. dertofusulata Sacc., Sacco, p. 16, pl. 1, fig. 27.
- 1891b Subula modesta var. ovulata Sacc., Sacco, p. 16, pl. 1, fig. 28.
- 1896 Terebra (Subula) fuscata Br. Cossmann, p. 52, pl. 4, fig. 7, 8 [non Subula fuscata (Brocchi, 1814)].
- 1911 Terebra (Subula) fuscata Brocc. Friedberg, p. 1, pl. 1, fig. 1 [non Subula fuscata (Brocchi, 1814)].
- 1916 *Terebra modesta* Trist. and var. *ventricosa* Stefanini, p. 46, pl. 1, figs 15-18.
- 1925 Terebra (Subula) fuscata Brocch. Kautsky, p. 195, pl. 12, fig. 24 [non Subula fuscata (Brocchi, 1814)].
- 1931 *Terebra (Subula) plicaria* Basterot Peyrot, no. 1359, pl. 10, figs 21-24, 34, 35.
- 1931 Terebra (Subula) salomacensis Peyrot, no. 1360, pl. 10, figs 25-26.

- 1931 *Terebra (Subula) modesta* Tristan *in* Defrance Peyrot, no. 1361, pl. 10, fig. 20.
- 1952a Terebra (Oxymeris) modesta Tristan in Defrance, 1829 – Glibert, p. 380, pl. 14, fig. 5.
- 1954 *Terebra (Subula) fuscata plicaria* Bast. Strausz, p. 61, pl. 2, fig. 44.
- 1954 *Terebra (Subula) fuscata modesta* Trist. Strausz, p. 61, pl. 2, fig. 45.
- 1956 *Terebra (Subula) plicaria* Bast. Csepreghy-Meznerics, p. 436, pl. 12, figs 5, 6.
- 1958 Terebra (Subula) fuscata (Brocchi) Erünal-Erentöz, p. 125, pl. 20, figs 15, 16 [non Subula fuscata (Brocchi, 1814)].
- 1960 Terebra (Subula) fuscata var. modesta Tristan in Defrance, 1829 – Kojumdgieva & Strachimirov, p. 218, pl. 52, figs 1, 2.
- 1962 *Terebra (Subula) fuscata plicaria* Basterot Strausz, p. 31, pl. 5, figs 8-10.
- 1962 Terebra (Subula) fuscata modesta Tristan Strausz, p. 31, pl. 5, figs 12-15.
- 1963 Subula (Oxymeris) modesta (Tristan in Defr.) Venzo & Pelosio, p. 133, pl. 41, figs 36-37.
- 1966 *Terebra (Subula) fuscata plicaria* Basterot, 1825 Strausz, p. 394, pl. 5, figs 8-10.
- 1966 *Terebra (Subula) fuscata modesta* Tristan (*in* Defrance), 1829 – Strausz, p. 395, pl. 5, figs 12-15.
- Subula (Oxymeris) fuscata (Brocchi, 1814) Tejkal et al., p. 209, pl. 12B, fig. 3 [non Subula fuscata (Brocchi, 1814)].
- 1968 Terebra fuscata (Brocchi, 1814) Zelinskaya et al., p. 231, pl. 52, figs 6, 7 [non Subula fuscata (Brocchi, 1814)].
- 1971 Subula (Oxymeris) fuscata modesta (Tristan, 1829) Steininger, p. 406, pl. 11, fig. 11.
- 1972 *Terebra (Subula) plicaria* (Basterot) Csepreghy-Meznerics, p. 34, pl. 18, figs 4, 5.
- 1973 Subula (Oxymeris) modesta (Tristan in Defrance)1829 Bohn-Havas, p. 1126, pl. 8, fig. 7.
- 1977 *Subula (Subula) plicaria* (Basterot) Davoli, p. 156, pl. 3, figs 1-5, 9, 19.
- 1977 Subula (Oxymeris) modesta (Tristan in Defrance) – Davoli, p. 158, pl. 3, figs 6-8, 10, 13, 17, 25.
- 1984 Subula conicoplicaria Sacco, 1891 Ferrero Mortara *et al.*, p. 55, pl. 7, fig. 3.
- 1984a Subula (Oxymeris) fuscata fuscata (Brocchi, 1814) – A.W. Janssen, p. 339, pl. 77, fig. 11, pl. 78, fig. 1 [non Subula fuscata (Brocchi, 1814)].
- 1990 *Subula (Subula) plicaria* (Basterot, 1825) Davoli, p. 104, pl. 10, figs 7, 8.
- 1997 *Subula (Oxymeris) plicaria* (Basterot, 1825) Bałuk, p. 68, pl. 24, figs 6-12.
- 1998 Subula (Subula) fuscata plicaria (Basterot) Schultz, p. 72, pl. 29, fig. 14.
- 2002 Subula (Oxymeris) plicaria (Basterot, 1825) Harzhauser, p. 115, pl. 10, fig. 7.
- 2004 Subula (Oxymeris) plicaria (Basterot 1825) İslamoğlu, p. 165, pl. 4, figs 11, 12.
- 2010 Subula (Oxymeris) plicaria (Basterot, 1825) Moths et al., p. 70, pl. 21, figs 5, 6, pl. 43, fig. 1.

Dimensions and material – Maximum height 83.2 mm. Locality 10: YI 461/2; locality 13: YI 464/1 (fragment); locality 17: NHMW 1847/0058/1260/1, 1847/0058/1261/1, 1847/0058/1262/15, JvdV/38, RGM 777 904/1 (ex JvdV collection), YI 460/46. Exact locality unknown: AÜ-LE-K-257/2.

Discussion – We agree entirely with Bałuk (1997) that *Subula plicaria* (de Basterot, 1825) and *Subula modesta* (Tristan *in* Defrance, 1829) represent extreme forms of a single species, with numerous intermediate forms. In the Karaman shells, the subsutural groove, which is stated to be the distinctive character of the subgenus *Oxymeris* Dall, 1903, is present on the last whorl in some shells, whilst it disappears from the last two or three whorls in others. The strength and perseverance of the spiral sculpture and inflation of the later teleoconch whorls is very variable, as described by Bałuk (1997) for the Polish specimens.

The Pliocene species *Subula fuscata* (Brocchi, 1814) differs from *S. plicaria* in having a more elongate shell, with more flat sided whorls, weaker axial sculpture and a narrower aperture.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Peyrot, 1931; Lozouet et al., 2001a); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1891b); Paratethys (Burdigalian): Austria, (Steininger, 1971; Harzhauser, 2002). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (A.W. Janssen, 1984a), Germany (Kautsky, 1925; Moths et al., 2010). Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Peyrot, 1931), (Langhian): Loire Basin, France (Glibert, 1952a); Proto-Mediterranean Sea (Langhian): Kasaba Basin, Turkey (İslamoğlu, 2004); Paratethys (Langhian-Serravallian): Austria, (Hörnes, 1852; Tejkal et al., 1967; Schultz, 1998), Poland (Friedberg, 1911; Bałuk, 1997), Bulgaria (Kojumdgieva & Strachimirov, 1960), hungary (Csepreghy-Meznerics, 1956; Strausz, 1954, 1962, 1966; Bohn-Havas, 1973), Ukraine (Zelinskaya et al., 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866); Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, Italy (Sacco, 1891b; Venzo & Pelosio, 1963; Davoli, 1977, 1990).

Genus Terebra Bruguière, 1789

Type species – Buccinum subulatum Linné, 1767, by subsequent designation (Lamarck, 1799). Recent, Indo-West Pacific.

Terebra acuminata Borson, 1820 Plate 51, figs 10-13

- *1820 Terebra Acuminata nobis, Borson, p. 224, pl. 1, fig. 17.
- 1825 *Terebra pertusa* var. β de Basterot, p. 53, pl. 3, fig. 9 (*non T. pertusa* Born, 1780).
- 1847 *Terebra neglecta* mihi, Michelotti, p. 214, pl. 13, fig. 8.
- ?1847 *Terebra tessellata* mihi, Michelotti, p. 215, pl. 17, fig. 9.
- 1852 *Terebra acuminata* Borson Hörnes, p. 130, pl. 11, figs 22-24.
- 1852 Terebra pertusa Bast. Hörnes, p. 131, pl. 11, figs 19-21 (non T. pertusa Born, 1780).
- 1854 *Terebra acuminata* Bors. Beyrich, p. 439, pl. 6, fig. 17.
- 1866 Terebra acuminata Borson Pereira da Costa, p. 79, pl. 13, figs 8, 9.
- 1869 Terebra tuberculifera Doderlein, p. 11, pl. 1, fig. 7.
- 1880 Terebra acuminata Borson var. Hoernes & Auinger, p. 110, pl. 12, fig. 13.
- 1891b *Terebrum acuminatum* (Bor.) Sacco, p. 18, pl. 1, fig. 29.
- 1891b *Terebrum acuminatum* var. *ascalarata* Sacc., Sacco, p. 19, pl. 1, fig. 30.
- 1891b Terebrum acuminatum var. subagranulata Sacc., Sacco, p. 19.
- 1891b Terebrum acuminatum var. pergranularis Sacc., Sacco, p. 19, pl. 1, fig. 31.
- 1891b *Terebrum acuminatum* var. *granulatoparva* Sacc., Sacco, p. 19, pl. 1, fig. 32.
- 1891b *Terebrum acuminatum* var. *inflatella* Sacc., Sacco, p. 19, pl. 1, fig. 33.
- 1891b Terebrum acuminatum var. taurocrassa Sacc., Sacco, p. 20, pl. 1, fig. 34.
- 1891b *Terebrum acuminatum* var. *simplicoscalaris* Sacc., Sacco, p. 20, pl. 1, fig. 35.
- 1891b *Terebrum acuminatum* var. *suprangulata* Sacc., Sacco, p. 20, pl. 1, fig. 36.
- 1891b Terebrum acuminatum var. asulcoelegans Sacc., Sacco, p. 21, pl. 1, fig. 37.
- 1891b Terebrum acuminatum var. asulcoornata Sacc., Sacco, p. 21 [nom nov. pro Terebra acuminata Borson var. in Hoernes & Auinger, 1880, pl. 12, fig. 13].
- 1891b *Terebrum acuminatum* var. *magnoplicata* Sacc., Sacco, p. 21, pl. 1, fig. 38.
- 1891b *Terebrum simplicodepressum* Sacc., Sacco, p. 21, pl. 1, fig. 40.
- 1891b *Terebrum cacellense* var. *dertoparva* Sacc., Sacco, p. 22, pl. 1, fig. 41.
- 1891b *Terebrum cacellense*? var. *dertonensis* Sacc., Sacco, p. 22, pl. 1, fig. 42.
- 1891b *Terebrum neglectum* (Micht.) Sacco, p. 28, pl. 1, fig. 63.
- 1891b *Terebrum neglectum* var. *expertusa* Sacc., Sacco, p. 28, pl. 1, fig. 64.
- 1891b *Terebrum neglectum* var. *carinatoides* Sacc., Sacco, p. 29, pl. 1, fig. 65.

- 1891b *Terebrum postneglectum* Sacc., Sacco, p. 29, pl. 1, fig. 66.
- 1891b Terebrum postneglectum var. subtessellatoides Sacc., Sacco, p. 30, pl. 1, fig. 67.
- 1891b *Terebrum postneglectum* var. *cingulatoides* Sacc., Sacco, p. 30, pl. 1, fig. 68.
- 1891b *Terebrum postneglectum* var. *subexpertusa* Sacc., Sacco, p. 30, pl. 1, fig. 69.
- 1896 Terebra acuminata Borson Cossmann, p. 48, pl. 4, fig. 11.
- 1904 *Terebra acuminata* var. *subagranulata* Sacc., Sacco, p. 106, pl. 23, fig. 32.
- 1911 Terebra acuminata Bors. Friedberg, p. 4, pl. 1, figs 2, 3.
- 1911 Terebra neglecta Micht. Friedberg, p. 5, pl. 1, fig. 4.
- 1925 *Terebra neglecta* Micht. Kautsky, p. 194, pl. 12, fig. 22.
- 1925 Terebra (Subula) fuscata Brocch. Kautsky, p. 195, pl. 12, fig. 24 [non Subula fuscata (Brocchi, 1814)].
- 1931 *Terebra pseudopertusa* Peyrot, p. 105, no. 1351, pl. 10, figs 27, 28, 36, 40, 43.
- 1931 *Terebra pseudopertusa* var. *subacuminata* Peyrot, p. 105, no. 1351 (*partim*, pl. 10, fig. 32 only).
- 1931 *Terebra pseudopertusa* var. *helvetica* Peyrot, p. 105, no. 1351 (*partim*, pl. 10, fig. 30 only).
- ?1931 Terebra Degrangei Peyrot, p. 108, no. 1352, pl. 10, fig. 29.
- 1938 *Terebra acuminata* var. *pergranularis* Sacco Stchepinsky, p. 83, pl. 8, fig. 12.
- 1952a Terebra (Terebra) acuminata Borson, 1820 Glibert, p. 381, pl. 14, fig. 6.
- 1952a Terebra (Terebra) neglecta Michelotti, 1847 Glibert, p. 382, pl. 14, fig. 7.
- 1952b *Terebra (Terebra) acuminata* forme *magnoplicata* Sacco, 1891– Glibert, p. 136, pl. 10, fig. 7a.
- 1952b *Terebra (Terebra) acuminata* forme *acuminata* Sacco, 1891– Glibert, p. 137, pl. 10, fig. 7b.
- 1952b *Terebra* (*Terebra*) *neglecta* Michelotti, 1847 Glibert, p. 138, pl. 10, fig. 8.
- 1954 *Terebra acuminata* Bors. Strausz, p. 36, 60, 113, pl. 2, fig. 40.
- 1954 *Terebra neglecta* Micht. Csepreghy-Meznerics, p. 57, pl. 7, figs 23, 33.
- 1956 *Terebra acuminata* Borson Csepreghy-Meznerics, p. 436, pl. 12, fig. 12.
- 1958 *Terebra acuminata* var. *pergranularis* Sacco Erünal-Erentöz, p. 125, pl. 20, figs 12-14.
- 1960 *Terebra (Terebra) acuminata* Borson 1820 Kojumdgieva & Strachimirov, p. 216, pl. 51, fig. 5.
- 1960 Terebra (Terebra) acuminata var. pergranularis Sacco, 1891 – Kojumdgieva & Strachimirov, p. 216, pl. 51, fig. 6.
- 1960 Terebra (Terebra) acuminata var. asulcoornata Sacco, 1891 – Kojumdgieva & Strachimirov, p. 216, pl. 51, fig. 7.
- 1960 Terebra (Terebra) neglecta (Michelotti) 1847 Kojumdgieva & Strachimirov, p. 217, pl. 51, fig. 8.

- 1960 *Terebra (Myurellina) acuminata* Borson, 1820 Malatesta, p. 188, pl. 9, fig. 10.
- 1962 *Terebra neglecta* Nyst Strausz, p. 30, pl. 4, figs 36-37.
- 1962 Terebra acuminata Borson Strausz, p. 30, pl. 5, figs 4-5.
- 1964 *Terebra (Myurellina) neglecta* Michelotti 1847 Anderson, p. 320, pl. 45, fig. 278.
- 1966 Terebra neglecta Michelotti, 1847 Strausz, p. 391, pl. 4, figs 36-37.
- 1966 *Terebra acuminata* Borson, 1820 Strausz, p. 392, pl. 5, figs 4-5.
- 1966 *Terebra (Terebra) acuminata* Borson Symeonidis, p. 293, pl. 65, fig. 6.
- 1968 *Terebra (Terebra) acuminata acuminata* Bors. Stancu & Andreescu, p. 465, pl. 6, fig. 71.
- 1968 *Terebra (Terebra) neglecta* Micht. Stancu & Andreescu, p. 465, pl. 6, fig. 72.
- 1971 *Terebra neglecta* Micht. Csepreghy-Meznerics, p. 34, pl. 18, fig. 8.
- 1972a Terebra neglecta Michelotti, 1847 Nordsieck, p. 120, pl. 30, fig. 201.
- 1972a Terebra acuminata Borson Nordsieck, p. 120, pl. 30, fig. 202.
- 1973 *Terebra neglecta* (Michelotti) 1847 Bohn-Havas, p. 1072, pl. 8, fig. 8.
- 1973 Terebra nov. sp. Bohn-Havas, p. 1129, pl. 8, fig. 12.
- 1973 *Terebra (Terebra) acuminata* Borson Caprotti & Vescovi, p. 185, pl. 3, fig. 2.
- 1973 *Terebra (Terebra) postneglecta* (Sacco) Caprotti & Vescovi, p. 185, pl. 3, fig. 3.
- 1974 *Terebra (Myurellina) acuminata* Borson, 1820 Malatesta, p. 398, pl. 32, fig. 6.
- 1975 *Terebra (Terebra) acuminata* Borson Fekih, p. 136, pl. 40, fig. 18.
- 1977 *Terebra (Myurellina) acuminata* Borson Davoli, p. 161, pl. 4, figs 2, 3, 11-14.
- 1977 Terebra (Myurellina) neglecta Michelotti Davoli, p. 165, pl. 4, figs 1, 4-7.
- 1982b *Terebra (Myurellina) acuminata* Borson, 1820 Martinell, p. 114, pl. 1, figs 27, 28.
- 1984 *Terebrum simplicodepressum* Sacco, 1891 Ferrero Mortara *et al.*, p. 57, pl. 7, fig. 1.
- 1984 *Terebrum cacellense* var. *dertoparva* Sacco, 1891 – Ferrero Mortara *et al.*, p. 57, pl. 7, fig. 7.
- 1984 *Terebrum postneglectum* Sacco, 1891 Ferrero Mortara *et al.*, p. 58, pl. 7, fig. 8.
- 1984a Terebra (Myurellina) acuminata neglecta Michelotti, 1847 A.W. Janssen, p. 340, pl. 13, fig. 11, pl. 77, figs 9-10.
- 1988 Terebra (Myurellina) acuminata Borson, 1820 Chirli, p. 23, pl. 11, fig. 5.
- 1992 Strioterebrum postneglectum (Sacco, 1891) Cavallo & Repetto, p. 148, fig. 411.
- 1992 *Terebra acuminata* Borson, 1820 Cavallo & Repetto, p. 148, fig. 414.
- 1992 *Terebra (Myurellina) postneglecta* Sacco, 1891– González Delgado, p. 50, pl. 6, figs 11-12.
- 1993 Terebra (Terebra) acuminata Borson, 1820 Iljina, p. 107, pl. 14, fig. 9.

- 1997 Terebra postneglecta (Sacco) Ruiz Muñoz, p. 186, pl. 40, figs 11, 12.
- 1997 Terebra (Myurella) acuminata Borson, 1820 Bałuk, p. 69, pl. 24, figs 1-5.
- 2001a Terebra pseudopertusa Peyrot, 1931 Lozouet et al., p. 71, pl. 31, fig. 9.
- 2007 Terebra (Myurellina) acuminata neglecta Michelotti, 1847 Wienrich, p. 725, pl. 120, fig. 5, pl. 157, fig. 6.
- 2010 Terebra (Myurella) acuminata Borson, 1820 Moths et al., p. 70, pl. 21, fig. 1.
- 2011 *Terebra acuminata* Borson, 1820 Landau *et al.*, p. 38, pl. 21, fig. 4.

Dimensions and material – Maximum height 58.4 mm. Locality 13: YI 462/2; locality 17: NHMW 1847/0058/1263-1847/0058/1265/3, 1847/0058/1266/9; JvdV/2; RGM 776 860/1 (ex JvdV collection), YI 465/18.

Discussion – We agree with Bałuk (1997), who considered the distinction between *Terebra acuminata* Borson, 1820 and *Terebra neglecta* Michelotti, 1847, based primarily on the strength of the axial ribs, to be rather artificial and inconsistent. Moreover, and in most European Neogene deposits both forms coexist. Despite Lozouet *et al.* (2001a) pointing out that such a synonymy would give an unusual longevity to *T. acuminata*, possibly from the Oligocene to the Pleistocene, we see no consistent characters on which to base any separation.

In the Karaman assemblages the *neglecta* morphotype is not represented, but all three of the *T. acuminata* 'groups' described by Davoli (1997) can be found ('*dertoparva*/ *dertonensis* group' Pl. 51, fig. 10; '*pergranularis* group' Pl. 51, fig. 12; '*magnoplicata* group' Pl. 51, fig. 11).

Distribution - Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Peyrot, 1931; Lozouet et al., 2001a); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1891b). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Germany (Beyrich, 1854; Kautsky, 1925; Anderson, 1964; Wienrich, 2007; Moths et al., 2010), Netherlands (Nordsieck, 1972a; A.W. Janssen, 1984a). Middle Miocene: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Peyrot, 1931), (Langhian): Loire Basin (France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1852), Bulgaria (Kojumdgieva & Strachimirov, 1960), Romania (Hoernes & Auinger, 1880; Stancu & Andreescu, 1968), Hungary (Strausz, 1954, 1962, 1966; Csepreghy-Meznerics, 1954, 1956, 1971; Bohn-Havas, 1973), Poland (Friedberg, 1928; Bałuk, 1997), eastern Paratethys (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Pereira da Costa, 1866); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1891b; Davoli, 1977), Tunisia (Stchepinsky, 1938). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Gonzàlez Delgado, 1992; Ruiz Muñoz, 1997; Landau *et al.*, 2011); western Mediterranean, Estepona Basin (NHMW collection), northeastern Spain (Martinell, 1982b); central Mediterranean, Italy (Sacco, 1892b), Tunisia (Fekih, 1975). **Early-late Pliocene**: central Mediterranean, Italy (Sacco, 1891b; Malatesta, 1974; Caprotti & Vescovi, 1973; Chirli, 1988; Cavallo & Repetto, 1992), Crete (Symeonidis, 1966). **Pleistocene**: central Mediterranean, Italy (Malatesta, 1960).

Terebra cf. *cacellensis* Pereira da Costa, 1866 Plate 51, fig. 14

- cf. *1866 *Terebra cacellensis* Costa, Pereira da Costa, p. 81, pl. 13, figs 3-6. cf. 1977 *Terebra (Myurellina) cacellensis* Da Costa – Da-
- cf. 1977 *Terebra (Myurellina) cacellensis* Da Costa Davoli, p. 163, pl. 3, figs, 15, 16, 18, 20-24.

Dimensions and material – Maximum height 24.5 mm. Locality 11: JvdV/9, RGM 794 065/1 (ex JvdV collection).

Discussion - This small terebrid is found exclusively in the brackish assemblage on the southwest bank of Gödet Creek near Tilkikaya (locality 11). This is unusual, as most terebrids are associated with shallow, fully marine environments. It is very distinctive, being the smallest terebrid in the Karaman assemblages, with a short spire, very weak to obsolete axial sculpture, and a well-delimited, swollen, nodular subsutural band, the band being just over one-third the whorl height. It is very similar to Terebra cacellensis Pereira da Costa, 1866, originally described from the late Miocene Tortonian deposits of Cacela, Portugal, but also recorded from the Tortonian of Italy (Davoli, 1977). Terebra cacellensis also has a nodular subsutural band, but in typical specimens the subsutural band is not as clearly delimited and the nodules are larger in most specimens. However, like all the terebrids discussed here, T. cacel*lensis* has a highly variable shell (see Davoli, 1977, pl. 3, figs 15, 16, 18, 20-24). A further difference can be seen in the shape of the last whorl, which is proportionally shorter and has a more constricted base in T. cacellensis. Despite these differences in size, character of the subsutural band and shape of the last whorl, it seems likely that the Tilkikaya shells are a brackishwater form of T. cacellensis.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Clade Heterobranchia Superfamily Architectonicoidea Gray, 1850 Family Architectonicidae Gray, 1850 Genus *Nipteraxis* Cossmann, 1915

Type species – Solarium plicatum Lamarck, 1804, by original designation. Eocene, France.

Nipteraxis monilifera (Bronn, 1831)

Plate 52, fig. 1

- *1831 Solarium moniliferum Bronn, p. 63.
- 1880 *Solarium moniliferum* Bronn Fontannes, p. 138, pl. 8, fig. 5.
- 1892b *Solarium moniliferum* Bronn Sacco, p. 52, pl. 1, fig. 76.
- 1892b Solarium moniliferum var. brocchiana Sacc., Sacco, p. 52, pl. 1, fig. 77.
- 1892b Solarium moniliferum var. perconoidalis Sacc., Sacco, p. 52, pl. 1, fig. 78.
- 1892b Solarium moniliferum var. testudinea Sacc., Sacco, p. 52, pl. 1, fig. 79.
- 1892b Solarium moniliferum var. permonilifera Sacc., Sacco, p. 53, pl. 1, fig. 80.
- 1892b Solarium moniliferum var. subamonilifera Sacc., Sacco, p. 53, pl. 1, fig. 81.
- 1892b Solarium moniliferum var. sulcosecarinata Sacc., Sacco, p. 53, pl. 1, fig. 82.
- 1892b Solarium moniliferum var. semisquamosiformis Sacc., Sacco, p. 53, pl. 1, fig. 83.
- 1892b Solarium moniliferum var. latesulcata Sacc., Sacco, p. 53, pl. 1, fig. 84.
- 1892b Solarium moniliferum var. basilatesulcata Sacc., Sacco, p. 53, pl. 1, fig. 85.
- 1892b Solarium moniliferum var. lyelliana Sacc., Sacco, p. 53, pl. 1, fig. 86.
- 1955 Architectonica (Architectonica) monilifera (Bronn) 1831 – Rossi Rochetti, p. 122, fig. 58.
- 1959 Architectonica (s.s.) monilifera (Bronn) Ruggieri & Curti, p. 109, pl. 22, fig. 137.
- 1974 Architectonica (Architectonica) monilifera (Bronn, 1831) – Malatesta, p. 179, pl. 13, fig. 4.
- 1984 Solarium moniliferum Bronn, 1831 Ferrero Mortara et al., p. 94, pl. 14, fig. 5.
- Architectonica (Architectonica) monilifera (Bronn, 1831) – González Delgado, p. 89, pl. 2, figs 13-15.
- Heliacus (Granoheliacus) moniliferus (Bronn, 1831) – Cavallo & Repetto, p. 150, fig. 417.
- 2002 Heliacus moniliferus (Bronn, 1831) Bogi et al.,
 p. 34, figs 19, 20.
- 2008 Heliacus moniliferus (Bronn, 1831) Chirli & Richard, p. 74, pl. 15, fig. 1.
- 2010 *Heliacus moniliferum* (Bronn, 1831) Sosso & dell'Angelo, p. 50, unnumbered fig. p. 65 bottom right.
- 2011 Heliacus moniliferus (Bronn, 1831) Landau et al., p. 39, pl. 22, fig. 1.
- 2013 *Heliacus moniliferus* (Bronn, 1831) Chirli, p. 13, pl. 4, figs 10-15.
- non 1856 Solarium moniliferum Bronn Hörnes, p. 466, pl. 46, fig. 5 [= Heliacus exmonilifera (Sacco, 1892)].
- non 1956 Architectonica monilifera (Bronn) Csepreghy-Meznerics, p. 386, pl. 1, figs 29, 30 [= Heliacus exmonilifera (Sacco, 1892)].
- non 1962 Solarium moniliferum Bronn Strausz, p. 123, pl. 51, figs 8-10 [= Heliacus exmonilifera (Sacco, 1892)].

non 1966 Solarium moniliferum Bronn, 1831 – Strausz, p. 118, pl. 51, figs 8-10 [= Heliacus exmonilifera (Sacco, 1892)].

Dimensions and material – Maximum diameter 13.8 mm. Locality 13: NHMW 1847/0058/1269/1, 1847/0058/1270/1, YI 424/1.

Discussion – This species has been placed in the genus *Heliacus* d'Orbigny *in* Sagra, 1842 by most authors during the last decades. However, the weak infra-peripheral rib (*sensu* Bieler, 1985), its general profile and the absence of spiral sculpture in the umbilicus are characters corresponding to the genus *Nipteraxis* Cossmann, 1915. The smaller shells from the middle Miocene Paratethys Vienna Basin with strong spiral ribs on the base close to the periphery identified as *Solarium moniliferum* by Hörnes (1856, pl. 46, fig. 5) were considered to be a distinct species *Solarium exmoniliferum* by Sacco (1892b) and should also be placed in *Heliacus* because of their peripheral sculpture and umbilical spiral cord.

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (NHMW collection); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1892b). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Gonzàlez Delgado, 1986; Landau *et al.*, 2011); western Mediterranean, Estepona Basin (NHMW collection), Roussillon Basin, France (Fontannes, 1880; Chirli & Richard, 2008). Early-late Pliocene: western Mediterranean, Morocco (Lecointre, 1952); central Mediterranean, Italy (Sacco, 1892b; Ruggieri & Curti, 1959; Malatesta, 1974; Cavallo & Repetto, 1992; Bogi *et al.*, 2002; Sosso & dell'Angelo, 2010; Chirli, 2013).

Genus Pseudotorinia Sacco, 1892

Type species – *Solarium obtusum* Bronn, 1831, by original designation. Pliocene, Italy

Pseudotorinia obtusa (Bronn, 1831)

Plate 52, fig. 2

- *1831 Solarium canaliculatum var. obtusum nob., Bronn, p. 64.
- 1892b Torinia obtusa (Bronn) Sacco, p. 67, pl. 2, fig. 45.
- 1984 *Torinia obtusa* (Bronn, 1831) Ferrero Mortara *et al.*, p. 67, pl. 15, fig. 4.
- 1985 *Pseudotorinia obtusa* (Bronn, 1831) Bieler, p. 91, pl. 1, fig. 1.
- non 1914 Solarium (Torinia) obtusum Brn. Cerulli-Irelli, p. 188, pl. 15, figs 17-20 (= Heliacus fallaciosus Tiberi, 1872).
- non 1972 Architectonica (Pseudotorinia) obtusa (Bronn, 1831) s. l. – A.W. Janssen, p. 26, pl. 5, fig. 2 (= Heliacus fallaciosus Tiberi, 1872).

- non 1984a Architectonica (Pseudotorinia) obtusa (Bronn, 1831) s. lat. – A.W. Janssen, p. 143, pl. 47, fig. 4 (= Heliacus fallaciosus Tiberi, 1872).
- non 2007 Architectonica (Pseudotorinia) obtusa (Bronn, 1831) s. lat. – Wienrich, p. 730, pl. 119, fig. 1, pl. 158, fig. 5 (= Heliacus fallaciosus Tiberi, 1872).

Dimensions and material – Maximum diameter 16.0 mm. Locality 6: JvdV/1, RGM 776 861/1 (ex JvdV collection); locality 17: NHMW 1847/0058/1271/3, JvdV/1.

Discussion - Melone & Taviani (1984) commented that the fossil form usually known as Solarium obtusum Bronn, 1831 or Solarium fallaciosum Tiberi, 1872 was indistinguishable from the Recent species identified as Solarium subvariegatum d'Orbigny, 1852. Solarium subvariegatum d'Orbigny, 1852 was based on Solarium variegatum (Gmelin, 1791), sensu Sismonda (1847, p. 49) and is a nomen nudum. Therefore, the valid name for the Recent shells is Heliacus fallaciosus. From both dorsal and ventral views our shells from Sevithasan are identical to Pliocene and Recent specimens of H. fallaciosus. However, the Turkish shells have only two prominent cords at the carina, whereas all Pliocene and Recent shells we have examined have a further, finer cord between the two major cords. Sacco (1892b) interpreted Bronn's species as having only two cords at the periphery, clearly illustrated in the specimen he figured (Sacco, 1892b, pl. 2, fig. 45, refigured by Ferrero Mortara et al., 1984, pl. 15, fig. 4). Sacco (1892b, p. 68) went on to say that the variety subvariegata d'Orb. differs in having a finer cord between the two major cords at the periphery. The same arrangement of peripheral cords is seen in the specimen figured by Bieler (1985, pl. 1, fig. 1). We therefore restrict the name Pseudotorinia obtusa (Bronn, 1831) to shells with only two cords at the periphery, without a finer central cord. The presence of this species in the Paratethys was reported by Strausz (1966, pl. 51, figs 2-4), but his specimen is too poor to identify with certainty. Heliacus fallaciosus, with intermediate peripheral spirals, is already present in the middle Miocene North Sea Basin (A.W. Janssen, 1984a; Wienrich, 2007).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1892b). **Early-late Pliocene**: central Mediterranean, Italy (Sacco, 1892b; Bieler, 1985).

Genus Psilaxis Woodring, 1928

Type species – Architectonica krebsii Mörch, 1875, by original designation. Recent, West Indies and Florida, USA.

Psilaxis simplex (Bronn, 1831)

Plate 52, fig. 3

*1831 Solarium simplex Bronn, p. 63.

1841b Solarium neglectum mihi, Michelotti, p. 213, pl. 2,

figs 7-9.

- 1846 *Solarium carocollatum* Grateloup (*partim*, pl. 12, figs 27-28 only) (*non* fig. 29 = *S. carocollatum*).
- 1852 Solarium subconoideum d'Orbigny, p. 45, no. 715.
- 1856 Solarium simplex Bronn Hörnes, p. 463, pl. 46, fig. 3.
- 1880 Solarium simplex Bronn Fontannes, p. 137, pl. 8, fig. 4.
- 1892b Solarium simplex Bronn Sacco, p. 45, pl. 1, fig. 49.
- 1892b Solarium simplex var. crassulosa Sacc., Sacco, p. 46, pl. 1, fig. 50.
- 1892b Solarium simplex var. subacrenula Sacc., Sacco, p. 46, pl. 1, fig. 51.
- 1892b Solarium simplex var. gibbosoacrenula Sacc., Sacco, p. 46, pl. 1, fig. 52.
- 1892b Solarium simplex var. subacingulosa Sacc., Sacco, p. 46, pl. 1, fig. 53.
- 1892b Solarium simplex var. rugulodepressa Sacc., Sacco, p. 46, pl. 1, fig. 54.
- 1892b Solarium simplex var. infernelineata Sacc., Sacco, p. 47, pl. 1, fig. 56.
- 1892b Solarium simplex var. trilineata Sacc., Sacco, p. 47, pl. 1, fig. 57.
- 1892b Solarium simplex var. antiquoscalarata Sacc., Sacco, p. 47, pl. 1, fig. 58.
- 1892b Solarium simplex var. pyramidata Sacco, p. 48, pl. 1, fig. 59.
- 1896 Solarium simplex var. bicinctum Penecke, p. 61, pl. 3, fig. 14.
- Solarium simplex Bronn Dollfus et al., p. 8, pl. 32, fig. 7.
- 1904 Solarium simplex var. neglecta Micht. Sacco, p. 111, pl. 24, fig. 37.
- 1919 Solarium simplex Bronn Cossmann & Peyrot, no. 386, pl. 15, figs 33-38.
- 1919 Solarium simplex var. subconoideum d'Orbigny Cossmann & Peyrot, no. 387, pl. 15, figs 42-44.
- Solarium simplex Bronn Friedberg, p. 413, pl. 25, fig. 5.
- 1949 Solarium simplex Bronn, 1831 Glibert, p. 123, pl. 7, fig. 6.
- 1951 Solarium simplex Bronn Montanaro Gallitelli & Tacoli, p. 177, pl. 2, figs 6-8.
- 1952b Solarium simplex Bronn, 1831 Glibert, p. 29, pl. 2, fig. 14.
- 1954 Architectonica simplex Bronn Csepreghy-Meznerics, p. 18, pl. 1, figs 16-18.
- 1955 Solarium simplex Bronn Ferreira, p. 26, pl. 6, figs 35, 36.
- 1958 Solarium simplex Bronn Erünal-Erentöz, p. 16, pl. 2, figs 6, 7.
- 1959 Architectonica (s.s.) simplex (Bronn) Ruggieri & Curti, p. 109, pl. 23, fig. 138.
- 1959 Architectonica (s.s.) simplex rugulodepressa Sacco – Ruggieri & Curti, p. 110, pl. 23, fig. 139.
- 1960a Architectonica (Architectonica) simplex (Bronn 1831) – Anderson, p. 47, pl. 8, fig. 2.
- 1960 Architectonica (Architectonica) simplex (Bronn 1831) – Kojumdgieva & Strachimirov, p. 91, pl.

29, fig. 14.

- 1962 Solarium simplex Bronn Strausz, p. 124, pl. 51, fig. 15, pl. 52, fig. 1.
- 1966 *Solarium simplex* Bronn, 1831 Strausz, p. 116, pl. 51, fig. 15, pl. 52, fig. 1.
- 1967 Architectonica (Architectonica) simplex (Bronn 1831) – A.W. Janssen, p. 133, pl. 7, fig. 1.
- Solarium simplex Bronn, 1831 Zelinskaya et al.,
 p. 133, pl. 34, figs 12-14.
- 1970 Architectonica (Architectonica) simplex (Bronn) Caprotti, p. 142, pl. 1, fig. 11.
- 1972a Architectonica cf. simplex (Bronn) Nordsieck, p. 56, pl. 13, fig. 31.
- 1973 Architectonica (Architectonica) simplex (Bronn) Steininger, p. 404, pl. 4, fig. 4.
- 1974 Architectonica (Architectonica) simplex (Bronn, 1831) Malatesta, p. 182, pl. 13, fig. 3.
- 1975 Solarium simplex Bronn Fekih, p. 57, pl. 21, fig. 1.
- 1975 Solarium simplex var. crassulosa Sacco Fekih, p. 57, pl. 21, fig. 4.
- 1975 Solarium simplex var. neglecta Michelotti Fekih, p. 58, pl. 21, fig. 7.
- 1975 Architectonica (Architectonica) simplex (Bronn, 1831) Bałuk, p. 117, pl. 13, figs 1, 2.
- 1984a Architectonica (Architectonica) simplex (Bronn, 1831) – A.W. Janssen, p. 142, pl. 47, fig. 2.
- 1984 Solarium simplex Bronn, 1831 Ferrero Mortara et al., p. 92, pl. 14, fig. 2.
- 1986 Architectonica (Architectonica) simplex (Bronn, 1831) – González Delgado, p. 86, pl. 2, figs 10-12.
- 1988 Architectonica simplex (Bronn, 1831) Chirli, p. 16, pl. 1, fig. 7.
- 1992 Basisulcata simplex (Bronn, 1831) Cavallo & Repetto, p. 150, fig. 415.
- 1992 Architectonica (Architectonica) simplex (Bronn, 1831) Silva, p. 4, pl. 1, figs 1, 2.
- 1997 Architectonica simplex (Bronn, 1831) Ruiz Muñoz, p. 166, pl. 30, figs 3-7.
- 2001 Basisulcata simplex (Bronn, 1831) Silva, p. 563, pl. 26, figs 10-12.
- 2001a Architectonica simplex subconoidea (d'Orbigny, 1852) Lozouet et al., p. 73.
- 2002 *Basisulcata simplex* (Bronn, 1831) Bogi *et al.*, p. 32, figs 1, 2.
- 2002 Architectonica (Architectonica) simplex (Bronn, 1831) – Harzhauser, p. 122, pl. 11, figs 14-15.
- 2007 Architectonica (Architectonica) simplex (Bronn, 1831) Wienrich, p. 727, pl. 117, figs 3-4, pl. 158, fig. 3.
- 2008 Basisulcata simplex (Bronn, 1831) Chirli & Richard, p. 73, pl. 14, fig. 10.
- 2010 Basisulcata simplex (Bronn, 1831) Sosso & dell'Angelo, p. 50, unnumbered fig. p. 66 top middle.
- 2010 *Psilaxis simplex* (Bronn, 1831) Moths *et al.*, p. 81, text-fig. 46, pl. 23, fig. 4.
- 2011 Basisulcata simplex (Bronn, 1831) Landau et al., p. 39, pl. 21, fig. 11.
- 2013 Basisulcata simplex (Bronn, 1831) Chirli, p. 7, pl. 2, figs 7-15.

- non 1961 Architectonica (Architectonica) simplex Bronn Marinescu, p. 531, pl. 5, fig. 19 [= Psilaxis carocollata (Lamarck, 1822].
- non 1966 Solarium simplex sobiensis Strausz, p. 116, pl. 52, figs 3, 4, 6 [= Psilaxis carocollata (Lamarck, 1822].

Dimensions and material – Maximum diameter 18.8 mm. Localities 2 & 3: JvdV/5; locality 6: JvdV/1; localities 7 & 8: NHMW 1847/0058/1275/4; locality 12: JvdV/2; locality 10: YI 440/1; locality 13: NHMW 1847/0058/1272/1, 1847/0058/1273/6, JvdV/2, YI 425/7; locality 17: NHMW 1847/0058/1274/2, RGM 783 739/1.

Discussion – Bieler (1985) placed the *Solarium simplex* species group in the genus *Philippia* J.E. Gray, 1847, subgenus *Psilaxis* Woodring, 1928, which was later raised to full generic rank by Bieler (1993). This taxonomic placement was confirmed by Bieler (personal communication *in* Moths *et al.*, 2010, p. 81).

Psilaxis simplex (Bronn, 1831) is widespread in the European Miocene and Pliocene assemblages, and varies greatly is size and shape. The specimens from the Karaman Basin are relatively small compared with the large size attained by some specimens in the Pliocene assemblages, and are relatively depressed. The weak sculpture is characteristic of the species.

Architectonica simplex subconoidea (d'Orbigny, 1852) from the Atlantic early Miocene Aquitanian of the Aquitaine Basin, France was considered a valid subspecies by Lozouet *et al.* (2001a, p. 73). In their discussion, Cossmann & Peyrot (1919, p. 666) already doubted the validity of this 'variety', which differs from the nominate species by being larger and relatively more elevated. Within both the Miocene and Pliocene populations great variation is found in both these characters, as reflected by the huge number of varieties described by Sacco (1892b). Even in the early Miocene Atlantic French assemblages the elevated form coexists with the more common depressed form (Cossmann & Peyrot, 1919, p. 666-667), and therefore subspecific status is not justified.

Distribution - Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1919; Lozouet et al., 2001a); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Michelotti, 1841b; Sacco, 1892b); Paratethys (Aquitanian and Burdigalian): Austria (Harzhauser, 2002). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Germany (Anderson, 1960a, 1964; A.W. Janssen, 1967; Wienrich, 2007; Moths et al., 2010), Netherlands (Nordsieck, 1972a; A.W. Janssen, 1984a). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Grateloup, 1846; Cossmann & Peyrot, 1919), (Langhian): Loire Basin (France (Glibert, 1949); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Csepreghy-Meznerics, 1954; Strausz, 1962, 1966), Poland (Friedberg, 1923; Bałuk, 1975), Ukraine (Zelinskaya et al., 1968); northeastern Atlantic, Azores (Ferreira, 1955); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Erünal-Erentöz, 1958). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Dollfus et al., 1903); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1892b). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Gonzàlez Delgado, 1986; Ruiz Muñoz, 1997; Landau et al., 2011); western Mediterranean, Estepona Basin (NHMW collection), Roussillon Basin, France (Fontannes, 1880; Chirli & Richard, 2008); central Mediterranean, Italy (Sacco, 1892b; Chirli, 1988), Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Zbyszewski, 1959; Silva, 1992, 2001), Morocco (Lecointre, 1952); western Mediterranean, Morocco (Lecointre, 1952); central Mediterranean, Italy (Sacco, 1892b; Ruggieri & Curti, 1959; Malatesta, 1974; Caprotti, 1970; Cavallo & Repetto, 1992; Bogi et al., 2002; Sosso & dell'Angelo, 2010; Chirli, 2013).

Superfamily Mathildoidea Dall, 1889 Family Mathildidae Dall, 1889 Genus *Mathilda* Semper, 1865

Type species – Turbo quadricarinatus (Brocchi, 1814), by subsequent designation (de Boury, 1883). Pliocene, Italy.

Mathilda granosa (Borson, 1821)

Plate 52, fig. 4

- *1821 *Turritella granosa* nob., Borson, p. 344, pl. 6, fig. 19.
- 1896a *Mathilda granosa* (Bors.) Sacco, p. 35, pl. 3, fig. 32.
- 1976 *Mathilda (M.) granosa* (Borson 1821) Pavia, p. 152, pl. 1, fig. 2.
- 2010 Mathilda granosa (Borson, 1821) Sosso & dell'Angelo, p. 51, unnumbered fig. p. 66 centre middle.
- 2011 Mathilda granosa (Borson, 1821) Landau et al.,
 p. 39, pl. 22, fig. 3.

Dimensions and material – Maximum diameter 3.0 mm (incomplete). Locality 6: RGM 794 058/1 (ex JvdV collection).

Discussion – Mathilda granosa (Borson, 1821) is represented in the Karaman assemblages by a single incomplete specimen. Nevertheless, it can be ascribed to this species with relative certainty. It is characterised by its sculpture of four equidistant granular spiral cords per whorl, the adapical and abapical cords weakly developed, with the central two cords much more prominent. Mathilda concinna Millet de la Turtaudière, 1866 from the Atlantic middle Miocene Loire Basin of France differs in having the adapical cord very weak, the two central cords strong and much more close-set and, unlike M. granosa, the abapical cord is also strongly developed (see Glibert, 1949, pl. 7, fig. 5b). We are not convinced that the specimen from the Miocene North Sea Basin of Germany illustrated by Wienrich (2007) as *Mathilda s. lat. concinna* is conspecific with the French shells. The central cords are not as close-set and there is a secondary cord between the third and fourth primary spirals that is not present in the French specimens.

The middle Miocene Paratethyan species *Mathilda clara* Boettger, 1902 has coarser sculpture and the spiral rows of nodes are narrowly spaced. *Mathilda praeclara* Boettger, 1902, also from the middle Miocene Paratethys of Romania, has much weaker sculpture and a medial keel.

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896a). Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Landau *et al.*, 2011); western Mediterranean, Estepona Basin (NHMW collection). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (NHMW collection); central Mediterranean, Italy (Sosso & dell'Angelo, 2010).

Superfamily Omalogyroidea G.O. Sars, 1878 Family Omalogyridae G.O. Sars, 1878 Genus *Ammonicerina* O.G. Costa, 1861

Type species – Ammonicerina simplex O.G. Costa, 1861, by subsequent designation. Recent, Mediterranean.

Ammonicerina rota (Forbes & Hanley, 1853) *s. lat.* Plate 74, fig. 6

- *1853 *Skenea rota* Forbes & Hanley, p. 160, pl. 73, fig. 10, pl. 88, figs 1, 2.
- 1950 Adeorbis ammonoides Csepreghy-Meznerics, p. 23, pl. 1, fig. 8.
- 1966 *Omalogyra (Ammonicera) rota* (Forbes & Hanley) – Strausz, p. 51, text-fig. 30, pl. 50, fig. 39.
- 1970 *Omalogyra (Ammonicera) rota* (Forbes & Hanley) – Greco, p. 285, pl. 6, fig. 11.
- 1975 *Omalogyra rota* (Forbes & Hanley, 1853) Bałuk,p. 96, pl. 11, figs 1, 2.
- 1978 Ammonicera rota (Forbes & Hanley, 1853) Gaglini & Galletti, p. 211, fig. 3.
- 1988 *Ammonicera rota* (Forbes & Hanley, 1850 [*sic*]) Graham, p. 276, fig. 111.
- 1988 Ammonicerina rota (Forbes & Hanley, 1853) Palazzi, p. 104, figs 9, 17, 24.
- 2013 Ammonicera rota (Forbes & Hanley, 1850 [sic]) Chirli, p. 4, pl. 1, figs 4-6.

Dimensions and material – Maximum diameter 550 μm. Locality 13: RGM 784 058/1.

Discussion – In his revision of the Omalogyridae in the Mediterranean, Palazzi (1988) showed the group to be far more speciose than previously recognised. The species

are distinguishable only under high magnification and well-preserved shells are essential. Unfortunately, the shell from Turkey falls far short of these requirements. The shell illustrated probably represents Ammonicerina rota (Forbes & Hanley, 1853).

Distribution - Middle Miocene: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1975), Hungary (Csepreghy-Meznerics, 1950; Strausz, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: central Mediterranean, Italy (Chirli, 2013). Pleistocene: central Mediterranean, Italy (Greco, 1970). Recent: Mediterranean (Palazzi, 1988).

Genus Omalogyra Jeffreys, 1860

Type species - Helix nitidissima J. Adams, 1800, by subsequent designation (Tate, 1868). Recent, British seas.

Omalogyra atomus (Philippi, 1841) s. lat. Plate 74, fig. 7

- *1841 Truncatella atomus Philippi, p. 54, pl. 5, fig. 4.
- 1970 Omalogyra atomus (Philippi) - Greco, p. 285, pl. 9, figs 9, 10.
- 1975 Omalogyra atomus (Philippi, 1860 [sic]) - Bałuk, p. 96, pl. 11, figs 4, 5.
- 1978 Omalogyra atomus (Philippi, 1841) - Gaglini & Galletti, p. 209, fig. 1.
- 1988 Omalogyra atomus (Philippi, 1841) - Graham, p. 274, fig. 110.
- 1988 Omalogyra atomus (Philippi, 1841) - Palazzi, p. 102, figs 3, 19, 26.
- 2013 Omalogyra atomus (Philippi, 1841) - Chirli, p. 3, pl. 1, figs 1-3.

Dimensions and material - Locality 13: damaged during SEM microscopy.

Discussion - The observations made above for Ammonicerina rota hold true here as well. The Turkish shell was not perfectly preserved and it is unclear whether the protoconch is granular. Nevertheless, the shell illustrated here is extremely close to, if not conspecific with Omalogyra atomus (Philippi, 1841).

Distribution - Middle Miocene: Paratethys (Langhian-Serravallian): Poland (Bałuk, 1975); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: central Mediterranean, Italy (Chirli, 2013). Pleistocene: central Mediterranean, Italy (Greco, 1970). Recent: Mediterranean (Palazzi, 1988).

Superfamily Pyramidelloidea Gray, 1840

Note - The superfamily includes a large number of extremely small gastropods, which live as ectoparasites on invertebrates. Important steps in understanding the taxonomy in the Recent European faunas were made by van Aartsen (1977, 1981, 1986, 1987, 1994). He highlighted species-specific shell characters and drew special attention to their protoconch morphology. The protoconch types he described were:

- protoconch consisting of about two whorls Type A with its axis at right angles to the shell axis; type A1 (planispiral), A2 (helicoidal).
- axis of the protoconch is at about 135° to the Type B shell axis. The topwhorl is hidden in the first teleoconch whorl in most species.
- Type C an even greater angle is present between the protoconch axis and the shell axis so that none of the topwhorls can be seen; usually called 'intorted' (van Aatrsen, 1987, p. 1).

These protoconchs are best illustrated in Peñas et al. (1996, p. 9). Their model has been followed by most subsequent authors (i.e. Peñas et al., 1996; Peñas & Rolán, 1997, 1999) and is followed here.

Although this superfamily has now been investigated extensively in the Recent European and West African faunas, no systematic work has been undertaken on European Miocene assemblages using the criteria proposed by van Aartsen. Consequently, their taxonomy in the fossil assemblages is a mess. Boettger (1902, 1907) described numerous species from the middle Miocene Paratethys (illustrated by Zilch, 1934). These taxa need to be evaluated using electron microscopy. For these reasons, the identifications in this work must be considered provisional.

Family Pyramidellidae Gray, 1840 Subfamily Pyramidellinae Gray, 1840 Tribe Pyramidellini Gray, 1840 Genus Pyramidella Lamarck, 1799

Type species – Trochus dolabratus Linnaeus, 1758, by monotypy. Recent, Caribbean.

Pyramidella plicosa Bronn, 1838 Plate 52, fig. 5

- *1838 Pyramidella plicosa nob., Bronn, p. 1026, pl. 40, fig. 24.
- 1842 Pyramidella laeviuscula S. Wood - Wood, p. 537.
- Pyramidella plicosa Bronn von Koenen, p. 239, 1882 pl. 6, fig. 15.
- Pyramidella plicosa Bronn Sacco, p. 609, pl. 1, 1892a fig. 53.
- 1892a Pyramidella plicosa var. suturatissima Sacc., Sacco, p. 609.
- 1892a Pyramidella plicosa var. angulatina Sacc., Sacco, p. 610, pl. 1, fig. 54.
- 1892a Pyramidella plicosa var. sublaeviuscula Sacc., Sacco, p. 610, pl. 1, fig. 55.
- 1892a Pyramidella plicosa var. ovuloides Sacc., Sacco, p. 610, pl. 1, fig. 56.

- 1848 Pyramidella laeviuscula S. Wood Wood, p. 77, pl. 9, fig. 2.
- 1878 Pyramidella plicosa Bronn Nyst, pl. 6, fig. 1.
- 1881 *Pyramidella plicosa* Bronn Nyst, p. 71.
- 1898 Pyramidella plicosa Bronn Almera & Bofill, p. 184, pl. 3, fig. 8.
- 1907 Pyramidella plicosa Bronn Ravn, p. 300, pl. 3, fig. 22.
- 1907 *Pyramidella plicosa* Bronn Almera, p. 184, pl. 3, fig. 8.
- 1914 *Pyramidella plicosa* Bronn Cerulli-Irelli, p. 425, pl. 22, figs 6-12.
- 1917 Pyramidella plicosa Bronn Cossmann & Peyrot, p. 299, no. 170, pl. 9, figs 8, 9.
- 1920 *Pyramidella laeviuscula* S.V. Wood Harmer, p. 558, pl. 49, fig. 8.
- 1928 Pyramidella plicosa Bronn Friedberg, p. 442, pl. 27, fig. 7.
- 1944 *Pyramidella (Pyramidella) plicosa* Bronn van Voorthuysen, p. 39, pl. 13, figs 18, 19.
- 1949 Pyramidella plicosa Bronn, 1838 Glibert, p. 197, pl. 12, fig. 11.
- 1952b *Pyramidella (Pyramidella) plicosa* Bronn, 1838 Glibert, p. 62, pl. 4, fig. 17.
- 1954 *Pyramidella plicosa* Bronn Strausz, p. 21, pl. 2, fig. 36.
- 1956 *Pyramidella (Pyramidella) plicosa* Bronn, 1838 Rasmussen, p. 102, pl. 10, fig. 6.
- 1958 Pyramidella (Pyramidella) plicosa Bronn Sorgenfrei, p. 332, pl. 72, fig. 247.
- 1958 Pyramidella laeviuscula Wood, 1842 Glibert, p. 21, pl. 2, fig. 18.
- 1960 Pyramidella (Pyramidella) plicosa (Bronn, 1838)
 Kojumdgieva & Strachimirov, p. 96, pl. 30, fig. 5.
- 1962 *Pyramidella plicosa* Bronn Strausz, p. 29, pl. 4, figs 28-30, pl. 78, fig. 6.
- 1964 *Pyramidella plicosa* (Bronn, 1838) Anderson, p.
 329, pl. 50, fig. 293.
- 1966 Pyramidella plicosa Bronn, 1838 Strausz, p. 190, pl. 4, figs 28-30, pl. 78, fig. 6.
- 1969 *Pyramidella plicosa* Bronn Fekih, p. 9, pl. 1, fig.1.
- 1969 Pyramidella suturatissima Sacco Fekih, p. 9, pl. 1, fig. 2.
- 1969 *Pyramidella angulatina* Sacco Fekih, p. 9, pl. 1, fig. 3.
- 1972a *Tiberia (Cossmannica) mioemarginata* Nordsieck, p. 130, pl. 33, fig. 239.
- 1972a Pyramidella (Voluspa) plicosa Bronn, 1838 Nordsieck, p. 353, pl. 14, fig. 242.
- 1973 Pyramidella (Pyramidella) plicosa Bronn Caprotti & Vescovi, p. 187, pl. 2, fig. 17.
- 1974 Pyramidella (Pyramidella) plicosa Bronn, 1838 Malatesta, p. 438, pl. 32, fig. 19.
- 1976 Pyramidella plicosa Bronn Caprotti, p. 13, pl. 17, fig. 17.
- 1982c Pyramidella (Pyramidella) plicosa Bronn, 1838 Martinell, p. 226, pl. 1, figs 10, 11.
- 1982 Pyramidella plicosa Bronn Martinell &

Domènech, p. 18, pl. 2, fig. 9.

- 1984a Pyramidella (Voluspa) plicosa (Bronn, 1838) A.W. Janssen, p. 353, pl. 14, figs 17-18.
- 1989 *Pyramidella plicosa* Bronn, 1838 Moths, p. 154, pl. 21, fig. 111.
- 1992 *Pyramidella (Pyramidella) plicosa* Bronn, 1838 Cavallo & Repetto, p. 152, fig. 424.
- 1993 *Pyramidella plicosa* Bronn, 1838 Iljina, p. 107, pl. 14, fig. 9.
- 1997b *Pyramidella laeviuscula* Wood, 1842 Marquet, p. 104, pl. 9, figs 7, 8.
- 1997b *Pyramidella plicosa* Bronn, 1838 Marquet, p. 105, pl. 9, figs 5, 6.
- 1998 *Pyramidella laeviuscula* Wood, 1842 Marquet, p. 188, pl. 9, fig. 160.
- 2001 *Pyramidella (Pyramidella) plicosa* Bronn, 1838 Silva, p. 567, pl. 26, figs 13-15.
- 2005 *Pyramidella (Voluspa) plicosa* Brocchi, 1814 [*sic*] – Schnetler, p. 123, pl. 9, fig. 11.
- 2007 Pyramidella (Voluspa) plicosa Bronn, 1838 –
 Wienrich, p. 753, pl. 129, figs 1, 2, pl. 163, figs 4, 5-7.
- 2008 Pyramidella (Voluspa) plicosa Bronn, 1838 Moths & Tüxen, p. 119, pl. 15, fig. 7.
- 2008 Pyramidella plicosa (Bronn, 1838) Chirli & Richard, p. 75, pl. 15, fig. 2.
- 2010 Pyramidella (Voluspa) plicosa Bronn, 1838 Moths et al., p. 82, pl. 23, fig. 5.
- 2011 *Pyramidella plicosa* Bronn, 1838 Chirli & Micali, p. 4, pl. 1, figs 6-8.
- non 1856 Pyramidella plicosa Bronn Hörnes, p. 492, pl. 46, fig. 20 [= Longchaeus unisulcatus (Dujardin, 1837)].

Dimensions and material – Maximum height 8.2 mm. Locality 6: JvdV/3; locality 13: NHMW 1847/0058/1383/1, JvdV/5, YI 442/1.

Discussion – Pyramidella plicosa Bronn, 1838 is very variable shell in height, angle of the spire, angulation of the base, and strength of the three columellar folds. The protoconch is of type A2 tending towards B. The arguments for separating the North Sea Basin Pliocene species *Pyramidella laeviuscula* Wood, 1842 from *P. plicosa* given by Marquet (1997b) are unconvincing, in our opinion, especially as the two forms are found together in the Belgian deposits.

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1892a). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Bulgaria (Kojumdgieva & Strachimirov, 1960), Denmark (Ravn, 1907; Sorgenfrei, 1958), Germany (von Koenen, 1882; Anderson, 1964; Wienrich, 2007; Moths, 1989, Moths *et al.*, 2010), Netherlands (van Voorthuysen, 1944; Nordsieck, 1972a; A.W. Janssen, 1984a). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Cossmann & Peyrot, 1917), (Langhian): Loire Basin (France (Glibert, 1949); Paratethys (Langhian-Serravallian): Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Strausz, 1954, 1962, 1966), Poland (Friedberg, 1928), eastern Paratethys (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: North Sea Basin (Tortonian): Denmark (Schnetler, 2005; Moths & Tüxen, 2008); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1892a). Early Pliocene: North Sea Basin, England (Wood, 1842, 1848; Harmer, 1920), Belgium (Nyst, 1878, 1881; Glibert, 1958; Marquet, 1997b, 1998); western Mediterranean, Estepona Basin (NHMW collection), northeastern Spain, (Almera & Bofill, 1898; Martinell, 1982c; Martinell & Domènech, 1982), Roussillon Basin, France (Chirli & Richard, 2008); central Mediterranean, Italy (Chirli & Micali, 2011), Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1892a; Malatesta, 1974; Caprotti & Vescovi, 1973; Caprotti, 1976; Cavallo & Repetto, 1992). Late Pliocene: North Sea Basin, England (Harmer, 1920), ?Belgium (Marquet, 1997b, 1998). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1914).

Genus Longchaeus Mörch, 1875

Type species – Pyramidella punctata Chemnitz (invalid, ICZN, 1944, 1954) = *Pyramidella punctata* Schubert & Wagner, 1829, by subsequent designation (Dall & Bartsch, 1904). Holocene, Polynesia and Indian Ocean.

Longchaeus unisulcatus (Dujardin, 1837) Plate 52, fig. 6

- *1837 Pyramidella unisulcata Duj., Dujardin, p. 282.
- 1856 Pyramidella plicosa Bronn Hörnes, p. 492, pl. 46, fig. 20 (non P. plicosa Bronn, 1838).
- ?1885 Obeliscus suturalis von Maltzan, p. 26 [non Pyramidella (Longchaeus) suturalis Lea, 1846].
- 1892a Pyramidella unisulcata Duj. Sacco, p. 612, pl. 1, fig. 62.
- 1892a Pyramidella unisulcata var. pseudoplicosa Sacc., Sacco, p. 612, pl. 1, fig. 63.
- 1892a Pyramidella unisulcata var. sulcolaeviuscula Sacc., Sacco, p. 612, pl. 1, fig. 64.
- 1918 *Pyramidella unisulcata* Dujardin Cossmann & Peyrot, p. fig. 39.
- 1928 Pyramidella unisulcata Duj. Friedberg, p. 443, pl. 27, fig. 8.
- 1944 *Pyramidella (Pyramidella) unisulcata* Dujardin van Voorthuysen, p. 39, pl. 13, figs 18-20.
- 1949 Pyramidella unisulcata Dujardin, 1837 Glibert, p. 198, pl. 11, fig. 11.
- 1972a Pyramidella (Longchäus) unisulcata Dujardin, 1837 – Nordsieck, 131, fig. 241.
- 1984a Pyramidella (Pyramidella) unisulcata Dujardin, 1837 – A.W. Janssen, p. 353, pl. 14, fig. 16.
- 1993 Pyramidella unisulcata (Dujardin, 1837) Iljina, p. 108.

- ?1994 Obeliscus suturalis von Maltzan, 1885 Schander, p. 49, 66, fig. 7d.
- ?1998 Pyramidella (Longchaeus) schanderi van Aartsen, Gittenberger & Goud, p. 6, fig. 1 [nom. nov. pro Obeliscus suturalis von Maltzan, 1885, non Pyramidella (Longchaeus) suturalis H. C. Lea, 1843].
 ?2005 Pyramidella (Longchaeus) schanderi van Aartsen, Gittenberger & Goud, 1998 – Rolán, p. 195, fig. 963.

Dimensions and material – Maximum height 11.2 mm. Locality 17: NHMW 1847/0058/1276/1, 1847/0058/1277/7, JvdV/13, RGM 783 965/4 + 8 fragments, YI 433/2.

Discussion – The genus *Longchaeus* Mörch, 1875 differs from *Pyramidella* Lamarck, 1799 in having three columellar folds and a peripheral sulcus on the last whorl. *Longchaeus unisulcatus* (Dujardin, 1837) is probably under-reported in the literature, but is present in the Miocene North Sea Basin, Proto-Mediterranean and Paratethys. We are not aware of any record of *Longchaeus* in the Pliocene or Pleistocene of Europe.

In the Recent faunas the genus is represented in West Africa by L. inopinatus (Schander, 1994) and Longchaeus schanderi (van Aartsen, Gittenberger & Goud, 1998). As pointed out by Rolán (2005), the two are extremely similar, and if synonymous, Schander's name had priority. Van Aartsen, Gittenberger & Goud (1998) commented that the West African species differs from two closely similar western Atlantic species, Longchaeus candida (Mörch, 1875) and L. crenulata (Holmes, 1860) in having orthocline to slightly opisthocline growth lines, whereas the Western Atlantic species has prosocline growth lines. The shells from Karaman clearly have growth lines of the West African type. Most illustrated specimens of L. unisulcatus have a more rounded last adult whorl than in the Recent West African species, but as shown by Sacco (1892a, pl. 1, figs 62-64), the angle of the spire and the basal angulation are variable. It is quite possible that the fossil and Recent shells are conspecific, in which case Dujardin's name would have priority.

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1892a). Ear-Iy-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (van Voorthuysen, 1944; Nordsieck, 1972a; A.W. Janssen, 1984a). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, France (Cossmann & Peyrot, 1918), (Langhian): Loire Basin (France (Glibert, 1949; Glibert, 1962c); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856), Poland (Friedberg, 1928), eastern Paratethys (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1892a). ?Recent: West Africa and the Cape Verde Islands (Rolán, 2005).

Subfamily Syrnolinae Saurin, 1958 Tribe Syrnolini Saurin, 1958 Genus *Syrnola* A. Adams, 1860 *Type species – Syrnola gracillima* A. Adams, 1860, by monotypy. Holocene, Japan.

Syrnola sp.

Plate 74, figs 8-10

Dimensions and material – Maximum height 4.2 mm. Locality 13: JvdV/17, locality 17: RGM 784 088/1, 784 089/1, 783 600/1; locality 17: NHMW 1847/0058/1711/14.

Discussion – It is unclear whether all three of the shells illustrated represent the same species. We place them in the genus *Syrnola* A. Adams, 1860 based on the relatively strongly developed columellar fold, although it is less strongly developed than in most other *Syrnola* species and the interior of the outer lip lacks the lirae that are present in most *Syrnola* species (see Peñas & Rolán, 1999). The protoconch is of the A2-type. Several illustrations of European fossil *Syrnola* species are similar, such as the specimen illustrated by A.W. Janssen (1984a, pl. 16, fig. 3) from the middle Miocene North Sea Basin of the Netherlands. A revision of this fossil group is required.

Nisosyrnola nov. gen.

Type species – Niso concava Boettger, 1907: Fossil, middle Miocene, Paratethys.

Other species included – Monotypic.

Diagnosis – Shell small, slender, conical, larval shell heterostrophic, of 1.5 whorls, apex moderately elevated, at right angles to the teleoconch; teleoconch whorls almost flat-sided, suture impressed, last whorl angled at the shoulder, base deeply and widely umbilicate; aperture small, outer lip smooth within, columella smooth.

Etymology – Niso, the genus of Eulimidae to which the new genus bears striking resemblance, plus the pyramidellid genus name *Syrnola*. Gender feminine.

Discussion - This unusual pyramidellid genus is quite distinctive in having a shell that, when decollate of its protoconch, is indistiguishable from those belonging to the eulimid genus Niso Risso, 1826. However, this species has a typical pyramidellid protoconch of type A2. Other umbilicate shells without columellar folds have been assigned to the Pyramidellidae, such as Myxa Hedley, 1903, Orinella Dall & Bartsch, 1904 and Sulcorinella Dall & Bartsch, 1904. However, none of these have the Niso-shaped teleoconch shell, or the wide umbilicus. Nisostomia Cossmann, 1921 (type species Odontostomia nisoides Cossmann, 1888) has a somewhat Niso-shaped teleoconch, but lacks the peripheral angulation and the prominent umbilicus typical of Niso. Colsyrnola Iredale, 1929, also has a weakly umbilicate base. However, this genus has spire whorls angulated close to the abapical suture and a has twisted columella with a prominent fold, whereas the whorls are almost straight-sided in the Turkish shell and the columella is straight, without any trace of a fold.

Nisosyrnola concava (Boettger, 1907) Plate 52, figs 7, 8; Plate 74, fig. 11

- *1907 Niso concava Boettger, p. 107, no. 377.
- 1934 Niso concava Boettger Zilch, p. 233, pl. 11, fig.
 94.

Dimensions and material – Maximum height 4.2 mm. Locality 17: NHMW 1847/0058/1278/1, 1847/0058/1470/1.

Discussion - This interesting little shell has an elongate conical adult shell with a relatively narrow apical angle of about 30°, flat-sided spire whorls, and a coeloconoid profile. This shape and the wide umbilicus in the base are characters suggestive of the eulimid genus Niso Risso, 1826. However, the protoconch is clearly pyramidelloid, heterostrophic, of the helicoid type A2 (of van Aartsen, 1981) and not eulimoid. Most Niso species have tall, homeostrophic, multispiral protoconchs. One of the Turkish specimens (Pl. 52, fig. 7) is very similar to the holotype of Niso concava Boettger, 1907, illustrated by Zilch (1934, pl. 11, fig. 94), but has a slightly wider apical angle. Fortunately, the illustrations of the middle Miocene Paratethyan shells of Romania published by Zilch (1934) are of extremely good quality for the time and the heterostrophic protoconch can clearly be seen in the photograph. We have refigured the holotype (Figure 28) from Romania with images kindly sent by R. Janssen of the Senckenberg Museum, Frankfurt am Main (Germany), who had also realized this was a pyramidellid and not a Niso (R. Janssen personal communication, 2013). The second shell illustrated here (Pl. 52, fig. 8) has a narrower apical angle and a slightly more rounded periphery to the last adult whorl, but otherwise shares the same shell characters. We are not aware of any other shell with which to compare this unusual species.





Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Boettger, 1907; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subfamily Odostomiinae Pelseneer, 1928 Tribe Odostomiini Pelseneer, 1928

Note – For protoconch terminology and shell characters considered to be species specific see (van Aartsen, 1987; Peñas *et al*, 1996).

Genus Megastomia Monterosato, 1884

Type species – Odostomia conspicua Alder, 1850, by original designation. Recent, Europe.

Note – Megastomia Monterosato, 1884 differs from *Odostomia* Fleming, 1813 in having a series of well developed, elongated teeth within the outer lip (Peñas & Rolán, 1999).

Megastomia conoidea (Brocchi, 1814)

Plate 74, fig. 12

- *1814 *Turbo conoideus* nob., Brocchi, p. 660, pl. 16, fig. 2.
- 1832 Ovatella polita Bivona, p. 59, pl. 1, fig. 7, pl. 2, fig. 11.
- 1867 *Odostomia conoidea* var. *australis* Jeffreys, p. 128, pl. 6, fig. 27.
- 1878 Odontostomia conoidea Brocchi Nyst, pl. 6, fig. 2.
- 1881 Odontostomia conoidea Brocchi Nyst, p. 71.
- 1884 *Odostomia tenuis* Jeffreys, Jeffreys, p. 347, pl. 26, fig. 4 (*non* Carpenter, 1857).
- 1892a Odontostomia conoidea var. Sismondae (Seg.) Sacco, p. 615, pl. 1, fig. 66.
- 1892a Odontostomia conoidea var. triangulatoides Sacc., Sacco, p. 616, pl. 1, fig. 67.
- 1892a Odontostomia conoidea var. infundibuloides Sacc., Sacco, p. 616, pl. 1, fig. 68.
- 1892a Odontostomia conoidea var. perconoidalis Sacc., Sacco, p. 617, pl. 1, fig. 69.
- 1892a Odontostomia conoidea var. magniumbilicata Sacc., Sacco, p. 617, pl. 1, fig. 70.
- ?1903 Odontostomia conoidea Brocchi Dollfus et al., p. 14, pl. 34, fig. 1.
- 1903 Odontostomia pallidaeformis Sacco Dollfus et al., p. 14, pl. 34, fig. 2.
- 1904 Odontostomia conoidea (Br.) Sacco, p. 108, pl. 24, fig. 7.
- 1904 *Odontostomia conoidea* var. *explicata* Sacc., Sacco, p. 108, pl. 1, fig. 8.
- 1914 Odontostomia conoidea Br. Cerulli-Irelli, p. 252, pl. 22, figs 14-17.
- 1920 Odostomia conoidea (Brocchi) Harmer, p. 599, pl. 50, fig. 33.
- 1928 Odontostomia conoidea Brocc. Friedberg, p. 447, pl. 27, fig. 14.

- 1955 *Odostomia (Megastomia) conoidea* (Brocchi) 1814 – Rossi Ronchetti, p. 152, figs 77, 77a.
- 1960 Odostomia (Megastomia) conoidea (Brocchi 1814) – Kojumdgieva & Strachimirov, p. 97, pl. 30, fig. 7.
- 1960 Odostomia (Megastomia) conoidea (Brocchi) Pelosio, p. 148, pl. 2, fig. 2.
- 1963 *Odostomia (Megastomia) conoidea* (Brocchi 1814) Venzo & Pelosio, p. 77, pl. 34, figs 20-22.
- 1969 *Odostomia conoidea* (Brocchi.) –Fekih, p. 13, pl. 1, fig. 10.
- ?1974 Odostomia (Megastomia) conoidea (Brocchi), 1814 – Caprotti, p. 36, pl. 4, fig. 4.
- 1975 Odostomia (Megastomia) conoidea (Brocchi, 1814) – Pavia, p. 158, pl. 10, figs 9-13.
- 1978 *Turbo conoideus* Brocchi, 1814 Pinna & Spezia,
 p. 162, 53, fig. 4.
- 1982c Odostomia (Megastomia) conoidea (Brocchi, 1814) Martinell, p. 224, pl. 1, figs 3-4.
- 1986 *Odostomia conoidea* (Brocchi, 1814) Fretter *et al.*, p. 616, figs 427-428.
- 1987 *Odostomia (Megastomia) conoidea* (Brocchi, 1814) Cuerda Barceló, p. 327, pl. 30, fig. 11.
- 1987 Odostomia (Megastomia) conoidea (Brocchi, 1814) – van Aartsen, p. 7, fig. 12.
- 1988 Odostomia conoidea (Brocchi, 1814) Graham,
 p. 600, figs 261, 258, 252/2.
- 1988 *Odostomia conoidea* (Brocchi, 1814) Graham, p. 600, fig. 261, 258, 252,2.
- 1992 *Odostomia (Megastomia) conoidea* (Brocchi, 1814) Cavallo & Repetto, p. 160, fig. 454.
- 1993 *Odostomia* (*O*.) *conoidea* (Brocchi, 1814) Marquet, p. 94, pl. 4, figs 9, 10.
- 1997 Odostomia conoidea (Brocchi) Ruiz Muñoz, p. 186, pl. 40, figs 15, 16.
- 1998 *Odostomia (Megastomia) conoidea* (Brocchi, 1814) van Aartsen *et al.*, p. 33, fig. 36.
- 1998a Odostomia (Megastomia) cfr. conoidea (Brocchi, 1814) Marquet, p. 199, fig. 171.
- 1999 Odostomia conoidea (Brocchi, 1814) Peñas & Rolán, p. 26, figs 53-60, 91, 92.
- 2001 Odostomia (Megastomia) ex gr. conoidea (Brocchi, 1814) – Silva, p. 570, pl. 26, figs 18-21.
- 2003 Odostomia (Megastomia) conoidea (Brocchi, 1814) – İslamoğlu & Taner, p. 45, pl. 2, fig. 15.
- 2005 Megastomia conoidea (Brocchi, 1814) Rolán, p. 183, fig. 856.
- 2010 Odostomia conoidea (Brocchi, 1814) Sosso & dell'Angelo, p. 52, unnumbered fig. p. 67, top second from right.
- 2011 *Megastomia conoidea* (Brocchi, 1814) Landau *et al.*, p. 40, pl. 22, fig. 6.
- 2011 Odostomia conoidea (Brocchi, 1814) Chirli & Micali, p. 53, pl. 18, figs 1-7.
- ?non 1950 Odontostomia conoidea (Brocchi) Csepreghy-Meznerics, p. 36, pl. 2, fig. 10.
- non 1958 Odostomia conoidea (Brocchi) Sorgenfrei, p. 312, pl. 70, fig. 231 [= Megastomia tuexeni (Weinbrecht, 2002)].

- non 1964 Odostomia (Megastomia) conoidea (Brocchi 1814) – Anderson, p. 323, pl. 46, fig. 282 [= Megastomia tuexeni (Weinbrecht, 2002)].
- non 1984a Odostomia (Megastomia)? conoidea (Brocchi, 1814) – A.W. Janssen, p. 350, pl. 15, fig. 7 [= Megastomia tuexeni (Weinbrecht, 2002)].
- non 1984 Odostomia (Megastomia) conoidea (Brocchi, 1814) – Kuster-Wendenburg, p. 347, pl. 1, fig. 8 [= Megastomia tuexeni (Weinbrecht, 2002)].
- non 1989 Odostomia (Megastomia) conoidea (Brocchi, 1814) – Moths, p. 112, pl. 20, fig. 104 [= Megastomia tuexeni (Weinbrecht, 2002)].
- ?non 2002 Odostomia (Megastomia) conoidea (Brocchi, 1814) – Weinbrecht, p. 23, pl. 1, figs 1-12.
- ?non 2007 Odostomia (Megastomia) cf. conoidea (Brocchi, 1814) – Wienrich, p. 745, pl. 124, fig. 2, pl. 127, figs 5-6, pl. 161, fig. 5.
- ?non 2008 Odostomia conoidea (Brocchi, 1814) Chirli & Richard, p. 76, pl. 15, figs 4, 5 [?= Odostomia unidentata (Montagu, 1803)].

Dimensions and material – Height 1.9 mm. Localities 2 & 3: JvdV/15; locality 13: JvdV/30; locality 17: NHMW 1847/0058/1702/23, RGM 784 040/3, RGM 783 170/50+, YI 434/9.

Discussion – Megastomia conoidea (Brocchi, 1814) is characterised by its helicoid protoconch of type A2, in having a relatively broad shell, in having orthocline growth lines and a strongly developed columellar tooth. The shell can be extremely variable (Peñas & Rolán, 1999), and the last whorl may be rounded (in littoral forms) or have a more or less pronounced carina (in deeper-water forms) (van Aartsen, 1987).

Many references to this species in the fossil literature represent distinct taxa (see synonymy). The specimens figured by Weinbrecht (pl. 1, figs 1-12) and Wienrich (2007, pl. 124, fig. 2, pl. 127, figs 5-6, pl. 161, fig. 5) from the North Sea Basin Miocene of Germany differ in having far weaker teeth within the outer lip and provisionally have been excluded from the synonymy. Those figured by Chirli & Richard (2008) from the Mediterranean Pliocene of France seem to have a smooth inner lip and probably represent *Odostomia unidentata* (Montagu, 1803). The specimens from the middle Miocene Paratethys of Hungary illustrated by Strausz (1954, pl. 1, fig. 5; 1966, pl. 1, figs 17-18) are too poor to be certain of their specific assignment.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Bulgaria (Kojumdgieva & Strachimirov, 1960), Poland (Friedberg, 1928); Proto-Mediterranean Sea (Serravallian): Antalya Basin (İslamoğlu & Taner, 2003), Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Dollfus *et al.*, 1903); Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, Italy (Sacco, 1892a, 1904; Venzo & Pelosio, 1963), Turkey (early Tortonian): Antalya Basin (İslamoğlu & Taner, 2003). Early Pliocene: North Sea Basin, British Isles (Harmer, 1920), Belgium (Marquet, 1998a); northeastern Atlantic, Guadalquivir Basin, Spain (Ruiz Muñoz, 1997; Landau et al., 2011); western Mediterranean, Estepona Basin (NHMW collection), northeastern Spain (Martinell, 1982c); central Mediterranean, Italy (Sacco, 1892a; Caprotti, 1974; Pavia, 1975; Chirli & Micali, 2011), Tunisia (Fekih, 1969). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 1992, 2001); central Mediterranean, Italy (Sacco, 1892a, 1904; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010). Late Pliocene: North Sea Basin, British Isles (Harmer, 1920), Belgium (Marquet, 1993, 1998a). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1914; Pelosio, 1960). Earlylate Pleistocene: North Sea Basin, British Isles (Harmer, 1920); western Mediterranean, Balearic Islands (Cuerda Barceló, 1987). Recent: Norway to Mediterranean, absent in North Sea (Graham, 1988), Angola, Cape Verde Islands, Sâo Tomé and Principe archipelagos (Rolán, 2005).

Genus Odostomia Fleming, 1813

Type species – Turbo plicatus Montagu, 1803, by subsequent designation (Gray, 1847). Recent, Europe.

Odostomia fusulus Monterosato, 1878

Plate 74, fig. 13

- *1878b *Odostomia (Auriculina) fusulus* Monterosato, Monterosato, p. 316.
- 1987 *Odostomia (Auristomia) fusulus* Monterosato, 1878 – van Aartsen, p. 16, fig. 43.
- 1996 Odostomia fusulus Monterosato, 1878 Peñas et al., p. 46, fig. 102.
- ?non 2011 Odostomia fusulus Monterosato, 1878 Chirli & Micali, p. 60, figs 11-15.

Dimensions and material – Height 2.2 mm. Locality 17: RGM 776 912/1.

Discussion – This species is characterised by its slender shape. The apex is blunt, and the protoconch is of type C. The spire whorls are convex, separated by an impressed non-canaliculate suture and the growth lines are weakly prosocline. The last whorl is rounded at the periphery, the aperture is ovate, with a weak fold developed and no umbilicus. It probably fits within the range of variability of *Odostomia fusulus* Monterosato, 1878 and is very similar to the shell illustrated by Peñas *et al.* (1996, fig. 102). The shells illustrated by Chirli & Micali (2011) from the early Pliocene of Italy as *O. fusulus* have a deeply canaliculate suture and are excluded from the synonymy.

A very similar species was described by Lozouet *et al.* (2001a) from the early Miocene of France as *Ondina cicatricosa*. It differs mainly in its wider outline and in having a comparatively lower protoconch.

Distribution - Middle Miocene: Proto-Mediterranean

Sea (Serravallian): Karaman Basin, Turkey (this paper). **Recent**: Mediterranean (van Aartsen, 1987; Peñas *et al.*, 1996).

Odostomia elisabethae Boettger, 1907

Plate 74, fig. 14

- *1907 Odostomia elisabethae Boettger, p. 110.
- 1934 Odostomia elisabethae Boettger Zilch, p. 238, pl. 12, fig. 18.
- 1984 *Odostomia (Brachyostomia) dispar* Boettger, 1905 [*sic*] – Švagrovský, p. 180, pl. 2, fig. 2.
- ?1998 Odostomia (Odostomia) paardekooperi van Aartsen et al., p. 26, fig. 28.
- ?1999 Odostomia paardekooperi van Aartsen, Gittenberger & Goud, 1998 – Peñas & Rolán, p. 86, figs 229-232.

Dimensions and material – Height 3.0 mm. Locality 17: RGM 776 913/1

Discussion – This Turkish odostomiine is characterised by its slender shell, with straight-sided whorls, its protoconch of type B tending towards C, the suture is impressed, weakly canaliculate, the growth lines prosocline, the last adult whorl weakly angled, the columellar tooth prominent and the umbilicus well-developed. The shell shape, umbilicus and columellar tooth match those of *Odostomia elisabethae* Boettger, 1907, described from the middle Miocene Paratethys of Romania. Unfortunately, the illustration of the protoconch of the holotype is unclear.

It is also indistinguishable from the holotype of *Odostomia paardekooperi* van Aartsen, Gittenberger & Goud, 1998 described from the Recent fauna of West Africa. We add *O. paardekooperi* to the synonymy with some reservation; if correct, this name would become a junior subjective synonym of *O. elisabethae*. The dimensions of the protoconch illustrated here (dp = 220 μ m; Pl 74, fig. 14) are almost the same as those recorded by Peñas & Rolán (1999, p. 86). *Odostomia pyxidata* Schander, 1994, also from Recent fauna of West Africa has the same protoconch type, but the shell is even more slender and the suture is more deeply canaliculate, the columellar tooth is weaker and the umbilicus is not developed. For further comparison see Peñas & Rolán, 1999, p. 86).

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Boettger, 1907; Zilch, 1934), Slovakia (Švagrovský, 1984); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **?Recent**: Cape Verde Archipelago (van Aartsen *et al.*, 1998; Peñas & Rolán, 1999).

Odostomia erjaveciana Brusina, 1869 Plate 75, fig. 1

*1896 Odostomia Erjaveciana Brusina, Brusina, p. 242.

- 1972b Menestho tenuicula (Monterosato, 1878) Nordsieck, p. 105, pl. 3, fig. 8 (non O. tenuicola Monterosato, 1878; see van Aartsen & Menkhorst, 1996).
- 1984 *Odostomia (Auristomia) erjaveciana* Brusina, 1869 – van Aartsen *et al.*, p. 53, fig. 251.
- 1987 *Odostomia (Auristomia) erjaveciana* Brusina, 1869 van Aartsen, p. 16, fig. 42.
- 1996 Odostomia erjaveciana Brusina, 1869 Peñas et al., p. 44, fig. 101.
- 1996 Odostomia (Auristomia) erjaveciana Brusina, 1869 – van Aartsen & Menkhorst, p. 54, fig. 16.
- 1999 *Odostomia erjaveciana* Brusina, 1869 Peñas & Rolán, p. 106, figs 284-289.

Dimensions and material – Height 1.6 mm. Locality 17: NHMW 1847/0058/1562/1.

Discussion – This species is characterised by its small shell. The apex is blunt, and the protoconch is of type C. The first teleoconch whorl is rather broad, the spire whorls are convex, separated by a deeply impressed, narrowly canaliculate suture and the growth lines are weakly prosocline. The last whorl is rounded at the periphery, and the aperture is ovate, with no columellar tooth or fold developed and no umbilicus. It probably fits within the range of variability of Odostomia erjaveciana Brusina, 1869. This species is the type species of the genus/subgenus Auristomia Monterosato, 1884 (by subsequent designation, Crosse, 1885), which is characterised by shells with only a slight fold or no tooth on the columella (van Aartsen, 1987), although this supraspecific taxon has not been recognised by subsequent authors (i.e. Peñas et al., 1996; Peñas & Rolán, 1999). Odostomia erjaveciana is closely similar to O. fusulus Monterosato, 1878 but differs in being larger and more turriculate. Van Aartsen (1987) distinguished the two on the basis of the growth lines, said to be orthocline in O. erjaveciana and prosocline in O. fusulus, whereas Peñas et al. (1996, p. 44) described the growth lines in *O. erjaveciana* as orthocline or prosocline. The Turkish shell has weakly prosocline growth lines, but is closer in shape, size and other shell characters to O. erjaveciana.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Recent**: Mediterranean (Peñas *et al.*, 1996; van Aartsen *et al.*, 1984) Atlantic, Canaries (Peñas & Rolán, 1999).

Odostomia unidentata (Montagu, 1803) Plate 75, fig. 2

- *1803 *Turbo unidentatus* Montagu, p. 324.
- 1846 Turbonilla albella Lovén, p. 49, pl. 1, fig. 11.
- 1850 *Odostomia unidentata* Montague [*sic*] S.V. Wood, p. 317, pl. 31, fig. 11.
- 1867 *Odostomia unidentata* var. *elata* Jeffreys, p. 134 (*non* A. Adams, 1860).
- 1914 Odontostomia [sic] unidentata Mtg. Cerulli-

Irelli, p. 255, pl. 22, figs 38, 39.

- 1925 Odostomia albella (Lovén) Harmer, p. 829, pl. 64, fig. 5.
- 1925 Odostomia unidentata (Montagu) Harmer, p. 830, pl. 64, figs 6, 7.
- 1965 Odostomia (Odostomia) unidentata (Montagu, 1803) van Regteren Altena et al., p. 46, pl. 20, fig. 195.
- 1969 *Odontostomia* [sic] unidentata (Montagu) Fekih, p. 16, pl. 2, fig. 7.
- 1986 *Odostomia unidentata* (Montagu, 1803) Fretter *et al.*, p. 614, figs 425, 426, 431 bottom left.
- 1987 Odostomia unidentata (Montagu, 1803) van Aartsen, p. 11, fig. 17.
- 1988 Odostomia unidentata (Montagu, 1803) Graham, p. 604, figs 263, 258 bottom left,
- 1992 Odostomia (Odostomia) unidentata (Montagu, 1803) – Cavallo & Repetto, p. 158, fig. 445.
- 1993 Odostomia (O.) unidentata (Montagu, 1803) Marquet, p. 94, pl. 4, figs 11, 12.
- 1996 *Odostomia unidentata* (Montagu, 1803) Peñas *et al.*, p. 54, figs 125, 126.
- 1998 Odostomia (Odostomia) unidentata (Montagu, 1803) van Aartsen et al., p. 23, fig. 24.
- 1998 Odostomia (O.) unidentata (Montagu) Ferrero Mortara et al., p. 52, pl. 2, fig 3.
- 1998 Odostomia (O.) unidentata (Montagu, 1803) Marquet, p. 198, fig. 170.
- 1999 Odostomia unidentata (Montagu, 1803) Peñas & Rolán, p. 63, figs 153-161.
- 2011 *Odostomia unidentata* (Montagu, 1803) Chirli, p. 65, pl. 22, figs 4-11.

Dimensions and material – Height 2.8 mm. Locality 17: RGM 776 915/1.

Discussion – This species is characterised by its tall conical shell. The protoconch is of type A2 (dp = 270 μ m), the suture is impressed and weakly canaliculate, the spire whorls are almost straight-sided, the growth lines are orthocline, the last whorl is angular at the periphery, the aperture is subrhomboidal, the columellar tooth is prominent and there is no umbilicus. It probably fits within the range of variability of Odostomia unidentata (Montagu, 1803) (see Peñas & Rolán, 1999, figs 153-161; Chirli, 2011, pl. 22, figs 4-11). The Turkish shell is more slender and smaller than usual, and is similar to O. romburghi van Aartsen, Gittenberger & Goud, 1998, which was considered possibly to be a synonym of O. unidentata by Peñas & Rolán (1999) and the columellar tooth is not as strong as usual for this species.

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: North Sea Basin, England (Harmer, 1925); central Mediterranean, Italy (Chirli, 2011), Tunisia (Fekih, 1969). Late Pliocene: North Sea Basin, England (Wood, 1850; Harmer, 1925), Belgium (Marquet, 1993, 1998); central Mediterranean, Italy (Cavallo & Repetto, 1992; Ferrero Mortara *et al.*, 1998). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1914). **Recent**: eastern Atlantic Canaries, Madeira, West Africa, Mediterranean (van Aartsen *et al.*, 1998; Peñas & Rolán, 1999).

Odostomia sp.

Plate 75, fig. 3

Dimensions and material – Height 4.1 mm. Locality 17: RGM 776 913/1

Discussion - This relatively large Turkish odostomiine is characterised by its tall, pointed spire and relatively large, inflated last whorl. The protoconch is of type A, the suture is weakly impressed, the growth lines are orthocline to weakly prosocline, the last whorl is rounded at the periphery, the outer lip is markedly flared and everted abapically, the columella bears a fold, but no tooth, and there is no umbilicus. This shell possibly should be placed in Ondina de Folin, 1870, based on its large last whorl and the presence of a fold rather than a tooth on the columella. However, Ondina species have a protoconch of type B or C (Peñas & Rolán, 1999), whereas this shell has a type A protoconch. We cannot find any comparable congener with such a tall, pointed spire and inflated last whorl. There is some similarity between the Turkish shell and the middle Miocene Paratethyan species Odostomia pararissoides Boettger, 1902 in the shape of the aperture, but that species differs clearly in its stouter shape.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Pyramistomia Cossmann, 1921

Type species – Odostomia deubeli Boettger, 1902, by monotypy. Miocene Paratethys, Romania.

Pyramistomia deubeli (Boettger, 1902)

Plate 75, fig. 4

- *1902 Odostomis deubeli Boettger, p. 99, no. 313.
- 1907 Odostomia deubeli Bttgr. Boettger, p. 112, no. 398.
- 1921 Odontostomia (Pyramistomia) Deubeli Boettg. Cossmann, p. 240, pl. 6, figs 34, 35.
- 1934 Odostomia (Pyramistomia) deubeli (Boettger) Zilch, p. 238, pl. 12, fig. 14.

Dimensions and material – Height 1.6 mm. Locality 13: NHMW 1847/0058/1434/1.

Discussion – Pyramistomia deubeli (Boettger, 1902) is a very distinctive species characterised by its very solid, squat shell and by the presence of strong sculpture consisting of a subsutural collar, a swollen suprasutural band, and spiral cords on the base. The suture is deeply impressed and narrowly canaliculate, the growth lines are prosocline, the aperture is small and the columella is thickened, bordering a small umbilical chink. In the single shell from Turkey the columellar tooth is small and there is no sculpture within the outer lip. The protoconch is poorly preserved, but seems to be of type C.

A closely similar species, Pyramistomia suprasulcata (Peñas & Rolán, 1999), occurs in the Recent West African fauna. It differs from P, deubeli in having a protoconch of type A2, in having a more slender shell and in having three spiral cords on each whorl. Pyramistomia funiculustriata (Peñas & Rolán, 1999), also from the Recent West African fauna has an even more slender shell and only a single subsutural cord and a few weak spiral cords on the base. Pyramistomia fehrae (van Aartsen, Gittenberger & Goud, 1998) from the Azores has a type B protoconch, has a more angular shell, with the canal much more canaliculate, the whorl sharply angled below the sutural canal, a single narrow, elevated spiral cord abapically, and the base is smooth. This genus is also present in the Caribbean, where it is represented by P. didyma (Verrill & Bush, 1900), which is extremely similar to the Turkish shell, but differs in lacking the subsutural spiral cord. The protoconch in the Caribbean shell is of type B.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Boettger, 1902; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Tribe Chrysallidini Saurin, 1958 Genus Chrysallida Carpenter, 1856

Type species – Chemnitzia communis C.B. Adams, 1852, by subsequent designation (Carpenter, 1863). Recent tropical American Pacific

Note – In the European fossil and Recent literature this group of shells has always been placed in the genus *Chrysallida* Carpenter, 1856. The type species of *Chrysallida* is *Chemnitzia communis* C.B. Adams, 1852 from the Recent tropical American Pacific. Although two recent papers covering the genus discussed the higher taxonomic problems (Peñas & Rolán, 1998; van Aartsen *et al.*, 2000), neither paper questioned whether the eastern Atlantic and Mediterranean species belonged to the same genus as *Chrysallida communis*.

A lectotype of *Chrysallida communis* was illustrated by Turner (1956, p. 113, pl. 01, fig. 5). Her illustration shows quite a different shell, especially in the character of the aperture, and this species is unlikely to be related to the European shells. It is a species parasitic on chitons (Pat laFolette personal communication to A.W. Janssen, 2009). Little is known about the ecology of living eastern Atlantic and Mediterranean '*Chrysallida*' species, although at least one species is parasitic on *Bursa scrobilator* (Linnaeus, 1758) (Oliverio & Vega-Luz, 1997).

The eastern Atlantic and Mediterranean fossil and living species might be better placed in *Parthenina* Bucquoy, Dautzenberg & Dollfus, 1883 [type species: *Turbo* *interstinctus* (Montagu, 1803) *sensu* Jeffreys, 1867, by original designation. Recent, Europe]. However, it is likely that they represent more than one genus and a palaeontological work such as this is not the ideal platform to introduce major changes in taxonomy within such a poorly known group. We provisionally retain these species in *Chrysallida*.

Chrysallida emaciata (Brusina, 1866)

Plate 75, fig. 5

- 1865 *Turbonilla pygmaea* mihi, Brusina, p. 22 (*non Actaeon pygmaeus* Grateloup, 1838).
- *1866 *Turbonilla emaciata* Brusina, Brusina, p. 69 (*nov. nom. pro Turbonilla pygmaea* Brusina, 1865, *non Actaeon pygmaeus* Grateloup, 1838).
- 1972b Chrysallida (Perparthenina) emaciata form. minor Nordsieck, p. 97.
- 1977 Chrysallida emaciata (Br.) van Aartsen, p. 56, fig. 17.
- 1992 *Chrysallida emaciata* (Brusina, 1866) van der Linden & Eikenboom, p. 13, fig. 21.
- 1996 Chrysallida (Perparthenina) emaciata (Brusina, 1866) van Aartsen & Menkhorst, p. 49, fig. 8.
- 1998 Chrysallida emaciata (Brusina, 1866) Peñas & Rolán, p. 44, figs 127, 128.

Dimensions and material – Maximum height 1.8 mm. Locality 17: RGM 784 069/1.

Discussion – This shell is characterised by its small pupoid form, with a type B intorted protoconch, a wide first teleoconch whorl, spire whorls canaliculate at the shoulder and angled abapically close to abapical suture, with sculpture of fine widely-spaced, sinuous axial ribs, and a single spiral cord on spire whorl and two on the last whorl. The fossil shell from Turkey is almost identical to the Recent shell illustrated by van Aartsen & Menkhorst (1996, fig. 8), which was described as the form *minor* by Nordsieck (1972b). These are now considered to be juvenile shells of *Chrysallida emaciata* (Brusina, 1866). The adult shell illustrated by Peñas & Rolán (1998, fig. 127) is taller-spired, with a less canaliculate suture, and looks somewhat different from the subadult form described by Nordsieck (1972b).

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Recent: eastern Atlantic, Canaries, Madeira, West Africa (van der Linden & Eikenboom, 1992; Peñas & Rolán, 1998), Mediterranean (van der Linden & Eikenboom, 1992; van Aartsen & Menkhorst, 1996).

Chrysallida cf. *fenestrata* (Jeffreys, 1848) Plate 75, fig. 6

cf. *1848 Odostomia fenestrata Jeffreys, p. 345.

cf. 1914 Parthenina (Tragula) fenestrata Forbes - Cerulli-

Irelli, p. 266, pl. 23, figs 18, 19.

- cf. 1921 Tragula fenestrata (Forbes) Cossmann, p. 262, fig. 90fc.
- cf. 1969 *Pyrgulina (Tragula) fenestrata* (Forbs) Fekih, p. 26, pl. 4, fig. 4.
- cf. 1981 *Chrysallida fenestrata* (Forbes in Jeffreys, 1848) van Aartsen, p. 63, 65, pl. 1, fig. 1.
- cf. 1986 *Tragula fenestrata* (Jeffreys, 1848) Fretter *et al.*, p. 578, figs 392, 393.
- cf. 1988 *Tragula fenestrata* (Jeffreys, 1848) Graham, p. 564, fig. 243.
- cf. 1992 *Chrysallida fenestrata* (Jeffreys, 1848) van der Linden & Eikenboom, p. 48, fig. 57.
- cf. 1998 *Chrysallida fenestrata* (Jeffreys, 1848) Peñas & Rolán, p. 14, figs 38-42.
- cf. 2011 *Chrysallida fenestrata* (Jeffreys, 1848) Chirli & Micali, p. 27, pl. 8, figs 11-15.

Dimensions and type material – Height 1.9 mm. Locality 13: RGM 794 575/1.

Discussion - 'Chrysallida' fenestrata (Jeffreys, 1848) is characterised by its very elongate slender shell, much like a Turbonilla species. However, van Aartsen (1981, p. 63) considered this species to belong in Chrysallida and not in *Turbonilla* because of its intorted protoconch top-whorls. It is the type species by monotypy of the (sub)genus Tragula Monterosato, 1884. The protoconch is of type B, strongly tending to A (see van der Linden & Eikenboom, 1992, figs 1-7 for terminology). The shell has 5-7 teleoconch whorls, in which the upper two-thirds of the whorl are straight-sided and the lower third is convex, the lower part bearing two spiral cords on spire whorls and three on the last whorl. The Turkish shell has five teleoconch whorls and is very similar to C. fenestrata, but differs in having the upper 2/3 of the teleoconch whorls less flattened and there is a tooth on the columella that is absent in C. fenestrata. The protoconch diameter of the shell illustrated here is similar to that recorded by Fretter *et al.* (1986) for the Recent shells, about 200 μ m. Chrysallida emaciata (Brusina, 1866) from the Recent Mediterranean and West Africa is similar in its slender shape and whorl profile, but has more numerous axial ribs and only one spiral cord abapically on the spire whorls. Chrysallida mauritanica Peñas & Rolán, 1998 from the Recent West African fauna is also slender, with two spiral cords on the spire whorls, but has fewer axial ribs than in the Turkish shell.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Chrysallida longula (Boettger, 1907)

Plate 52, fig. 9; Plate 75, fig. 7

- 1838d *Acteon pygmea* Grateloup, p. 282, pl. 6, figs 77-78 (*non* Lea, 1833).
- 1846 Acteon pygmea Grat., Grateloup, pl. 11, figs 77-78.

- 1902 Parthenia (Pyrgisculus) scalaris Phil. Boettger,
 p. 106 [non Turbonilla scalaris Philippi, 1836)].
- *1907 *Parthenia (Pyrgisculus) longula* Boettger, p. 122, no. 427.
- 1917 *Chrysallida pygmaea* (Grat.) Cossmann & Peyrot, p. 338, no. 198, pl. 9, figs 61-63.
- 1921 Actaeopyramis (Chrysallida) pygmaea (Grat.) Cossmann, p. 266, pl. 6, figs 13-16.
- 1992 *Chrysallida interita* van der Linden & Eikenboom, p. 41, fig. 53 (*nom. nov. pro Acteon pygmea* Grateloup, 1838, *non* Lea, 1833).
- 1934 Chrysallida (Parthenia) longula (Boettger) Zilch, p. 234, pl. 11, fig. 96.
- 2001a *Chrysallida interita* van der Linden & Eikenboom, 1992 Lozouet *et al.*, p. 75.

Dimensions and material – Maximum height 3.0 mm. Localities 2 & 3: JvdV/3, RGM 783 951/1; localities 7 & 8: RGM 783 960/1; locality 13: JvdV/4; locality 17: NHMW 1847/0058/1443/1, RGM 783 941/1.

Discussion – Chrysallida pygmaea (Grateloup, 1838) from the early Miocene Atlantic Aquitaine Basin is a junior homonym of Acteon pygmea Lea, 1833, and was renamed Chrysallida interita van der Linden & Eikenboom, 1992. These authors separated the Miocene populations from the closely similar Pliocene-Recent species Chrysallida stefanisi (Jeffreys, 1869) on the basis of shell morphometrics. The Turkish specimens fall within the range of *C. interita* for all measurements taken by van der Linden & Eikenboom (1992, fig. 1) (LW = 63%, L/B = 2, B/b 1.95). Apart from these morphometrics, the Turkish specimen clearly exhibits the flatter whorls, more scalate spire and more elevated ribs typical of the Miocene species.

However, van der Linden & Eikenboom (1992) did not consider the description of *Parthenia (Pyrgisculus) longula* by Boettger (1907) from the middle Miocene Paratethys of Romania. In our opinion, this is conspecific with the French Miocene fossil shells. Therefore, *Chrysallida interita* must be considered to be a junior subjective synonym of *Chrysallida longula* (Boettger, 1907).

Shells within the Chrysallida longula-stefanisi group have been widely recorded in the Neogene European fossil literature. Glibert (1958) described the North Sea Basin Miocene shells as a subspecies, Chrysallida pygmaea belgica, which Lozouet et al. (2001a) suggested might be a synonym of C. interita. It is difficult to interpret the often poor illustrations given in the literature, however, the North Sea Basin shell has been illustrated clearly in recent literature by A.W. Janssen (1984a, pl. 14, fig. 5), Wienrich (2007, pl. 159, figs 7-8) and Moths et al. (2010, pl. 155, fig. 5) and it has more rounded whorls. Pending further review these records have been excluded from the distribution. Similarly, the Paratethian shells, illustrated by Hörnes (1856, pl. 43, fig. 32), Friedberg (1928, pl. 28, fig. 10); Csepreghy-Meznerics (1950, pl. 2, fig. 8) and Strausz (pl. 13, figs 18-20, pl. 46, fig. 27), all seem to have more inflated whorls, less scalate spires and less elevated axial ribs, and are more similar to the Pliocene to Recent species *C. stefanisi*. They have also been excluded from the synonymy.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot, 1917; Lozouet *et al.*, 2001a; van der Linden & Eikenboom, 1992). Middle Miocene: Paratethys (Langhian-Serravallian): Romania (Boettger, 1902; Zilch, 1934); northeastern Atlantic, Azores (Ferreira, 1955); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Chrysallida majae nov. sp. Plate 75; figs 8, 9

Dimensions and type material – Holotype RGM 794 573, height 1.7 mm; paratype 1 RGM 794 574, height 1.5 mm.

Other material - Known only from type material.

Derivatio nominis – Named after Maja Paques, friend of the senior author.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small pupoid *Chrysallida* species with a type B intorted protoconch, a wide first teleoconch whorl, close-set sinuous axial ribs and weaker spiral cords, five cords on the penultimate whorl, forming reticulate sculpture that almost completely covers the teleoconch whorls and persists onto the base.

Description – Shell small, pupoid, apex blunt. Protoconch almost completely intorted, type B. Teleoconch of 3.5-4 convex whorls, with periphery below mid-whorl. Suture impressed, linear. Axial sculpture of 21 sinuous ribs per whorl. Spiral sculpture of five equidistant spiral cords, the adapical cord placed a slightly greater distance from the suture than the distance between the first and subsequent cords. Cords weaker than axial ribs, not crossing axial sculpture, forming a reticulate pattern. Last whorl convex, base evenly rounded, with reticulate sculpture persisting onto base. Aperture ovate, outer lip thin, interior of aperture and columella obscured by matrix.

Discussion – *Chrysallida majae* nov. sp. is characterised by its type B protoconch and its reticulate sculpture, which covers almost the entire teleoconch surface and persists onto the base. It is similar to *Chrysallida silviae* Chirli & Micali, 2011 from the early Pliocene of Italy, but differs in having five spiral cords on the penultimate whorl, whereas the Italian species only has four. In the Italian species the axial and spiral elements are of equal strength, resulting in an evenly reticulate sculpture, whereas in *C. majae* the axials are broader and stronger than the spirals. Another Italian Pliocene species; *C. palazzii* Micali, 1984 is also similar in shape and, like *C. majae*, the axials are dominant, but it has only three spiral cords on the penultimate whorl, restricted to the abapical portion of the whorl. This last Italian species is extremely similar in sculpture to *C. willeminae* van Aartsen, Gittenberger & Goud, 2000 from the Recent coasts of West Africa. *Chrysallida willeminae* also has three spiral cords on the penultimate whorl restricted to the abapical half of the whorl. However, in *C. palazzii* the sculpture persists onto the base, whereas the West African shell has no sculpture on the base.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Chrysallida obtusa (Brown, 1827) Plate 75, fig. 10

- 1797 Turbo interstinctus J. Adams, p. 66.
- 1803 Turbo interstinctus Montagu, p. 324, pl. 12, fig. 10
- *1827 Jaminia obtusa Brown, pl. 50, fig. 38.
- 1844 Pyramis Lamarckii Brown, p. 15, pl. 9, fig. 39.
- 1872 *Elodia hortensiae* de Nansouty *in* de Folin & Périer, p. 48, pl. 2, fig. 2.
- 1963 *Chrysallida (Parthenina) interstincta* Adams Venzo & Pelosio, p. 76, pl. 34, figs 15-17.
- 1972b *Chrysallida (Perparthenina) farolita* Nordsieck, p. 96, pl. PI, fig. 22.
- 1977 *Chrysallida obtusa* (Brown) van Aartsen, p. 57, fig. 22.
- 1986 Chrysallida obtusa (Brown, 1827) Fretter et al., p. 561, fig. 378.
- 1991 Chrysallida interstincta (J. Adams, 1797) Warén, p. 95, figs 29A, B, 39C.
- 1992 *Chrysallida obtusa* (Brown, 1827) van der Linden & Eikenboom, p. 23, figs 8, 9, 30-32.
- 1996 *Chrysallida farolita* Nordsieck, 1972 van Aartsen & Menkhorst, p. 49, fig. 7.
- 1996 Chrysallida interstincta (J. Adams, 1797) Peñas et al., p. 22, figs 43-46.
- 1996 Chrysallida interstincta (J. Adams, 1797) Peñas & Rolán, p. 42, figs 118-126.
- 2000 *Chrysallida (Parthenina) obtusa* (Brown, 1827) van Aartsen *et al.*, p. 28, fig. 33.
- 2011 *Chrysallida intermixta* (Monterosato, 1884) Chirli & Micali, p. 34, pl. 11, figs 1-5 (*non* Monterosato, 1884).
- 2012 Chrysallida obtusa (Brown, 1827) d'Amico et al., p. 169, pl. 3, figs 34-35.

Dimensions and material – Maximum height 1.2 mm. Localities 2 & 3: JvdV/4; locality 13: JvdV/1, RGM 784 012/3; locality 17: NHMW 1847/0058/1715/1, RGM 783 166/14.

Discussion – There is disagreement as to the valid name for this species. Van Aartsen *et al.* (2000) disagreed with the neotype designation by Warén (1991). If Warén (1991)

is followed, the correct name for this species is *Chrysallida interstincta* (J. Adams, 1797). We also note that CLEMAM places this species in *Parthenina* Bucquoy, Dautzenberg & Dollfus, 1883, used at full genus level.

As discussed by van der Linden & Eikenboom (1999), this small *Chrysallida* species is very variable, but characterised by its rather broad axial ribs, one spiral cord just above the abapical suture on spire whorls and one or two on the last adult whorl, and its type B protoconch (see van der Linden & Eikenboom, 1992, figs 1-7 for terminology). The shells illustrated by Chirli & Micali (2011) as *Chrysallida intermixta* (Monterosato, 1884) are, in our opinion, *C. obtusa. Chrysallida intermixta* differs in having higher, narrower axial ribs and further fine spiral threads above the abapical broader spiral cord.

Distribution – Middle Miocene: northeastern Atlantic, Azores (Ferreira, 1955); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Venzo & Pelosio, 1963; d'Amico *et al.*, 2012). Early Pliocene: central Mediterranean, Italy (Chirli & Micali, 2011). Recent: northeastern Atlantic, Madeira and Canary Islands, Mediterranean (van der Linden & Eikenboom, 1999).

Chrysallida suturalis (Philippi, 1844)

Plate 75, fig. 11

- 1836 *Rissoa striata* Philippi, p. 154, pl. 10, fig. 8 (*non* J. Adams, 1797).
- *1844 Rissoa suturalis Philippi, p. 129.
- 1977 Chrysallida suturalis (Philippi) van Aartsen, p. 56, fig. 16.
- 1986 Chrysallida suturalis (Philippi, 1844) Fretter et al., p. 562, fig. 379.
- 1992 *Chrysallida suturalis* (Philippi, 1844) van der Linden & Eikenboom, p. 14, fig. 22.
- 2011 *Chrysallida suturalis* (Philippi, 1844) Chirli & Micali, p. 44, pl. 14, figs 11-15.

Dimensions and material – Height 2.9 mm. Locality 17: RGM 784 092/1.

Discussion – Chrysallida suturalis (Philippi, 1844) is characterised by its tall, slender shell, its type B protoconch, its flat-sided whorls bearing about 22-25 flexuous ribs per whorl and one (in some specimens two) spiral cord just above the suture. According to van der Linden & Eikenboom (1999), in the Recent faunas, this species is restricted to the Mediterranean.

Distribution – Middle Miocene: northeastern Atlantic, Azores (Ferreira, 1955); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: central Mediterranean, Italy (Chirli & Micali, 2011). Recent: Mediterranean (van der Linden & Eikenboom, 1999). Subfamily Turbonillinae Bronn, 1849 Tribe Turbonillini Bronn, 1849 Genus *Turbonilla* Risso, 1826

Type species – Turbon costulata Risso, 1826, by subsequent designation (Hermannsen, 1852), Pleistocene: France.

Note – Although the type species of the genus has been designated clearly, the identity of *Turbonilla costulata* is in doubt. Risso's type specimen is lost and the type figure is poor, but it clearly shows axial sculpture continuing uninterrupted onto the base. The illustration cannot represent *Turbonilla lactea*, in which the axial ribs terminate abruptly at the periphery. Until *T. costulata* is confidently associated with another living or Pleistocene Mediterranean species, the genus may continue to be used in the broad sense, as it is now. Eventually, *Turbo lactea* Linnaeus will be placed in *Chemnitzia* d'Orbigny, 1839 [or 1840], as it is a senior synonym of the type species, *Melania campanellae* Philippi, 1836 (Pat LaFollette personal communication 2013).

Turbonilla gastaldi auct. (?Semper 1861) Plate 75, fig. 12

- ?*1861 Turbonilla Gastaldii Semper, Semper, p. 406.
 1925 Turbonilla lactea var. Gastaldi Semp. Koenen, p. 75, pl. 6, fig. 31.
 - 1949 *Turbonilla elegantissima gastaldi* Semper, 1865 Glibert, p. 188, pl. 11, fig. 16.
 - 1952b *Turbonilla elegantissima* f. *gastaldi* Semper, 1865 – Glibert, p. 59, pl. 4, fig. 14.
 - 1964 *Turbonilla (Turbonilla) gastaldi* (Semper 1861) Anderson, p. 325, pl. 48, fig. 286.
 - 1972a Turbonilla (Chemnitzia) gastaldi Semper, 1865 Nordsieck, p. 128, fig. 231.
 - 1984a Turbonilla (Turbonilla) gastaldi auct. (? non Semper, 1861) – A.W. Janssen, p. 361, pl. 17, figs 4, 5.
 - 2007 *Turbonilla (Turbonilla) gastaldi* auct. (?Semper 1851 [*sic*]), sensu A.W. Janssen, 1984 Wienrich, p. 758, pl. 131, fig. 3, pl. 165, fig. 2.

Dimensions and material – Maximum height 5.2 mm. Locality 6: JvdV/2; locality 9: JvdV/2; locality 17: NHMW 1847/0058/1706/2, JvdV/10, RGM 784 090/1, RGM 783 973/11, RGM 783 940/12 fragments, YI 426/1.

Discussion – The turbonilline gastropod illustrated (Pl. 75, Fig. 12) is characterised by its tall, slender shell, opisthocline axial ribs, each roughly equal in width to one interspace, not extending onto the base on the last whorl, and by its protoconch of type A2, strongly helicoidal. It agrees with the shells illustrated as *Turbonilla (Turbonilla) gastaldi* auct. (? *non* Semper, 1861) by A.W.Janssen (1984a, pl. 17, figs 4, 5) and Wienrich (pl. 131, fig. 3, pl. 165, fig. 2) from the early-middle

Miocene North Sea Basin. The shell is similar to that of the Pliocene to Recent European species Turbonilla lactea (Linnaeus, 1758), which differs in having a shell with a slightly wider apical angle, having squatter spire whorls, a more superficial suture, fewer but stronger axial ribs, and a protoconch of type B of van Aartsen (1987) (see Fretter et al., 1986, fig. 442). Specimens from the North Sea Basin Miocene illustrated by Wienrich (2007, pl. 164, figs 5-6) show quite some variability in rib density, which is also true of T. lactea from the Italian Pliocene (Chirli & Micali, 2011, pl. 30, figs 7-18). In the Italian Pliocene specimens the whorl convexity and angle of the spire are also somewhat variable. However, we cannot agree with the position adopted by Chirli & Micali (2011) in synonymising the two, as they have different protoconch types. As pointd out by A.W. Janssen (1984a, p. 361) further revision of the group is needed to be certain all the shells reported in the literature as T. gastraldi are indeed conspecific.

Distribution – Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Germany (Kautsky, 1925; Anderson, 1964; Wienrich, 2007), Netherlands (Nordsieck, 1972a; A.W. Janssen, 1984a). Middle Miocene: northeastern Atlantic (Langhian): Loire Basin (France (Glibert, 1949); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Turbonilla cf. *superstructa* Boettger, 1907 Plate 75, fig. 13

- cf. * 1907 Turbonilla (Strioturbonilla) densecostata var. superstructa Boettger, p. 132, no. 457.
- cf. 1934 Turbonilla (Strioturbonilla) densecostata var. superstructa Boettger – Zilch, p. 241, pl. 12, fig. 35.

Dimensions and material – Height 3.9 mm. Locality 17: NHMW 1847/0058/1707/1, RGM 784 090/1.

Discussion – The specimen illustrated differs from *Turbonilla gastaldi* auct. (? *non* Semper, 1861) discussed above, in having an even more slender shell and in having more numerous, narrower and less prosocline axial ribs. The protoconch type is the same as in *T. gastaldi*, type A helicoidal. It is similar to and possibly conspecific with *Turbonilla superstructa* Boettger, 1907, which was described from the middle Miocene Paratethys of Romania and illustrated by Zilch (1934, pl. 12, fig. 35). However, the Romanian shell has less convex whorls. It is also quite possible that these are all forms of *T. gastaldi*. There is quite some intraspecific variability in shell shape and sculpture within *Turbonilla* species (see Wharton, 1976; Chirli &Micali, 2011).

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Turbonilla lanceae (Libassi, 1859) Plate 52, fig. 10

- *1859 Chemnitzia lanceae mihi, Libassi, p. 21, fig. 6.
 1892b Turbonilla (Pyrgostylus) Lanceae (Lib.) Sacco, p. 8.
- 1892a Turbonilla (Pyrgostylus) Lanceae var. communis Sacc., Sacco, pl. 2, fig. 139.
- 1892b Turbonilla (Pyrgostylus) Lanceae var. communis Sacc., Sacco, p. 9.
- 1892a Turbonilla (Pyrgostylus) Lanceae var. convexa Sacc., Sacco, pl. 2, fig. 140.
- 1892b Turbonilla (Pyrgostylus) Lanceae var. convexa Sacc., Sacco, p. 9.
- 1914 *Turbonilla (Pyrgostylus) pallida* var. *Lanceae* Lib. Cerulli-Irelli, p. 449, pl. 23, fig. 61.
- 1949 Turbonilla (Mormula) lanceae convexa Sacco, 1892 – Glibert, p. 196, pl. 12, fig. 8.
- 1969 Pyrgostylus lanceae Libassi Fekih, p. 43, pl. 8, fig. 1.
- 1969 Pyrgostylus lanceae var. communis Sacco Fekih, p. 43, pl. 8, fig. 2.
- 1969 Pyrgostylus lanceae var. convexa Sacco Fekih, p. 43, pl. 8, fig. 2.
- 1976 *Turbonilla (Mormula) lanceae* (Libassi) Marasti & Raffi, p. 196, pl. 2, fig. 9.
- 1989 *Turbonilla lanceae* (Libassi, 1859) Chirli, p. 113, fig. 1.
- 1992 *Turbonilla lanceae* (Libassi, 1859) Cavallo & Repetto, p. 162, fig. 462.
- 1997 Turbonilla lanceae (Libassi) Ruiz Muñoz, p. 186, pl. 40, fig. 20.
- 1998 *Turbonilla striatula* (L. 1758) Bogi & Cauli, p. 130, fig. 8 (*non* Linnaeus, 1758).
- 2010 *Turbonilla lanceae* (Libassi, 1859) Sosso & dell'Angelo, p. 53, unnumbered fig. p. 67 bottom third from left.
- 2011 *Turbonilla striatula* (Linnaeus, 1758) Landau *et al.*, p. 41, pl. 22, fig. 16 (*non* Linnaeus, 1758).
- 2011 *Turbonilla lanceae* (Libassi, 1859) Chirli & Micali, p. 87, pl. 31, figs 1-6.

Dimensions and material – Maximum height 9.5 mm. Locality 13: NHMW 1847/0058/1278/1, JvdV/17; locality 17: NHMW 1847/0058/1713/3, JvdV/1.

Discussion – Turbonilla lanceae (Libassi, 1859) is extremely similar to the Pliocene to Recent Mediterranean species *Turbonilla striatula* (Linnaeus, 1758). Indeed, Micali (1994) suggested they were conspecific, with modifications occurring in protoconch size and shape since the Pliocene, suggesting a shortening of the planktotrophic stage. However, Chirli & Micali (2011) again separated the two species, and considered both to be present in the late Miocene and Pliocene of Italy. *Turbonilla lanceae* was said to differ from *T. striatula* in having a taller protoconch, a less slender shell, the spire whorls having a more drop-shaped profile, the suture being more superficial and more inclined and, most importantly, the axial ribs do not touch the abapical suture (Chirli & Micali, 2011, p. 88). The shells from the Akpinar assemblage are clearly typical of *T. lanceae* in shape, and in the character of the ribs, which weaken considerably just above the abapical suture. Influenced by Micali (1994), Landau *et al.* (2011) placed the early Pliocene shells from the Atlantic Guadalquivir Basin of Spain in synonymy with *T. striatula*. However, we consider these shells to represent *T. lanceae*.

Distribution – Middle Miocene: northeastern Atlantic (Langhian): Loire Basin (France (Glibert, 1949); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1892a, b). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Ruiz Muñoz, 1997; Landau *et al.*, 2011); western Mediterranean, Estepona Basin (NHMW collection); central Mediterranean, Italy (Chirli, 1989; Chirli & Micali, 2011), Tunisia (Fekih, 1969). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (NHMW collection); central Mediterranean, Italy (Sacco, 1892a, b; Marasti & Raffi, 1976; Chirli, 1989; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1914).

Turbonilla miocrassulata (Sacco, 1892)

Plate 52, fig. 11

- *1892a Turbonilla (Strioturbonilla) miocrassulata Sacc., Sacco, p. 95, pl. 2, fig. 113.
- 1921 *Turbonilla (Strioturbonilla) miocrassulata* Sacco – Cossmann, p. 281, pl. 6, figs 73, 74.
- 1949 *Turbonilla (Strioturbonilla) miocrassulata* Sacco – Glibert, p. 191, pl. 11, fig. 17.

Dimensions and material – Maximum height 8.0 mm. Localities 2 & 3: JvdV/1; localities 7 & 8: NHMW 1847/0058/1384/1.

Discussion – As discussed by Glibert (1949), Turbonilla miocrassulata (Sacco, 1892) is characterised by its very pupoid shell, straight-sided whorls, about 20 close-set axial ribs per whorl, each roughly equal in width to one interspace, stopping abruptly at the base. The axial sculpture is overridden by very fine, close-set spiral threads, visible only under high magnification. The columellar fold is hardly developed. Unfortunately the protoconch is missing in the Turkish specimen. Turbonilla plicatula in Hörnes (1856, pl. 43, fig. 33) (non Brocchi, 1814) is closely similar in sculpture, but has a more conical spire, and the columellar fold is far more strongly developed. Turbonilla turriculiformis Boettger, 1907, described from the middle Miocene Paratethys of Romania, is again very similar and pupoid in profile, but differs in having a deeper suture and fewer axial ribs. The ribs are orthocline, whereas the ribs in T. miocrassulata are slightly opisthocline. Turbonilla hemisyrnola Boettger, 1907, from the same middle Miocene Paratethys assemblages of Romania, has an identical pupoid shape, but with weaker axial ribs, which seem to become obsolete on the last whorl (see Zilch, 1934, pl. 12, fig. 43).

Another closely similar species is *Turbonilla miopupoides* Sacco, 1892 (see Chirli & Micali, 2011, pl. 32, figs 6-10) from the early Pliocene of Italy. This again differs from the Turkish shell in being lower-spired, with fewer teleoconch whorls and in having fewer orthocline axial ribs. The last whorl is also relatively lower and wider.

Distribution – **Middle Miocene**: northeastern Atlantic (Langhian): Loire Basin (France (Glibert, 1949); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Late Miocene**: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1892a).

Turbonilla pliopupoides (Sacco, 1892)

Plate 76, fig. 1

- *1892a Turbonilla (Pyrgolampros?) pliopupoides Sacc., Sacco, p. 674, pl. 2, fig. 106.
- 1975 Turbonilla (Pyrgolampros) pliopupoides (Sacco, 1892) Pavia, p. 165, pl. 11, figs 9-10.
- 1984 *Pyrgolampros? pliopupoides* Sacco, 1892 Ferrero Mortara *et al.*, p. 84, pl. 12, fig. 8.
- 1992 Turbonilla pliopupoides (Sacco, 1892) Cavallo & Repetto, p. 162, fig. 465.
- 2011 *Turbonilla pliopupoides* (Sacco, 1892) Chirli & Micali, p. 94, pl. 34, figs 1-6.

Dimensions and material – Height 4.1 mm. Locality 13: RGM 776 851/1 (ex JvdV collection).

Discussion – A rather elongate pupoid *Turbonilla* species is present in the Turkish deposits that has axial sculpture of low, wide, rounded ribs, about 13 per whorl, which do not extend onto the base, and no spiral sculpture. The protoconch is of type B. It is extremely similar to the holotype of *Turbonilla (Pyrgolampros?) pliopupoides* Sacco, 1892, reillustrated by Ferrero Mortara *et al.* (1984, pl. 12, fig. 8). Sacco (1892a, p. 673) described a similar species, *Turbonilla (Pyrgolampros?) miopupoides*, from the late Miocene Tortonian of Italy. This may well be a synonym, but the original illustrations are inadequate to distinguish the two, and the species has not been illustrated subsequently.

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: central Mediterranean, Italy (Pavia, 1975; Chirli & Micali, 2011). Early-late Pliocene: central Mediterranean, Italy (Sacco, 1892a; Cavallo & Repetto, 1992).

Turbonilla sp.

Plate 76, fig. 2

Dimensions and material – Height 4.1 mm. Locality 17: NHMW1847/0058/1714/7, RGM 776 918/1.

Discussion – This species is characterised by its small size and almost straight-sided whorls. The axial ribs are slightly curved, weakly opisthocline and each is narrower than one interspace. Spiral sculpture is absent. The axial costae do not extend onto the base, but do not stop abruptly and the protoconch is of type A. It is closely similar to several Recent Mediterranean species, Turbonilla acuta (Donovan, 1804) differs in having the first couple of teleoconch whorls smooth, and the ribs are straight. Turbonilla pumila Seguenza, 1876 shares the same teleoconch characters, but has a type B protoconch. Turbonilla acutissima Monterosato, 1884 is also similar, with a type A protoconch, but its axial ribs are wider than their interspaces. From the Pliocene of Italy, Turbonilla meneghini Libassi, 1859 has a wider apical angle and a smaller protoconch of type B. As we have only one specimen, its identity must await more material.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Tribe Eulimellini Saurin, 1958 Genus *Eulimella* Forbes & MacAndrew, 1846

Type species – Eulima macandrei Forbes, 1844 (= *Melania scillae* Scacchi, 1835), by original designation. Recent, Europe.

Eulimella scillae (Scacchi, 1835)

Plate 76, figs 3, 4

- *1835 Melania Scillae Scacchi, p. 51.
- 1839 Eulima crassula Jeffreys, p. 34 (nomen nudum).
- 1844 *Eulima macandrei* Forbes, p. 412.
- 1844 Eulimella Scillae Scacchi Philippi, p. 135, pl. 24, fig. 6.
- 1892 Eulimella Scillae Scacch. Sacco, p. 632, pl. 2, fig. 1.
- 1892 Eulimella Scillae var. anteconica Sacc., Sacco, p. 632, pl. 2, fig. 2.
- 1892 Eulimella Scillae var. graciliturrita Sacc., Sacco, p. 632, pl. 2, fig. 3.
- 1892 Eulimella Scillae var. scalarioinflata Sacc., Sacco, p. 633, pl. 2, fig. 4.
- 1914 Eulimella Scillae Scacchi Cerulli-Irelli, p. 430, pl. 22, figs 46-50.
- 1921 Eulimella Scillai [sic] Scacchi Cossmann, p. 301, pl. 6, figs 17, 18.
- 1946 Eulimella (Eulimella) scillae (Scacchi, 1835) Beets, p. 52, pl. 3, fig. 10.
- 1956 Eulimella (Eulimella) scillae (Scacchi 1836) Rasmussen, p. 100, pl. 10, fig. 2.
- 1958 Eulimella Scillae Scacchi Sorgenfrei, p. 322, pl. 69, fig. 239.
- 1969 Eulimella scillae Scacchi Fekih, p. 48, pl. 10, figs 1, 2.
- 1984a Eulimella (Eulimella) sp. A.W. Janssen, p. 347, pl. 16, fig. 7.
- 1986 Eulimella scillae (Scacchi, 1835) Fretter et al.,

p. 624, figs 434, 435.

- 1988 *Eulimella scillae* (Scacchi, 1835) Graham, p. 612, fig. 267.
- 1989 Eulimella scillae (Scacchi, 1836 [sic]) Moths, p. 112, pl. 20, fig. 105.
- 1992 *Eulimella scillae* (Scacchi, 1835) Cavallo & Repetto, p. 156, fig. 437.
- 1994 Eulimella scillae (Scacchi, 1835) van Aartsen, p. 96, fig. 17.
- 1996 Eulimella scillae (Scacchi, 1835) Peñas et al., p. 34, figs 66-68.
- 2000 *Eulimella scillae* (Scacchi, 1835) van Aartsen *et al.*, p. 3, figs 1, 2.
- 2005 *Eulimella scillae* (Scacchi, 1835) Rolán, p. 199, fig. 912.
- 2005 Eulimella (Eulimella) scillae (Scacchi, 1836 [sic])
 Schnetler, p. 121, pl. 9, fig. 5 (in plate caption and text quoted as fig. 6; ? *lapsus* figures 5 and 6 inverted).
- 2007 Eulimella (Eulimella) scillae (Scacchi, 1836 [sic])
 Wienrich, p. 743, pl. 123, fig. 4, pl. 160, fig. 8, pl. 161, fig. 3.
- 2008 Eulimella scillae (Scacchi, 1835) Chirli & Richard, p. 76, pl. 15, fig. 3.
- 2011 Eulimella scillae (Scacchi, 1835) Chirli, p. 14, pl. 4, figs 1-8.
- 2011 *Eulimella scillae* (Scacchi, 1835) Landau *et al.*, p. 42, pl. 23, fig. 5.

Dimensions and material – Maximum height 9.5 mm. Localities 2 & 3: RGM 783 249/2; locality 6: RGM 776 911/1 (ex JvdV collection); locality 9: JvdV/1; locality 13: NHMW 1847/0058/1278/1, JvdV/4, RGM 783 164/2; locality 17: NHMW 1847/0058/1712/3, RGM 783 597/1.

Discussion – The shells from Turkey illustrate clearly the characters of *Eulimella scillae* (Scacchi, 1835): the rather large helicoid protoconch (see van Aartsen, 1994, fig. 1), the flexuous, opisthocline growth lines and the angled periphery of the last whorl. This species has not so far been recorded from the Paratethys.

Distribution - Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Germany (Moths, 1989; Wienrich, 2007), Netherlands (A.W. Janssen, 1984a). Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: North Sea Basin (Tortonian): Denmark (Rasmussen, 1956; Sorgenfrei, 1958; Schnetler, 2005); Proto-Mediterranean Sea (Tortonian): Po Basin (Sacco, 1892). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); western Mediterranean, Estepona Basin (NHMW collection), Roussillon Basin, France (Chirli & Richard, 2008); central Mediterranean, Italy (Sacco, 1892; Chirli, 2011), Tunisia (Fekih, 1969). Early-late Pliocene: North Sea Basin, Netherlands (Beets, 1946); northeastern Atlantic, Mondego Basin, Portugal (NHMW collection); central Mediterranean, Italy (Sacco, 1892; Cavallo & Repetto, 1992). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1914).

Recent: northeastern Atlantic, Azores, Madeira, Canary and Cape Verde Islands, West Africa (Rolán, 2005).

Eulimella cerullii (Cossmann, 1915)

Plate 76, fig. 5

- 1884 Odostomia praelonga Jeffreys, Jeffreys, p. 350, pl. 26, fig. 6 (non Deshayes, 1861)
- 1914 Syrnola praelonga Jeffr. Cerulli-Irelli, p. 433, pl. 22, figs 58-60.
- *1915 Syrnola Cerillii nobis, Cossmann, p. 60 (nom. nov. pro Syrnola praelonga Jeffreys in Cerulli-Irelli, 1914; non Deshayes, 1861).
- 1994 Eulimella cerullii (Cossmann, 1915) van Aartsen, p. 100, fig. 20.
- 1996 *Eulimella cerullii* (Cossmann, 1915) Peñas *et al.*, p. 34, figs 64, 65.

Dimensions and material – Height 1.1 mm. Locality 17: RGM 776 916/1.

Discussion – The Turkish shell shows the characteristics of *Eulimella cerullii* (Cossmann, 1915): relatively short for the genus, with slightly convex whorls, a slightly twisted columella without the formation of a tooth, and a large globose protoconch.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Early Pleistocene**: central Mediterranean, Italy (Cerulli-Irelli, 1914). **Recent**: Mediterranean (Peñas *et al.*, 1996).

Family Amathinidae Ponder, 1987 Genus *Clathrella* Récluz, 1864

Type species – Nerita costata Brocchi, 1814 (= *Fossarus clathratus* Philippi, 1844), by monotypy. Pliocene, Italy.

Clathrella clathrata (Philippi 1844)

Plate 52, fig. 12

- 1814 Nerita costata Brocchi, 1814, p. 300, pl. 1, fig.
 11 (junior homonym of Nerita costata Gmelin, 1791).
- 1828 Turbo minutus Michaud, p. 122, pl. unnumbered, figs 7-9 (junior homonym of Turbo minutus Brown & Allan, 1818).
- *1844 Fossarus clathratus Philippi, p. 148, pl. 25, fig. 5.
- 1856 *Fossarus costatus* Brocc. Hörnes, p. 468, pl. 46, fig. 25.
- 1878 *Fossarus costatus* var. *crassicostata* Fontannes, Fontannes, p. 521, pl. 6, fig. 1.
- 1880 Fossarus costatus Brocchi Fontannes, p. 180, pl. 10, fig. 12.
- 1895b *Phasianema costatum* (Br.) Sacco, p. 17, pl. 1, fig. 32.
- 1895b Phasianema costatum var. infracosticillata Sacc., Sacco, p. 17, pl. 1, fig. 33.

- 1895b *Phasianema costatum* var. *pluricostata* Sacc., Sacco, p. 17, pl. 1, fig. 34.
- 1895b *Phasianema costatum* var. *parvulicincta* Sacc., Sacco, p. 18, pl. 1, fig. 35.
- 1895b *Phasianema costatum* var. *paucicostata* Sacc., Sacco, p. 18, pl. 1, fig. 36.
- 1904 Fossarus (Phasianema) costatus Brocchi Dollfus et al., p. 9, pl. 33, fig. 1.
- 1914 Fossarus (Phasianema) costatus (Br.) Cerulli-Irelli, p. 361, pl. 15, figs 11-16.
- 1915 Fossarus (Phasianema) costatus Brocchi Cossmann, p. 89, pl. 3, figs 46, 47, pl. 4, figs 49-50.
- 1923 Fossarus costatus Brocc. Friedberg, p. 410, pl. 25, fig. 3.
- 1949 *Phasianema costatum* Brocchi, 1814 Glibert, p. 198, pl. 12, fig. 12.
- 1954 Phasianema costata burdigalensis [sic] (d'Orb.)
 Csepreghy-Meznerics, p. 26, pl. 2, fig. 22 [non Carinorbis burdigalus (d'Orbigny, 1852)].
- 1955 Phasianema (Phasianema) costatum (Brocchi)1814 Rossi Ronchetti, p. 150, fig. 76.
- 1960 Fossarus (Phasianema) costatum (Brocchi) Švagrovský, p. 74, pl. 7, fig. 6.
- 1962 Phasianema costatum burdigalum Orbigny Strausz, p. 110, pl. 46, fig. 29 [non Carinorbis burdigalus (d'Orbigny, 1852)].
- 1966 Phasianema costatum burdigalum Orbigny, 1852
 Strausz, p. 204, pl. 46, fig. 29 [non Carinorbis burdigalus (d'Orbigny, 1852)].
- 1968 Fossarus costatus (Brocchi, 1814) Zelinskaya et al., p. 173, pl. 41, figs 13, 14.
- 1970 Fossarus (Fossarus) costatus (Brocchi) Caprotti, p. 151, pl. 3, fig. 2.
- 1975 Fossarus (Phasianema) costatus (Brocchi) Fekih, p. 72, pl. 25, fig. 3.
- 1976 Fossarus costatus (Brocchi) Caprotti, p. 8, pl. 10, fig. 2.
- 1978 Nerita costata Brocchi, 1814 Pinna & Spezia, p. 156, pl. 43, fig. 1.
- 1981 Fossarus (Phasianema) costatus burdigalensis [sic] (Orbigny) – Krach, p. 65, pl. 23, fig. 13 [non Carinorbis burdigalus (d'Orbigny, 1852)].
- 1988 Fossarus costatus (Brocchi, 1814) González Delgado, p. 120, pl. 1, figs 18, 19.
- 1992 *Clathrella clathrata* (Philippi 1844) Cavallo & Repetto, p. 154, fig. 433.
- 1996 Clathrella clathrata (Philippi 1844) Peñas et al.,p. 75, fig. 53.
- 1997 Fossarus costatus (Brocchi) Ruiz Muñoz, p. 168, pl. 31, figs 8-9.
- 1995 Fossarus costatus (Brocchi, 1814) Bałuk, p. 171, pl. 4, figs 6-8.
- 2001 *Clathrella clathrata* (Philippi 1844) Silva, p. 569, pl. 26, figs 16, 17.
- 2008 Fossarus costatus (Brocchi, 1814) Chirli, p. 14, pl. 4, figs 6-10.
- 2011 Clathrella clathrata (Philippi 1844) Landau et al., p. 42, pl. 23, figs 6, 7.
- non 1845 Turbo minutus Michaud Grateloup, pl. 14, figs

24, 25 [= *Carinorbis burdigalus* (d'Orbigny, 1852)].

non 1895b Phasianema costatum var. taurocrassa Sacc., Sacco, p. 18, pl. 1, fig. 37.

Dimensions and material – Maximum height 6.9 mm. Locality 6: JvdV/3: locality 17: NHMW 1847/0058/1280/1, 1847/0058/1281/1, YI 432/1.

Discussion – We agree with Lozouet et al. (2001a) that the French Atlantic early Miocene shells confused with Clathrella clathrata (Philippi, 1844) by many authors are not conspecific. The shell illustrated by Lozouet et al. (2001a, pl. 36, fig. 5) differs in having only two elevated spiral cords on spire whorls, as opposed to three in C. clathrata, the cords on the last whorl are of subequal strength, whereas in C. clathrata the shoulder and peripheral cords are more prominent than the others, and the aperture is smaller and far less dilated than in C. clathrata. Lozouet et al. (2001a) placed the French shells in the genus Carinorbis Conrad, 1862, recorded previously from the Pliocene western Atlantic of Virginia and Florida. We have also not included in our synonymy the early Miocene Proto-Mediterranean record of Phasianema costatum var. taurocrassa Sacco, 1895, which is probably not C. clathrata.

Clathrella clathrata is uncommon in the Turkish assemblages. All the specimens found are small and have not reached the large gerontic stage of some Pliocene shells, when the last whorl uncoils and expands dramatically (see Landau *et al.*, 2011, pl. 90, fig. 7).

Distribution – Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, (Cossmann & Peyrot, 1919), (Langhian): Loire Basin, France (Glibert, 1949); Paratethys (Langhian-Serravallian): Poland (Friedberg, 1923; Bałuk, 1995), Vienna (Hörnes, 1856), Hungary (Strausz, 1962, 1966), Ukraine (Zelinskaya et al., 1968), Slovakia (Švagrovský, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Messinian): Loire Basin, France (NHMW collection), (Tortonian): Cacela Basin, Portugal (Dollfus et al., 1904). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (González Delgado, 1988; Ruiz Muñoz, 1997; Landau et al., 2011); western Mediterranean, Estepona Basin (NHMW collection), Roussillon Basin, France (Fontannes, 1880); central Mediterranean, Italy (Sacco, 1895b; Chirli, 2008); Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1895b; Caprotti, 1970, 1976; Cavallo & Repetto, 1992). Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1914). Recent: Mediterranean (Peñas et al., 1996).

Genus Monotygma Gray, 1847

Type species – Monotygma striata Gray, 1847, by monotypy (= *Actaeopyramis* Fischer, 1885, unnecessary replacement; for discussion on generic usage see van Aartsen, 1986, Lozouet *et al.*, 2001a. *Monotigma* is an incorrect subsequent spelling of Sowerby, 1839. The correct spelling should be *Monotygma*; Pat LaFollette personal communication). Recent, Indo-West Pacific.

Monotygma elata (von Koenen, 1882) Plate 76, figs 6-7

- *1882 Tornatella elata von Koenen, p. 331, pl. 7, fig. 7.
- 1972a Kleinella (Leucotina) ivolasi (Mayer, 1900) Nordsieck, p. 127, pl. 32, fig. 223 [non Monotygma ivolasi (Mayer, 1900)].
- 1984 *Actaeopyramis elatus* (Von Koenen, 1882) A.W. Janssen, p. 340, pl. 15, figs 12, 13, pl. 78, fig. 6.
- 1994 Actaeopyramis elatus (Koenen, 1882) Moths, p. 182, pl. 13, fig. 1.
- 1998 *Tornatella elata* von Koenen van Aartsen *et al.*, fig. 6.
- 2005 Actaeopyramis elatus (Von Koenen, 1882) Schnetler, p. 120, pl. 9, fig. 1.
- 2007 Actaeopyramis elatus (Koenen, 1882) Wienrich, p. 735, pl. 120, fig. 6, pl. 159, fig. 5.
- 2010 Actaeopyramis elatus (Koenen, 1882) Moths et al., p. 83, pl. 23, fig. 12.

Dimensions and material – Maximum height 5.0 mm. Locality 6: NHMW 1847/0058/1388/1; locality 13: RGM 776 917/1 (ex JvdV collection).

Discussion – Specimens of Monotygma elata (von Koenen, 1882) from Turkey are small, similar in height to those of the middle Miocene North Sea Basin of Winterswijk, Miste, The Netherlands (A.W. Janssen, 1984). They are less globose than some of the Winterswijk shells, but well within the variation of this species (see A.W. Janssen, 1984, pl. 15, figs 12, 13). The protoconch is of type C, consisting of just over a single whorl, with a large nucleus (dp = 410 μ m, dn = 150 μ m; Pl. 76, fig. 6c), similar to that illustrated for shells from the North Sea Basin.

Monotygma ivolasi (Mayer, 1900) from the middle Miocene Langhian of the Loire Basin of France differs from *M. elata* in being more slender and taller spired. *Monotygma clavuliformis* (Boettger, 1902) from the middle Miocene Paratethys of Romania is also taller-spired, differing from *M. ivolasi* in being broader. Further direct comparison of these two middle Miocene forms is required to be certain that they are distinct. *Monotygma merignacensis* (Cossmann & Peyrot, 1917) from the early Miocene Burdigalian of the Aquitaine Basin, France is more slender than any of its European Neogene congeners, with almost straight-sided whorls.

Van Aartsen *et al.* (1998) included several Recent West African species in the genus *Adelactaeon* Cossmann, 1885 (type species: *Tornatella papyraceus* de Basterot, 1825) that are similar to *Monotygma elata*, of which *A. lilyae* van Aartsen, Gittenberger & Goud, 1998 is the most similar. However *M. elata* differs in being slightly squatter than *A. lilyae* and in having the outer lip more flared abapically. The generic differences between *Ad*-*elactaeon* and *Monotygma* are unclear.

Distribution – Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Germany (Wienrich, 2007; Moths, 1994; Moths *et al.*, 2010); Netherlands (Nordsieck, 1972a; A.W. Janssen, 1984a). Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: North Sea Basin (Tortonian): Denmark (Schnetler, 2005)

Family Murchisonellidae Casey, 1904 Genus Anisocycla Monterosato, 1880a

Type species – Aciculina emarginata Deshayes, 1861, subsequent designation (Warén, 1994, p. 208). Eocene, France.

Note – Warén (1994) separated *Ebala* Leach *in* Gray, 1847 from the Pyramidellidae Gray, 1840, based mainly on its having a complicated 'jaw apparatus', and erected the Ebalidae family for the genus. Van Aartsen (1995) considered Ebalidae, based on the genus *Ebala* Gray, 1847, to be invalid because the name is a junior homonym of *Ebala* Leach *in* Gray, 1847, and proposed the replacement name Anisocyclidae. Both of these were synonymised with Murchisonellidae Casey, 1904 by Bouchet & Rocroi (2005). Furthermore, van Aartsen (1995) considered *Ebala* Gray, 1847 to be a synonym of *Turbonilla* Risso, 1826 and defended the use of *Anisocycla* Monterosato, 1880, a position followed by Schander *et al.* (1999) and Peñas & Rolán (2001).

Anisocycla pointeli (de Folin, 1868)

Plate 76, fig. 8

- *1868 Turbonilla pointelli de Folin, p. 100, pl. 11, fig. 4.
- 1994 Anisocycla pointeli (de Folin, 1868) van Aartsen, p. 94, fig. 13.
- 1996 Ebala pointeli (De Folin, 1868) Peñas et al., p.
 75, figs 82-83, 85.
- 2001 Anisocycla pointeli (de Folin, 1868) Peñas & Rolán, p. 58, figs 3-6.
- 2005 Anisocycla pointeli (de Folin, 1868) -Rolán, p. 182, fig. 853.
- 2011 Ebala pointeli (de Folin, 1868) Chirli & Micali,
 p. 110, pl. 39, figs 13-15, pl. 40, figs 1-8.

Dimensions and material – Height 0.8 mm. Localities 2 & 3: RGM 783 250/1; locality 9: JvdV/2; locality 13: JvdV/2, RGM 784 062/1.

Discussion – Anisocycla pointeli (de Folin, 1868) is easily distinguished from *Anisocycla nitidissima* (Montagu, 1803) by its completely smooth shell, most specimens of which are more slender than *A. nitidissima*. The Turkish fossil shell has far fewer whorls than Recent specimens illustrated by Peñas & Rolán (2001, figs 3-6), more similar to the Italian fossil specimens (Chirli & Micali, 2011, pl. 39, figs 13-15, pl. 40, figs 1-8). Chirli & Micali (2011) illustrated two further congeners from the early Pliocene central Mediterranean; *A. eulimoides* Fekih, 1969 and *A. subscalarina* Fekih, 1969, both of which differ from *A. pointeli* in having much broader shells.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). **Early Pliocene**: central Mediterranean, Italy (Chirli, 2011). **Recent**: Atlantic European coast and Mediterranean, Atlantic coast of West Africa from Sahara to Ghana, Canaries, Madeira and Cabo Verde (Peñas & Rolán, 2001).

Anisocycla nitidissima (Montagu, 1803)

Plate 76, fig. 9

- *1803 Turbo nitidissimus Montagu, p. 299, pl. 12, fig. 1.
 1848 Chemnitzia nitidissima (?) Mont. S.V. Wood, p.
 80, pl. 10, fig. 4.
- 1965 *Eulimella (Elaba) nitidissima* (Montagu, 1803) van Regteren Altena *et al.*, p. 46, pl. 21, fig. 199.
- 1969 Anisocycla Nitidissima [sic] Montagu Fekih, p. 56, pl. 11, fig. 11.
- 1984 Anisocycla nitidissima (Montagu, 1803) van Aartsen et al., p. 50, fig. 243.
- 1986 Ebala nitidisima (Montagu, 1803) Fretter et al.,
 p. 629, figs 439, 440.
- 1988 *Ebala nitidisima* (Montagu, 1803) Graham, p. 618, fig. 270.
- 1993 *Ebala nitidisima* (Montagu, 1803) Iljina, p. 117, pl. 16, figs 10, 11.
- 1994 Ebala nitidisima (Montagu) Warén, p. 204, fig. 1A-C.
- 1994 Anisocycla nitidissima (Montagu, 1803) van Aartsen, p. 94, fig. 12.
- 1996 Ebala nitidissima (Montagu, 1803) Peñas et al.,
 p. 74, figs 87, 88, 92.
- 1997b Anisocycla nitidissima (Montagu, 1803) Marquet, p. 106, pl. 9, fig. 13.
- 1998 Anisocycla nitidissima (Montagu, 1803) Marquet, p. 193, fig. 165.
- 2001 Anisocycla nitidissima (Montagu, 1803) Peñas & Rolán, p. 60, figs 8-16.
- 2002 Elaba nitidissima (Montagu, 1803) Chirli & Bogi, p. 21, fig. 15.
- 2005 Anisocycla nitidissima (Montagu, 1803) –Rolán, p. 181, fig. 852.

Dimensions and material – Height 1.1 mm. Locality 13: NHMW 1847/0058/1433/1, JvdV/1, RGM 783 163/1.

Discussion – The specimens of *Anisocycla nitidissima* (Montagu, 1803) from the Pınarlar Yaylası deposits clearly shows the distinctive characters of the species: the weak spiral sculpture, and the presence of axial folds just below the adapical suture. These same characters are clearly illustrated in Recent shells illustrated by Peñas & Rolán (2001, figs 10-11), although the axial folds are

stronger in the Turkish fossil shell than in any Recent shells we have seen.

Distribution – Middle Miocene: eastern Paratethys (Langhian-Serravallian): (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: North Sea Basin, England (S.V. Wood, 1848); central Mediterranean, Tunisia (Fekih, 1969). Early-late Pliocene: central Mediterranean, Italy (Chirli & Bogi, 2002). Late Pliocene: North Sea Basin, Belgium (Marquet, 1997b, 1998), Netherlands (van Regteren Altena *et al.*, 1965). Recent: Atlantic European coast and Mediterranean, Atlantic coast of West Africa south to Angola, Canaries, Madeira and Cabo Verde (Peñas & Rolán, 2001).

Genus: Henrya Bartsch, 1947

Type species – Henrya henryi Bartsch, 1947, by original designation. Recent, Caribbean.

Note – The genus *Henrya* Bartsch, 1947 was placed in the pyramidellid family Ebalidae by Warén (1994). Rosenberg *et al.* (2009) assigned it to the Murchisonellidae. It is characterised by shells with an elongate-pupoid outline and the teleoconch whorls are strongly inflated. The apex is blunt, the protoconch consisting of a single rounded whorl (Bartsch, 1947).

Henrya wareni nov. sp. Plate 76, fig. 10

Dimensions and type material – Holotype NHMW 1847/0058/156, height 1.1 mm; paratype 1 RGM 776 942, height 2.0 mm; paratype 2 RGM 776 943, height 1.2 mm.

Other material – Known only by the type material.

Etymology – Named after Anders Warén of the Swedish Museum of Natural History, Stockholm, Sweden, the leading expert on bizarre gastropods.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Henrya* species with an elongatepupoid shape, strongly convex spire whorls, which hardly increase in diameter abapically, faint spiral sculpture and sinuous axial growth lines, giving the surface a weakly and irregularly reticulate appearance.

Description – Shell exceedingly small, elongate-pupoid in outline. Apex blunt, protoconch of one whorl with large nucleus. Teleoconch of 5.5 strongly convex whorls, hardly increasing in diameter abapically, with periphery mid-whorl. Suture deeply impressed. Sculpture of extremely fine spiral cords and conspicuous, sinuous growth lines, giving surface an irregularly reticulate appearance. Last whorl evenly rounded. Aperture ovate, outer lip thin, sinuous in profile.

Discussion – Shells in this genus are extremely small, and it is quite possible that their occurrence in the European fossil faunas has so far remained largely unnoticed. Thus, this is only the second record of the genus outside the Recent Caribbean faunas. The first and geologically oldest record so far is a species from the Aquitanian of France described as Murchisonella cf. bezanconi (Cossmann, 1892) by Lozouet et al. (2001a). Placement in Murchisonella is questionable as the extant type species, Murchisonella spectra (Mörch, 1875), as well as the better-known species Murchisonella columna (Hedley, 1907), are characterised by a distinct angulation of the whorls. Other extant species described by Bandel (2005) bear at least a median spiral rib, replacing the angulation or keel. Moreover, all extant species illustrated by Bandel (2005) display a tendency to develop a distinctly wrinkled appearance to the axial sculpture, which is unknown in Henrya. The early Miocene species from France is very similar to the Turkish species. It has a nearly identical protoconch and the same sculpture on the early teleoconch whorls. Separation is based on the finer spiral sculpture and more conical shape of the French species. Judging from the illustration in Cossmann, 1892, the Oligocene Truncatella bezanconi Cossmann, 1892 (considered to be a species of Murchisonella by Lozouet et al., 2001a) has an elongate-conical shell and a completely immersed protoconch.

Henrya wareni nov. sp. differs from the three Caribbean species *H. henryi* Bartsch, 1947, *H. goldmani* Bartsch, 1947 and *H. morrisoni* Bartsch, 1947 in having weak spiral sculpture. The Caribbean species have only incremental growth lines. The shell illustrated by Rolán (2005) from the Recent waters of Cape Verde as *Murchisonella* aff. *columna* (Hedley, 1907) differs from the Turkish shells in having teleoconch whorls that increase in diameter abapically, and the whorls are weakly carinate as opposed to evenly rounded in *H. wareni*. Like the Turkish shells it also has weak spiral sculpture, which is absent in all the western Atlantic species of *Henrya*.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus: Rissopsetia Dell, 1956

Type species – Rissopsetia maoria Dell, 1956, by original designation. Recent, New Zealand.

Rissopsetia? sp. Plate 56, fig. 1

Dimensions and material – Maximum height 2.3 mm. Localities 2 & 3: NHMW 1847/0058/1560/1. *Discussion* – A single small shell from the Lale assemblage is here provisionally placed in the genus *Rissopsetia*. Although the genus was originally described from New Zealand, it has been reported subsequently in the Recent faunas of Australia, the Philippines (Ponder, 1967, 1974), the Caribbean (Faber, 1984) and the Atlantic (Warén, 1989). This is the first record for the European Neogene.

The shell is very solid, somewhat cylindrical, with a small aperture and strongly thickened inner and outer lips. The teleoconch is similar to that of *R. islandica* Warén, 1989 from the Recent fauna of eastern Iceland, but differs in having very fine spiral sculpture (Pl. 56, fig. 1c). The protoconch, however, is poorly preserved in the Turkish shell and not clearly heterostrophic. *Rissopsetia hummelincki* Faber, 1984 from the Recent Caribbean is also similar in shape, but differs in having axial sculpture.

We await formal description until better preserved material is available.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Subclass Opisthobranchia *s. lat.* Superfamily Acteonoidea d'Orbigny, 1843 Family Acteonidae d'Orbigny, 1843 Subfamily Acteoninae d'Orbigny, 1843 Genus *Acteon* de Montfort, 1810

Type species – Voluta tornatilis Linnaeus, 1758, by original designation. Recent, European.

Note – We have placed the generic name *Acteon* de Montfort, 1810 within quotation marks, as shells within this and related genera are assigned to a particular genus based on their radula rather than on shell morphology.

Acteon' semistriatus (Férussac, 1822) Plate 52, fig. 13

- 1814 Voluta tornatilis L. Brocchi, p. 643 (partim, pl. 15, fig. 14 only) [non Acteon tornatilis (Linnaeus, 1758)].
- *1822 Tornatella semi-striata Férussac, p. 108.
- 1838 *Tornatella semi-striata* Fér. Grateloup, p. 267, pl. 6, figs 18, 21.
- 1846 *Tornatella semi-striata* Fér. Grateloup (*partim*, pl. 11, figs 20, 21 only).
- 1852 Actaeon Burdigalensis d'Orbigny, p. 35, no. 519 [nom. nov. pro Tornatella semi-striata Férussac, 1822 (partim)].
- 1856 Actaeon semistriatus Fér. Hörnes, p. 507, pl. 46, figs 22, 23.
- 1880 Actaeon tornatilis var. semistriata Ferussac Fontannes, p. 233, pl. 12, fig. 12.
- 1889 Actaeon semistriatus (Férrusac) Benoist, p. 45, pl. 3, fig. 7.
- 1889 Actaeon Burdigalensis d'Orb. Benoist, p. 52,

pl. 4, fig. 1a.

- 1896b Actaeon semistriatus Fèr [sic] Sacco, p. 33, pl. 3, figs 21-23.
- 1896b Actaeon semistriatus var. fusulatior Sacc., Sacco, p. 33, pl. 3, figs 24, 25.
- 1896b Actaeon semistriatus var. maculata (Bors.) Sacco, p. 34, pl. 3, figs 26, 26bis.
- 1896b Actaeon semistriatus var. ligustica Sacc., Sacco, p. 34, pl. 3, figs 27, 28.
- 1896b Actaeon semistriatus var. perstriata Sacc., Sacco, p. 34, pl. 3, fig. 29.
- 1896b Actaeon semistriatus var. totostriata Sacc., Sacco, p. 34, pl. 3, figs 30, 31.
- Acteon semistriatus Defrance Dollfus et al., p. 16, pl. 34, fig. 14.
- 1903 Acteon semistriatus var. totostriata Sacco Dollfus et al., p. 16, pl. 34, fig. 15.
- 1928 Actaeon semistriatus Fer. Friedberg, p. 538, pl. 35, fig. 10.
- 1932 Acteon semistriatus var. burdigalensis d'Orb. Peyrot, p. 154, no. 1375, pl. 11, figs 36, 45-46, 58-60.
- 1952a Acteon semistriatus burdigalensis d'Orbigny, 1852 – Glibert, p. 384, pl. 13, fig. 7.
- 1952b Actaeon semistriatus Ferrusac Glibert, p. 139, pl. 10, fig. 10.
- 1958 Acteon semistriatus (Basterot) Sorgenfrei, p. 298, pl. 65, fig. 216.
- 1958 Acteon laevigatus (Basterot) Sorgenfrei, p. 300, pl. 65, fig. 217 [non de Basterot, 1825].
- Acteon (Acteon) semistriatus (Ferussac 1822) –
 Kojumdgieva & Strachimirov, p. 219, pl. 52, fig. 3.
- 1962 Acteon semistriatus var. burdigalensis d'Orbigny
 Kecskemétiné-Körmendy, p. 93, pl. 11, fig. 9.
- 1964 Acteon semistriatus Ferussac, 1822 Brébion, p. 643, pl. 15, figs 24-27.
- 1964 Actaeon semistriatus (Ferrusac) Anderson, p. 330, pl. 50, fig. 295.
- Acteon semistriatus Férussac, 1822 Strausz, p. 467, fig. 209.
- 1968 Actaeon semistriatus (Ferrusac in Grateloup 1840) - Rasmussen, p. 214, pl. 25, figs 1, 2 (juvenile).
- 1972a Actaeon semistriatus (Férrusac, 1821 [sic]) Nordsieck, p. 121, fig. 205.
- 1973 Acteon semistriatus burdigalensis d'Orbigny, 1852 – Steininger, p. 448, pl. 9, fig. 7.
- 1975 Actaeon semistriatus (Ferussac) Fekih, p. 140, pl. 15, fig. 15.
- 1982c Actaeon semistriatus (Ferrusac, 1822) [sic] Martinell, p. 226, pl. 1, figs 14, 15 [in error Actaeon tornatilis (Linne, 166) on plate text].
- 1984a Actaeon (Actaeon) semistriatus (Férussac, 1822) –
 A.W. Janssen, p. 364, pl. 13, fig. 13, pl. 18, fig. 1, pl. 78, fig. 2.
- 1984a Actaeon (Actaeon) semistriatus f. burdigalensis d'Orbigny, 1852 – A.W. Janssen, p. 365, pl. 78, fig. 3.
- 1989 *Acteon semistriatus* (Férussac, 1822) Moths, p. 154, pl. 21, fig. 112.

- 1992 Acteon semistriatus (Férussac, 1822) Cavallo & Repetto, p. 164, fig. 469.
- 1997 Acteon semistriatus (Férussac) Ruiz Muñoz, p. 188, pl. 41, figs 5, 6.
- 2002 Acteon semistriatus burdigalensis d'Orbigny, 1852 – Harzhauser, p. 125, pl. 12, fig. 10.
- 2005 Acteon (Acteon) semistriatus (Férussac, 1822) Schnetler, p. 128, pl. 9, fig. 17.
- 2007 Actaeon (Actaeon) semistriatus (Férussac, 1822) and Actaeon (Actaeon) semistriatus fa. burdigalensis Orbigny – Wienrich, p. 768, pl. 132, fig. 9, pl. 168, figs 4-7.
- 2008 Acteon semistriatus (Férussac, 1822) Chirli & Richard, p. 79, pl. 16, figs 1, 2.
- 2013 Acteon semistriatus (Férussac, 1822) Chirli, p. 22, pl. 7, figs 7-12.
- *non* 1954 *Actaeon semistriatus* Fér. Strausz, p. 38, 73, 115, pl. 5, fig. 114 (? = *Melanopsis* sp.).

Dimensions and material – Maximum height 7.6 mm. Localities 2 & 3: NHMW 1847/0058/1268/1; localities 7 & 8: JvdV/14; locality 17: NHMW 1847/0058/1571/1, RGM 783 245/4.

Discussion – The Turkish shells are similar in shape to the form described from the French Atlantic Miocene as Actaeon burdigalensis d'Orbigny, 1852, which is characterised by its more slender shape and taller spire compared with typical 'Acteon' semistriatus (Férussac, 1822). However, also typical of this form is the absence of sculpture adapically on the last whorl (see Benoist, 1889, p. 52; Glibert, 1952a, p. 384), but this sculpture is clearly present on the Karaman specimens. Indeed, the extent of sculpture on the last whorl is very variable, which led Sacco (1896b) to describe numerous varieties based largely on this character. Although it is difficult to reconcile the Turkish shells being conspecific with the much larger, shorter-spired, inflated typical Pliocene forms, figured by Landau et al. (2011) and others, we agree with Peyrot (1932) and see no consistent shell characters to distinguish them, and therefore consider A. semistriatus to be a very variable, widespread and long-lived species.

Distribution - Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, France (Benoist, 1889; Peyrot, 1932); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896b); Paratethys (Aquitanian and Burdigalian): Austria (Steininger, 1973; Harzhauser, 2002). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Denmark (Sorgenfrei, 1958), Germany (Anderson, 1964; Moths, 1989; Wienrich, 2007), Netherlands (Nordsieck, 1972a; A.W. Janssen, 1984a). Middle Mio**cene**: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Grateloup, 1846; Benoist, 1889; Peyrot, 1932), (Langhian): Loire Basin (France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856), Bulgaria (Kojumdgieva & Strachimirov, 1960), Hungary (Kecskemétiné-Körmendy, 1962;

Strausz, 1966), Poland (Friedberg, 1928); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: North Sea Basin (Tortonian): Denmark (Rasmussen, 1968; Schnetler, 2005); northeastern Atlantic (Messinian): Loire Basin, France (Brébion, 1964), (Tortonian): Cacela Basin, Portugal (Dollfus et al., 1903); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896b). Early Pliocene: northeastern Atlantic, Guadalquivir Basin, Spain (Ruiz Muñoz, 1997; Landau et al., 2011); western Mediterranean, Estepona Basin (NHMW collection), northeastern Spain, (Martinell, 1982c), Roussillon Basin, France (Fontannes, 1880; Chirli & Richard, 2008); central Mediterranean, Italy (Sacco, 1896b), Tunisia (Fekih, 1975). Early-late Pliocene: central Mediterranean, Italy (Sacco, 1896b; Cavallo & Repetto, 1992; Chirli, 2013).

Acteon' subpunctulatus Boettger, 1902 Plate 52, fig. 14

- *1902 Actaeon subpunctulatus Boettger, p. 174, no. 540.
 1907 Actaeon subpunctulatus Bttgr. Boettger, p. 202, no. 680.
- 1934 Actaeon subpunctulatus Boettger Zilch, p. 276, pl. 22, fig. 11.

Dimensions and material – Maximum height 2.3 mm. Locality 17: RGM 776 928/1 (ex JvdV collection).

Discussion – This rather thin-shelled '*Acteon*' species is characterised by its very convex spire whorls, relatively large intorted protoconch, moderately inflated last whorl, strongly twisted columella and lack of sculpture. The material from Karaman is almost identical to that described by Boettger (1902) from the middle Miocene Paratethys of Romania as *Actaeon subpunctulatus*, with which we consider the Turkish shells conspecific. It can immediately be separated from '*Acteon*' semistriatus (Férussac, 1822), by its more solid shell, more fusiform shape and spiral sculpture covering at least part of the whorls. Indeed, the lack of sculpture and the inflated spire whorls make it difficult to compare with any other European Neogene *Acteon* species.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Romania (Boettger, 1902, 1907; Zilch, 1934); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

'Acteon' problematicus nov. sp. Plate 76, fig. 11

Dimensions and type material – Holotype RGM 784 064, height 1.0 mm.

Etymology – Name reflecting the difficulty in ascribing this small shell to a genus.
Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A minute '*Acteon*' species, thin-shelled, with a paucispiral protoconch, two teleoconch whorls bearing spiral sculpture with pitted interspaces, and last whorl moderately inflated, with a small aperture for the genus.

Description – Shell minute, fragile, globose. Protoconch paucispiral, of a single smooth whorl (Pl. 76, fig. 11b). Junction with teleoconch marked by prosocline scar. Teleoconch of 2.5 convex whorls with periphery just above abapical suture. Suture deeply impressed, linear. Sculpture of close-set spiral cords of irregular width, and of axial growth lines that do not cross spiral cords, but are elevated in their interspaces, giving interspaces an irregularly pitted appearance. Last whorl globose, 62% of total height, bearing spiral sculpture throughout. Aperture ovate, relatively small of genus. Outer lip simple, regularly convex, slightly flared abapically. Columellar edge sharp, elevated, without fold or tooth. Wide umbilical chink present, bordered medially by columella.

Discussion – Although we have placed this shell in the superfamily Acteonoidea d'Orbigny, 1843, it is difficult to assign it to a particular genus within this group as, in the Recent faunas, genera are distinguished based on their radulae and not their shell characters. It is also similar in shape to members of the superfamily Diaphanoidea Odhner, 1914 (1857), especially the European middle Miocene to Recent species *Diaphana minuta* Brown, 1827, but this species has very characteristic microsculpture of pits (see Marquet, 1998, fig. 182) rather than the spiral cords present on the Turkish shell. We know of no similar fossil or Recent shell to compare to this new species with.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Superfamily Ringiculoidea Philippi, 1853 Family Ringiculidae Philippi, 1853 Genus *Ringicula* Deshayes *in* Lamarck, 1838

Type species – Auricula ringens Lamarck, 1804, by subsequent designation (Gray, 1847). Eocene, France.

Ringicula exilis (Eichwald, 1829)

Plate 52, fig. 15; Plate 76, fig. 12

- *1829 *Voluta exilis* Eichwald, p. 298, pl. 5, fig. 15 (erroneously illustrated as sinistral shell).
- 1830 Marginella exilis mihi, Eichwald, p. 221.
- 1853 Ringicula buccinea Desh. Eichwald, p. 258 (non Brocchi, 1814).

- ?1904 Ringicula (Ringiculella) auriculata var. exilis (Eichw.) – Sacco, p. 110, pl. 24, figs 29-30.
- 1928 *Ringicula auriculata* Men. Friedberg, p. 551 (*partim*, pl. 36, figs 8-11 only) (*non* Ménard de la Groye, 1811).
- 1954 Ringicula (Ringiculella) auriculata exilis (Eichwald) Berger, p. 122, pl. 8, figs 37-40, pl. 9, figs 41-47, pl. 10, figs 48-50.
- 1954 *Ringicula* (*Ringiculella*) *auriculata buccinea* Brocchi, 1814 – Strausz, p. 38, pl. 5, fig. 117 (*non* Brocchi, 1814).
- 1956 Ringicula (Ringiculella) auriculata buccinea Br.
 Csepreghy-Meznerics, p. 436, pl. 12, figs 13-14 (non Brocchi, 1814).
- ?1958 Ringicula (Ringiculella) auriculata paulucciae Morlet 1878 – Hölzl, p. 281, pl. 22, fig. 10 [?non Ringicula paulucciae Morlet, 1878 (= Ringicula minor (Grateloup, 1838)].
- 1962 *Ringicula* (*Ringiculina*) *auriculata buccinea* Brocchi – Strausz, p. 101, pl. 41, figs 3-6, pl. 72, figs 11-14 (*non* Brocchi, 1814).
- 1966 Ringicula (Ringiculina) auriculata buccinea Brocchi, 1814 – Strausz, p. 469, pl. 41, figs 3-6, pl. 72, figs 11-14 (non Brocchi, 1814).
- 1968 Ringicula auriculata (Dubois de Montpereux, 1831) – Zelinskaya et al., p. 233, pl. 52, figs 17, 18 (non Ménard de la Groye, 1811).

Dimensions and material – Maximum height 10.4 mm. Localities 2 & 3: JvdV/38,; locality 6: JvdV/33; localities 7 & 8: NHMW 1847/0058/1556/1, NHMW 1847/0058/1447/30, JvdV/2, RGM 783 911/12; locality 13: NHMW 1847/0058/1482/30, JvdV/22, RGM 784 046/1, RGM 794 024/6, YI 443/21; locality 17: NHMW 1847/0058/1477/20, JvdV/50+, RGM 783 984/4, YI 429/6.

Discussion - Ringicula exilis (Eichwald, 1829) is closely similar in size to Ringicula buccinea (Brocchi, 1814), which is widespread in the northeastern Atlantic and Mediterranean Pliocene, but differs in having a taller spire. The spiral sculpture is also very weak and subobsolete on the last whorl, whereas in *R. buccinea* there is no spiral sculpture at all. The last whorl is far more evenly globose in R. buccinea, whereas in R. exilis the ventral aspect is slightly flattened and the two species have a different last whorl profile, which is much more asymmetrical in R. buccinea than in *R. exilis*, due to a marked flare of the outer lip abapically in R. buccinea. The thickness of the outer lip and the columellar and parietal callus is somewhat variable in *R. buccinea*, however, the lip and apertural armature is thicker in most specimens and the columellar callus is expanded further over the venter in R. exilis. Lastly, the columellar folds tend to be coarser in R. exilis. The protoconch of R. exilis is paucispiral, composed of 1.5 smooth whorls (dp = $280 \,\mu m$, hp = $330 \,\mu\text{m}, \, \text{dp/hp} = 0.85, \, \text{dV1} = 225 \,\mu\text{m}, \, \text{dn} = 125 \,\mu\text{m}; \, \text{Pl. 76},$ fig. 12). The protoconch of *R. buccinea* is also paucispiral. Interestingly, Eichwald (1853) considered his new species to be a synonym of Ringicula buccinea, which is probably the reason why this species has been overlooked by many later authors.

Ringicula buccinea has been used as a dumping ground for Ringicula species with a plump last whorl, and has been reported widely in the European Miocene (i.e. Brébion, 1954; Berger, 1954, Strausz, 1962, 1966). However, whether these Miocene specimens are conspecific with Pliocene shells is questionable. We (BL) have examined R. buccinea from the central Mediterranean Pliocene of Italy, western Mediterranean of Estepona and Atlantic Guadalquivir Basin of southern Spain and compared them with 'R. buccinea' from the late Miocene Messinian 'Redonian' of France and those from various Miocene Paratethyan deposits. All the Miocene Atlantic and Paratethyian forms have spiral sculpture, even if it is weak or restricted to the spire and base of the last whorl. Furthermore, none of them have the last whorl as strongly globose as in Pliocene specimens of R. buccinea. The North Sea Basin shells illustrated by Glibert (1952b, pl. 10, fig. 13), A.W. Janssen (1984a), Schnetler (2005, pl. 9, fig. 18) and Wienrich (2007, pl. 170, figs 1-3), amongst others, are more like Pliocene specimens of R. buccinea, with a smooth last whorl. However, all specimens seen (Netherlands, Germany, Belgium, Denmark; NHMW collection) are consistently smaller than Pliocene shells, with a higher spire and weak striae, as opposed to smooth in Pliocene specmens of R. buccinea. The North Sea Basin shells probably represent yet another species. This group needs to be revised, but we provisionally restrict R. buccinea to the Pliocene.

Distribution – Early Miocene: ?Proto-Mediterranean Sea (Burdigalian-Langhian): Colli Torinesi, Italy (Sacco, 1892b). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Berger, 1954), Hungary (Strausz, 1954, 1966; Csepreghy-Meznerics, 1956), Poland (Friedberg, 1928), Ukraine (Zelinskaya *et al.*, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Ringicula laevigata (Eichwald, 1830)

Plate 76, fig. 13

- *1830 Marginella laevigata Eichwald, p. 221.
- 1852 *Ringicula laevigata* Eichwald, pl. 10, fig. 45 (plate captions only).
- 1853 Ringicula laevigata m., Eichwald, p. 259.
- 1880 Ringicula Hochstetteri Hoernes & Auinger, p. 70, pl. 8, figs 19-22.
- 1928 *Ringicula laevigata* Eichw. Friedberg, p. 553, pl. 36, figs 12-13.
- 1954 Ringicula (Ringiculella) auriculata laevigata Eich. – Strausz, p. 38, 73, 115, pl. 5, fig. 116.
- 1954 *Ringicula* (*Ringiculella*) *auriculata laevigata* (Eichwald) Berger, p. 117, figs 19-24, pl. 8, figs 25-29.
- 1960 Ringicula (Ringiculella) auriculata var. laevigata
 Eichwald Kojumdgieva & Strachimirov, p. 220,
 pl. 52, fig. 6.
- 1962 *Ringicula* (*Ringiculella*) *auriculata laevigata* Eichwald – Strausz, p. 101, pl. 41, figs 7, 8.

- 1966 Ringicula (Ringiculella) auriculata laevigata (Eichwald) 1853 – Strausz, p. 470, pl. 41, figs 7, 8.
 2000 Ringicula (Ringiculella) laevigata (Eichwald, 1830) – Popa & Ianoliu, p. 87, pl. 3, fig. 8.
- non 1904 Ringicula auriculata var. laevigata Eich. Sacco, p. 110, pl. 24, fig. 27 (? = R. auriculata (Ménard de la Groye, 1811).
- non 1984 Ringicula (Ringiculella) laevigata (Eichwald, 1830) Švagrovský, p. 186, pl. 3, fig. 2.

Dimensions and material – Maximum height 2.3 mm. Locality 6: NHMW 1847/0058/1387/1, JvdV/11.

Discussion – Ringicula laevigata (Eichwald, 1830) is easily separated from its congeners in the Turkish assemblages by having by far the smallest shell size. The spire is relatively tall, with a blunter apex than either *Ringicula exilis* (Eichwald, 1829) or *Ringicula minor* (Grateloup, 1838). The spiral sculpture on the spire is very weak, and only visible under magnification. The last whorl is less inflated than usual for the group and the outer lip is rather straight in the mid-portion rather than evenly convex as in its congeners. The protoconch is paucispiral, consisting of about 1.5 smooth whorls (Pl. 76, fig. 13b)

The shell illustrated by Sacco (1904, pl. 24, fig. 27) as *Ringicula auriculata* var. *laevigata* from the Pliocene of Italy has none of the characters of this species and probably represents *R. auriculata* (Ménard de la Groye, 1811). If this reference is excluded, *R. laevigata* has been recorded until now exclusively from the Paratethys. The present record extends the range of this small ringiculid into the middle Miocene Proto-Mediterranean.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Austria (Hoernes & Auinger, 1880; Berger, 1954; Glibert, 1962c), Hungary (Friedberg, 1928; Strausz, 1954, 1962, 1966), Romania (Hoernes & Auinger, 1880; Popa & Ianoliu, 2000); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Ringicula minor (Grateloup, 1838)

Plate 52, fig. 16; Plate 76, fig. 14; Plate 77, fig. 1

- *1838 *Auricula ringens* var. b. *minor* Grateloup, p. 286, pl. 6, fig. 8.
- 1846 *Ringicula buccinea* Desh. Grateloup, pl. 11, fig.
 8-0 [*non Ringicula buccinea* (Brocchi, 1814)].
- 1852 *Ringicula buccinea* Desh. Hörnes, p. 86 (*partim*, pl. 9, fig. 4 only) [*non* fig. 3 = *Ringicula buccinea* (Brocchi, 1814)].
- 1878 *Ringicula paulucciae* Morlet, p. 266, pl. 6, fig. 6, pl. 8, fig. 9.
- 1878 *Ringicula (Ringiculella) tournoueri* Morlet, p. 287, pl. 6, fig. 10.
- ?1882 *Ringicula loegnanensis* Morlet, p. 207, pl. 9, fig.7.
- ?1892b Ringicula (Ringiculella) auriculata var. longominor Sacc., Sacco, p. 30, pl. 1, fig. 16.

- ?1892b Ringicula (Ringiculella) auriculata var. perminor Sacc., Sacco, p. 31, pl. 1, fig. 17.
- 1932 *Ringicula (Ringiculella) tournoueri* Morlet Peyrot, no 1371 'bis', pl. 11, figs 7, 11-13, 18-25, 37, 54, 61.
- 1954 *Ringicula* (*Ringiculella*) *auriculata paulucciae* Morlet – Berger, p. 115, pl. 7, figs 3-18
- 1960 Ringicula (Ringiculella) auriculata cfr. laevigata
 Eichwald Švagrovský, p. 106, pl. 14, figs 5-7 [non Ringicula laevigata (Eichwald, 1830)].
- 1962 *Ringicula (Ringiculina) auriculata* Ménard var. Strausz, p. 91, pl. 36, figs 8, 9.
- 1966 *Ringicula (Ringiculina) auriculata* Ménard, 1811 var. – Strausz, p. 471, pl. 36, figs 8, 9.
- 1984 *Ringicula (Ringiculella) paulucciae* Morlet Švagrovský, p. 184, pl. 2, fig. 6
- 1998 *Ringicula paulucciae* Morlet, 1878 Valdés & Héros, p. 700, fig. 2f
- 1998 *Ringicula tournoueri* Morlet, 1878 Valdés & Héros, p. 700, fig. 3g
- 2001a *Ringicula minor* (Grateloup, 1838) Lozouet *et al.*, p. 80, pl. 37, fig. 1
- 2005 *Ringicula minor* (Grateloup, 1828 [*sic*]) Lesport & Cahuzac, p. 98, pl. 4, figs 7, 8.
- 2011 Ringicula minor (Grateloup, 1838) Harzhauser et al., p. 218, fig. 6.2.
- 2012 *Ringicula minor* (Grateloup, 1838) Cahuzac *et al.*, p. 403, pl. 2B, fig. 6.
- 2012 *Ringicula minor* (Grateloup 1838) d'Amico *et al.*, p. 170, pl. 3, fig. 36.
- ?non 1958 Ringicula (Ringiculella) auriculata paulucciae Morlet 1878 – Hölzl, p. 281, pl. 22, fig. 10.

Dimensions and material – Maximum height 5.6 mm. Localities 2 & 3: JvdV/5; locality 6: JvdV/50+; localities 7 & 8: JvdV/50+, RGM 784 045/2; locality 13: JvdV/7, YI 444/17; locality 17: NHMW 1847/0058/1557/1, NHMW 1847/0058/1436/30, JvdV/50+, RGM 783 985/50+, YI 428/15.

Discussion - The ringiculids of the Paratethys were monographed by Berger (1954), who mainly referred to Morlet (1878) but failed to integrate other French literature (e.g. Peyrot, 1932). Consequently, he assigned the early and middle Miocene paratethyan ringiculid shells with an elongate spire and spiral sculpture to Ringicula paulucciae Morlet, 1878 and its synonym Ringicula tournoueri Morlet, 1878 (illustrated by Valdez & Herós, 1998, figs 2f, 3g). Later, Lozouet et al. (2001a) considered the types of these species to be conspecific with Ringicula minor (Grateloup, 1838). Ringicula minor, although referred to as Ringicula paulucciae in Paratethys literature, is a widespread species during the early and middle Miocene in the northeastern Atlantic, the Mediterranean Sea and the Central Paratethys. The shells described by Sacco (1892b) as Ringicula (Ringiculella) auriculata var. longominor and var. perminor from the Burdigalian-Langhian Colli Torinesi of Italy probably also represent this species, but the figures are too poor to be certain. The specimen figured by Hölzl (1958, pl. 22, fig. 10) as *Ringicula* (*Ringiculella*) auriculata paulucciae has no spiral sculpture and the spire and shell shape are not typical of *R. minor*. It is much more similar to some forms of *Ringicula exilis* (Eichwald, 1829), although a small example of this species. The protoconch of all three Turkish species is paucispiral, consisting of about 1.5 whorls or roughly similar diameter (Pl. 76; figs 12b, 13b; Pl. 77, fig. 1).

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin (Peyrot, 1932; Lozouet et al., 2001a; Lesport & Cahuzac, 2005; Cahuzac et al., 2012); ?Proto-Mediterranean Sea (Burdigalian-Langhian): Colli Torinesi, Italy (Sacco, 1892b); Paratethys (late Burdigalian): Slovakia (Harzhauser et al., 2011). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, (Peyrot, 1932); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1852; Berger, 1954), Hungary (Strausz, 1962, 1966), Slovakia (Švagrovský, 1960); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (d'Amico et al., 2012).

Superfamily Haminoeoidea Pilsbry, 1895b Family Haminoeidae Pilsbry, 1895b Subfamily Haminoeinae Pilsbry, 1895b Genus *Haminoea* Turton & Kingston, 1830

Type species – Bulla hydatis Linnaeus, 1758, by subsequent designation (Gray, 1847). Recent Mediterranean.

Haminoea cf. *hydatis miocaenica* Berger, 1953 Plate 52, fig. 17

- cf. 1758 Bulla hydatis Linnaeus, p. 726.
- cf. 1896d *Haminea hydatis* (L.) Sacco, p. 48, pl. 4, figs 1-5.
 - 1896d *Haminea hydatis* var. *hydantina* (Dod.) Sacco, p. 48, pl. 4, fig. 6.
- cf. 1910 Bulla (Haminea) hydatis L. Cerulli-Irelli, p. 229, pl. 4, fig. 10.
- 1928 Bulla hydatis L. Friedberg, p. 547, pl. 36, fig. 5.
- 1953 * Haminea hydatis miocaenica Berger, p. 87, pl. 16, figs 5-7
- cf. 1965 Haminea (Haminea) hydatis (L.) Ruggieri & Greco, p. 53, pl. 7, fig. 13.
 - 1970 Haminea hydatis miocaenica Berger Bałuk, p. 119, pl. 14, fig. 4.
- cf. 1987 *Haminoea hydatis* (Linné, 1758) Talavera *et al.*, p. 55, figs 5-8.
- cf. 1992 *Haminoea hydatis* (L., 1758) Cavallo & Repetto, p. 166, fig. 480.
- cf. 2011 *Haminoea hydatis* (Linnaeus, 1758) Landau *et al.*, p. 42, pl. 23, fig. 10.

Dimensions and material - Maximum height 7.6 mm.

Locality 17: NHMW 1847/0058/1378/1, 1847/0058/1497/2, JvdV/1, RGM 776 933/1 (ex JvdV collection).

Discussion – Berger (1953) separated Miocene specimens of *Haminoea hydatis* as the subspecies *H. hydatis miocaenica*, distinguished by having a smaller shell and alleged minor differences in the shape of the upper part of the aperture. He further commented that the transition from the Miocene to the Recent forms was gradual, Pliocene specimens being intermediate. The Miocene specimens from Turkey are indeed smaller than those seen in Pliocene and Recent assemblages (maximum 6.1 mm as opposed to about 15 mm height in Recent shells). However, Talavera *et al.* (1987, p. 61) pointed out that for Recent forms, apart from *H. orbygniana* (Férussac, 1822), species of *Haminoea* could not be separated reliably by shell characters alone.

Glibert (1952a) considered it possible to distinguish between the shells of *H. hydatis* and *H. navicula* (da Costa, 1778), using the concavity of the columella, which is greater in *H. navicula*. The specimen from the Atlantic middle Miocene Loire Basin figured by Glibert (1952a, pl. 15, fig. 2) as *H. navicula* has a deeply concave columella, whereas this is not the case in the Turkish specimens. Based on this character, we consider the Turkish shells most likely conspecific with the smaller Miocene forms discussed by Berger (1953), but leave the species in open nomenclature.

Haminoea saucatsensis (Peyrot, 1932) from the Atlantic Aquitanian and Burdigalian Aquitaine Basin of France is closely similar to *H. hydatis*, but differs in being more globular, but with a more flattened apex, and in having the outer lip rising higher above the apex.

Distribution – Early Miocene: Proto-Mediterranean Sea (Burdigalian-Langhian): Colli Torinesi, Italy (Sacco, 1896d). Middle Miocene: Paratethys (Langhian-Serravallian): Poland (Friedberg, 1928; Bałuk, 1970), Vienna (Berger, 1953); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (NHMW collection); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896d).

Subfamily Atydinae Thiele, 1925b Genus *Atys* Montfort, 1810

Type species – Bulla naucum Linnaeus, 1758, by original designation. Recent, Indo-West Pacific.

Atys latesulcata (Boettger, 1902)

Plate 53, fig. 9

- *1902 Coleophysis latesulcata Boettger, p. 179.
- 1932 *Roxania (Acrostemma) Tournoueri* Benoist, mss Peyrot, p. 201, pl. 12, figs 3-5.
- 1934 Retusa latesulcata (Boettger) Zilch, p. 277, pl. 22, fig. 16.
- 1953 Retusa (Acrostemma) edlaueri Berger, p. 96, pl.

16, fig. 30.

- 1953 Retusa (Acrostemma) kühnelti Berger, p. 96, pl. 16, fig. 31.
- 1953 Retusa (Acrostemma) latesulcata (Boettger) Berger, p. 97, pl. 16, fig. 32.

Dimensions and material – Maximum height 3.7 mm. Locality 6: JvdV/3; locality 17: JvdV/3, RGM 776 925/1 (ex JvdV collection), RGM 783 968/3.

Discussion - Berger (1953, pl. 16, figs 30-32) illustrated three specimens under different names, which in our opinion represent intraspecific variation of one species, Atys latesulcata (Boettger, 1902) being the earliest name. Within the Turkish material smaller specimens are present with a more flattened apex, the adapical extremity of the outer lip becoming more elevated with ontogeny. The extent and disposition of the spiral sculpture is variable. The specimen illustrated has more wide-spread spiral grooves than any of the shells figured by Berger (1953), but larger specimens with the spiral sculpture restricted to the extremities as in Berger's (1953, fig. 30) figure are present. Atys tournoueri (Peyrot, 1932) from the early Miocene Aquitanian and Burdigalian of the Aquitaine Basin of France differs in having a more elongate shell and weaker spiral sculpture, which is also only present at the extremities. We have not seen any specimens from France, but it is probably a synonym of A. latesulcata.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, (Peyrot, 1932). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Berger, 1953), Romania (Boettger, 1902, Zilch, 1934; Berger, 1953); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Micratys Habe in Kuroda & Habe, 1952

Type species – Micratys ovum Habe, 1952, by monotypy. Recent, Pacific.

Micratys fragilissimus nov. sp. Plate 77, figs 7, 8

Dimensions and type material – Holotype RGM 784 066, height 1.8 mm; paratype 1 RGM 784 067, height 1.8 mm; paratype 2 NHMW/0058/1344, height 2.0 mm; paratype 3 NHMW/0058/1703; paratype 4 NHMW/0058/1704; paratype 5 NHMW/0058/1705.

Other material and dimensions – Maximum height 3.0 mm. Locality 17: JvdV/13; RGM 783 242/8.

Etymology – From Latin *fragilis* – easily broken, brittle, fragile –, reflecting the very fragile nature of the shell, superlative – most fragile. Genus *Micratys* masculine.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A minute *Micratys* species, with a very thin shell and a strongly globose last whorl bearing five incised spiral grooves apically and on the base.

Description – Shell minute, very fragile, extremely globose. Apical perforation narrow, shallow. Last whorl representing whole whorl height, broad, regularly rounded, bearing five narrow incised spiral grooves adapically, five similar grooves on base; mid-portion smooth. Aperture narrow, widening slightly abapically. Outer lip thin, rising above apex, angled at highest point, regularly convex below. Parietal and columellar callus not developed. Columella short, straight, erect, bearing one, poorly defined fold. Small umbilicus present bordered medially by columella.

Discussion – We provisionally place this shell within the genus *Micratys* Habe *in* Kuroda & Habe, 1952. The shell shape is very similar to the type species, *Micratys ovum* Habe, 1952, which also has spiral grooves restricted to the extremities of the last whorl. The fossil genus *Bullichna* Nordsieck, 1972, a monotypic genus based on the species *Atys paucistriatus* Ravn, 1907 from the early-middle Miocene North Sea Basin, shows the same characters and is probably a junior subjective synonym of *Micratys*.

Micratys fragilissimus nov. sp. is, however, clearly not conspecific with *M. paucistriatus*. It differs in being far smaller and in having a much more fragile shell. Indeed, it is difficult to know how common it is in the Karaman assemblages as many specimens break at the slightest touch. Further differences are a more tapered apical portion of the last whorl in *M. paucistiatus* as opposed to the evenly rotund last whorl of *M. fragilissimus*, and the more recurved and thickened columella in *M. paucistiatus*. The columella in all Karaman specimens is very thin and sharply erect. We are aware of no other fossil or Recent shells with which to compare this new species.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Superfamily Philinoidea Gray, 1850 (1815) Family Philinidae Gray, 1850 (1815) Genus *Philine* Ascanius, 1772

Philine catena (Montagu, 1803)

Plate 77, fig. 2

- *1803 Bulla catena Montagu, p. 215, pl. 4, figs 43, 44.
- 1848 Bullaea sculpta Wood, p. 180, pl. 21, fig. 82.
- 1896d *Philine (Hermania) catena* (Montg.) Sacco, p. 54, pl. 4, figs 43, 44.
- 1953 *Philine (Hermania) catena* (Montagu) Berger, p. 114, pl. 18, fig. 82.

- 1965 *Philine (Hermania) catena* (Montg.) Ruggieri & Grecco, p. 53, pl. 9, fig. 3.
- 1975 *Philine catena* (Montagu) Fekih, p. 143, pl. 42, fig. 10.
- 1994 *Philine catena* (Montagu, 1803) van der Linden, p. 45, figs 11, 12.
- 2005 Philine catena (Montagu, 1803) Gruppo Malacologico Livornese, p. 26, 28, fig. 7, unnumbered fig. p. 28 centre.
- 2013 *Philine catena* (Montagu, 1803) Chirli, p. 33, pl. 9, figs 1-5.

Dimensions and material – Maximum height 2.1 mm. Localities 2 & 3: JvdV/1; locality 13: JvdV/1; locality 17: NHMW 1847/0058/1442/1, RGM 776 862/1 (ex JvdV collection), RGM 783 987/1.

Discussion – Philine catena (Montagu, 1803) is easily distinguished by its oval shape and very distinctive sculpture, which consists of a fan of spiral chains, composed of interconnected rings (Pl. 77, fig 2b). The shell illustrated has a slight constriction a short distance below the apex. This character is also seen in some Recent specimens. The Turkish shell is also slightly more slender than most specimens of the species, but as in its congener *Philine scabra* (Müller, 1784) discussed below, we see no reliable shell characters by which to separate the Neogene and Recent populations.

Distribution – Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Berger, 1953); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: North Sea Basin, England (Wood, 1848); western Mediterranean, Tunisia (Fekih, 1975). Early-late Pliocene: central Mediterranean, Italy (Sacco, 1896d; Chirli, 2013). Early Pleistocene: central Mediterranean, Italy (Ruggieri & Grecco, 1965). Recent: northeastern Atlantic, Norway south to Mediterranean, Canaries (Poppe & Goto, 1991).

Philine aff. *intricata* Monterosato, 1884 Plate 77, fig. 3

aff. 1875 Philine intricata Monterosato, Monterosato, p. 47 (nomen nudum). aff. *1884 Philine intricata Monterosato, Monterosato, p. 47. aff. 1897 Philine desmotis Watson, p. 237, fig. 5. aff. 1994 Philine intricata Monterosato, 1884 - van der Linden, p. 41, figs 1-6. aff. 2005 Philine intricata Monterosato, 1884 - Rolán, p. 207, figs 954, 955. aff. 2005 Philine intricata Monterosato, 1884 - Gruppo Malacologico Livornese, p. 26, aff. 28, fig. 1, unnumbered fig. p. 29 top.

Dimensions and material – Height 1.7 mm. Locality 17: JvdV/1, broken during photographing

Discussion - A single shell from the JvdV collection

representing a broader, rounded Philine species was photographed, but unfortunately stuck irreversibly to the mountant in the SEM and broke when manipulated to take a dorsal view. Nevertheless, enough of the dorsal sculpture can be seen to confirm that it consists of close-set rows of chains (Pl. 77, fig. 3b), similar to that of Philine catena (Montagu, 1803), but more crowded. Several European Philine species have a similarly broad shape, but only one has this type of sculpture: Philine intricata Monterosato, 1884 (see van der Linden, 1994). The Turkish shell, however, is far more rounded, whereas P. intricata is sub-quadrate in profile. Philine quadrata (Wood, 1839), which is known from the middle Miocene Paratethys (Berger, 1953) and the Pliocene North Sea Basin (S.V. Wood, 1839, 1848; Marquet, 1997b, 1998) has a similar shell shape, but differs in its dorsal sculpture, which consists of dots, similar to but smaller than those seen in P. scabra (Müller, 1776). The Recent species P. monilifera Bouchet, 1975 is roundish in shape, but has finer sculpture of rows of rings and ovals, and P. angulata Jeffreys, 1867 has a more quadrate profile and dorsal sculpture of rows of widely-spaced dots.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Philine scabra (Müller, 1784)

Plate 77, fig. 4

- *1784 Bulla scabra Müller, p. 90, figs 1-3.
- 1848 Bullaea scabra Müll. Wood, p. 181, pl. 21, fig. 12.
 1895 Hermania scabra (Müll.) Cossmann, p. 128, pl.
- 7, figs 1, 2. 1896d *Philine (Hermania) scabra* var. *pliocenica* Sacc.,
- Sacco, p. 54, pl. 4, fig. 42.
- 1910 Philine (Hermania) scabra Müll. Cerulli-Irelli, p. 46, pl. 4, figs 42-44.
- 1923 *Philine scabra* (Müller) Harmer, p. 809, pl. 63, fig. 20.
- 1952 *Philine scabra* Müller, 1776 van der Berg, p. 52, pl. 3, figs 8-10.
- 1952 *Philine scabra pliocaenica* [sic] Sacco, 1897 Csepreghy-Meznerics, p. 229, pl. 14, figs 13, 14.
- 1953 *Philine (Hermania) scabra* (Müller) Berger, p. 115, pl. 18, figs 83-86.
- 1960b *Philine scabra* Müller, 1776 Glibert, p. 25, pl. 4, fig. 29.
- 1962 Philine scabra pliocaenica [sic] Sacco Strausz, p. 156, pl. 75, figs 12, 13.
- 1966 Philine scabra pliocaenica [sic] Sacco, 1897 Strausz, p. 483, pl. 75, figs 12, 13.
- 1975 *Philine scabra* (Müller) Fekih, p. 144, pl. 42, fig. 16.
- 1982c *Philine (Hermania) scabra* (Müller, 1776 [*sic*]) Martinell, p. 231, pl. 1, figs 26, 27.
- 1984a *Philine (Hermania) scabra* (Müller, 1776 [*sic*]) A.W. Janssen, p. 374, pl. 19, fig. 12.
- 1988 *Philine scabra* (Müller, 1776 [*sic*]) Thompson,p. 65, fig. 24.

- 1992 *Philine scabra* (Müller, 1784) Cavallo & Repetto, p. 168, fig. 486.
- 1996 *Philine scabra* (Müller, 1776 [*sic*]) van der Linden & Janssen, p. 101, fig. 4.
- 1997b *Philine scabra* (Müller, 1776 [*sic*]) Marquet, p. 114, pl. 12, fig. 4.
- 2001 *Philine (Hermania) scabra* (Müller, 1776) Silva, p. 585, pl. 27, figs 20-22.
- 2005 Philine scabra (Müller, 1784) Gruppo Malacologico Livornese, p. 26, 30, fig. 5, unnumbered fig. p. 30 bottom.
- 2008 Philine scabra (Müller, 1784) Chirli & Richard, p. 82, pl. 16, fig. 8.
- 2010 *Philine scabra* (Müller, 1784) Sosso & dell'Angelo, p. 54, unnumbered fig. p. 68 bottom row right.
- 2011 *Philine scabra* (Müller, 1776 [*sic*]) Landau *et al.*, p. 42, pl. 23, fig. 11.
- 2013 *Philine scabra* (Müller, 1784) Chirli, p. 34, pl. 9, figs 6-11.

Dimensions and material – Maximum height 3.2 mm. Localities 2 & 3: JvdV/6, locality 13: JvdV/1; locality 17: NHMW 1847/0058/1389/1, JvdV/3, RGM 776 850/1 (ex JvdV collection), RGM 783 986/4, YI 456/1.

Discussion – Philine scabra (Müller, 1776) differs from *P. catena* (Montagu, 1803) in having a more slender shell and in its dorsal sculpture, which is composed of a fan of spiral dots rather than chains (Pl. 77, fig 4b). We note that the shell illustrated here is more rounded adapically at the outer lip than most Recent shells (see van der Linden & Janssen, 1996, figs 4a, b), but some fossil forms from the Pliocene of Italy are also more rounded (see Cavallo & Repetto, 1992, fig.486) and vice versa, strongly shouldered forms also occur in the Miocene (see Berger, 1953, fig. 85). Therefore we see no reliable way to separate these Neogene and Recent populations and provosionally consider them to be a single long-lived species.

Distribution - Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (A.W. Janssen, 1984a). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Berger, 1953), Hungary (Csepreghy-Meznerics, 1952; Strausz, 1962, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (NHMW collection). Early Pliocene: North Sea Basin, England (Wood, 1848; Harmer, 1923), Belgium (Glibert, 1960b; Marquet, 1997b), Netherlands (van der Berg, 1952); northeastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); western Mediterranean, Estepona Basin (NHMW collection), northwestern Spain (Martinell, 1982c), Roussillon Basin, France (Chirli & Richard, 2008), Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, central west Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1896d; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010; Chirli, 2013). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1910).

Recent: northeastern Atlantic, Norway south to West Africa, Madeira, Iceland (Poppe & Goto, 1991).

Philine seyithasanensis nov. sp. Plate 77, figs 5-6

Dimensions and type material – Holotype RGM 776 919, height 2.2 mm; paratype 1 RGM 776 921, height 2.2 mm.

Other material – Known only by the type material.

Etymology - From type locality, Seyithasan.

Locus typicus – Seyithasan, Karaman Basin, Karaman Province, Turkey.

Stratum typicum – Tırtar Formation, Serravallian, middle Miocene.

Diagnosis – A small *Philine* species with a cylindrical shell, the last whorl sharply angled at the shoulder, a deeply canaliculate suture and mirosculpture of rows of very small pits.

Description – Shell small, fragile, cylindrical. Protoconch depressed, of about ½ whorl. Spire flattened, tilted about 20° from horizontal to the right in relation to shell axis. Teleoconch of just over one whorl, with sharply angular shoulder. Suture deeply canaliculate. Last whorl cylindrical, with weak bulge mid-whorl opposite aperture. Microsculpture of many rows of very small pits (Pl. 77, fig 5c). Aperture large, widening abapically, truncated at base. Outer lip horizontal to shoulder, roundely angled and vertical below, slightly pinched at ¼ shell height.

Discussion – Philine seyithasanensis nov. sp. is a very distinctive species, with its very cylindrical shell and angular shoulder. The microsculpture is useful in separating European *Philine* species, which can be roughly divided into species with rows of chains or pits. *Philine seyithasanensis* nov. sp. belongs within the second group. The species with rows of pits, *P. punctata* (J. Adams, 1800), *P. quadrata* (Wood, 1839) and *P. angulata* Jeffreys, 1867, all have a much broader shell and a more globose last whorl. *Philine calva* van der Linden, 1995 is somewhat similar, but the last whorl is less cylindrical, not angled at the shoulder, and the rows of pits are more closely spaced.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Family Cylichnidae H. Adams & A. Adams, 1854 Genus Cylichna Lovén, 1846

Type species – Bulla cylindracea Pennant, 1877, by subsequent designation (Hermannsen, 1852). Recent, Europe.

Cylichna clathrata (Defrance, 1825) Plate 52, fig. 18

- *1825 Bulla clathrata Defrance, p. 131.
- 1825 Bulla clathrata Defrance de Basterot, p. 21, pl. 1, fig. 10.
- 1837 Bulla Tarbelliana Nob., Grateloup, p. 398, 422, pl. 3, figs 29, 30.
- 1846 Bulla Tarbelliana Grat. Grateloup, pl. 2, figs 29, 30.
- 1856 Bulla clathrata Defr. Hörnes, p. 623, pl. 50, fig.
 8.
- 1896d Cylichnina intermedia Sacc., Sacco, p. 52, pl. 4, figs 31-32.
- 1903 Bullinella (Cylichnina) clathrata (Defrance) Dollfus et al., p. 23, pl. 36, fig. 18.
- 1932 Bullinella (Cylichnina) clathrata (Defrance) Peyrot, p. 185, no. 1395, pl. 13, figs 11, 15, 17.
- ? 1953 Retusa (Cylichnina) intermedia Sacco Berger, p. 101, pl. 19, figs 93, 94.
- ?1953 Retusa (Cylichnina) clathrata (Defrance) Berger, p. 101, pl. 19, fig. 95.
- 1984 *Cylichnina intermedia* Sacco, 1897 Ferrero Mortara *et al.*, p. 288, pl. 53, fig. 1.

Dimensions and material-Maximum height 11.5 mm. Locality 13: JvdV/2; locality 17: NHMW 1847/0058/1471/1, NHMW 1847/0058/1472/30, JvdV/50+, RGM 783 694/30, YI 439/29.

Discussion - Cylichna clathrata (Defrance, 1825) is characterised by its rather large shell, cylindrical shape, with the apex rounded, its small apical perforation, and its very fine close-set spiral grooves on the base, almost invisible to the naked eve. Remnants of a colour pattern consisting of small squares, similar to that described by Peyrot (1932, p. 186), is preserved on some of the Turkish shells. We see few grounds by which to distinguish Cylichnina intermedia Sacco, 1896. The original figures are poor, but a syntype was illustrated by Ferrero Mortara et al. (1984, pl. 53, fig. 1). Cylichna pliocrassa (Sacco, 1896), described from the early Pliocene of Italy, but also recorded from the Austrian Paratethys (Berger, 1953) differs in having a straighter-sided last whorl, a more angular edge to the apex, and is rather truncated anteriorly. The whole whorl surface is covered with spiral sculpture. Cylichna dertocrassa (Sacco, 1896), also from the late Miocene of Italy, has a broader shell and strong spiral sculpture covering the entire last whorl.

Distribution – Early Miocene: northeastern Atlantic (Aquitanian and Burdigalian): Aquitaine Basin, (Peyrot, 1932). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, (Peyrot, 1932); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Berger, 1953), Romania (Berger, 1953); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Dolfuss *et al.*, 1903); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896d).

Cylichna subcylindrica (d'Orbigny, 1852) Plate 52, fig. 19

- 1827 Bulla cylindroides Desh. Grateloup, p. 9 [non Cylichna cylindroides (Deshayes, 1824)].
- 1837 Bulla cylindrica Bruguière Grateloup, p. 425, pl.3, figs 39, 40.
- 1847 *Bulla cylindrica* Bruguière Grateloup, pl. 2, figs 39, 40.
- *1852 Bulla subcylindrica d'Orbigny, p. 95 (nom nov. pro Bulla cylindroides Desh. in Grateloup, 1847; non Deshayes, 1824).
- 1856 Bulla Brocchii Micht. Hörnes, p. 622, pl. 50, fig.
 6 [non Atys brocchii (Michelotti, 1847)].
- 1932 Bullinella pseudoconvoluta var. subcylindrica d'Orbigny – Peyrot, p. 184, no. 1393, pl. 13, figs 21-23.
- 1954 Bullinella pseudoconvoluta subcylindrica d'Orb. – Csepreghy-Meznerics, p. 59, pl. 8, fig. 6.
- 1963 *Cylichna (Cylichna) cylindrica* (Penn.) Steininger, p. 57, pl. 12, fig. 17 [*non Cylichna cylindracea* (Pennant, 1777)].
- 1966 *Cylichna cylindracea subcylindrica* Orbigny, 1852 – Strausz, p. 479, pl. 74, fig. 33.
- 1970 Cylichna convoluta (Brocchi) Bałuk, p. 119, pl. 14, fig. 3 (non Borcchi, 1814).
- 1984a *Cylichna* (*Cylichna*) *subcylindrica* (d'Orbigny, 1852) A.W. Janssen, p. 372, pl. 19, fig. 3.
- 2002 *Cylichna cylindracea subcylindrica* (d'Orbigny, 1852) Harzhauser, p. 126, pl. 11, figs 20-21.
- 2007 Cylichna (Cylichna) subcylindrica (d'Orbigny, 1852) Wienrich, p. 775, pl. 133, fig. 9, pl. 171, fig. 5.
- non 1965 Retusa (Cylichnina) subcylindrica (Brown, 1827) – van Regteren Altena et al., p. 48, pl. 21, fig. 206 [non Volvaria subcylindrica Brown, 1827 = Cylichnina umbilicata (Montagu, 1803)].

Dimensions and material – Maximum height 4.5 mm. Locality 17: JvdV/2, RGM 776 927/1 (ex JvdV collection), RGM 783 967/3.

Discussion – Cylichna subcylindrica (d'Orbigny, 1852) is characterised by its small very cylindrical shell, adapically the outer lip hardly rises above the apex, and the last whorl bears very fine but distinct, wide-set spiral grooves. In shape it is very similar to the Atlantic Aquitanian to Serravallian species *Cylichna pseudoconvoluta* (d'Orbigny, 1852), from the Aquitaine and Loire basins of France, but in *C. pseudoconvoluta* the last whorl is totally smooth, without spiral sculpture. The specimen illustrated by Hörnes (1856, pl. 50, fig. 6) may represent this species. It is certainly not *Atys brocchii* (Michelotti, 1847), which is a much larger and less cylindrical species with more prominent spiral sculpture.

Distribution – **Early Miocene**: northeastern Atlantic (Burdigalian): Aquitaine Basin, (Peyrot, 1932); Paratethys (Burdigalian): Austria, (Steininger, 1963; Harzhauser, 2002).

Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Germany (Wienrich, 2007); Netherlands (A.W. Janssen, 1984a). Middle Miocene: northeastern Atlantic (Serravallian): Aquitaine Basin, (Peyrot, 1932); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856), Hungary (Csepreghy-Meznerics, 1954; Strausz, 1966), Poland (Bałuk, 1970); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Roxania Leach in Gray, 1847

Type species – Bulla cranchii Fleming, 1828 (= *Bulla utriculus* Brocchi, 1814), by monotypy. Recent, Europe.

Roxania utriculus (Brocchi, 1814)

Plate 53, figs 1, 2

- 1814 Bulla striata Bruguiere Brocchi, p. 276, pl. 1, fig. 6 (non B. striata Bruguière, 1792).
- *1814 Bulla utriculus nob., Brocchi, p. 633.
- 1843 Bulla utricula Br. Nyst, p. 457, pl. 39, fig. 9.
- 1896d Roxania utriculus (Br.) Sacco, p. 45, pl. 3, figs 127-129.
- 1904 *Roxania utriculus* Brocchi Dollfus *et al.*, p. 22, pl. 36, fig. 15.
- 1907 Atys utriculus Broc. Ravn, p. 367, pl. 8, fig. 13.
- 1907 Roxania utriculus Brocchi Almera, p. 207, pl. 15, fig. 28.
- 1910 *Roxania utriculus* Br. Cerulli-Irelli, p. 36, pl. 4, figs 8, 9.
- 1936 *Sabatia utricula* Br. Bogsch, p. 82, pl. 3, figs 43, 44.
- 1952a Sabatia (Damoniella) utricula Brocchi Glibert, p. 397, pl. 15, fig. 9.
- 1952b Sabatia (Damoniella) utricula Brocchi 1814 Glibert, p. 145, pl. 10, fig. 16.
- 1856 Bulla utricula Brocc. Hörnes, p. 618 (partim) [non pl. 50, fig. 2 = Sabatia callifera (Boettger, 1907)].
- 1953 *Roxania (Roxania) utriculus utriculus* (Brocchi) Berger, p. 111, pl. 18, figs 75, 76.
- 1955 Sabatia (Damoniella) utriculus (Brocchi 1814) Rossi Ronchetti, p. 337, fig. 182.
- 1958 Roxania utriculus (Brocchi) Sorgenfrei, p. 350, pl. 76, fig. 260.
- 1963 Roxania (Roxania) utriculus (Br.) Venzo & Pelosio, p. 137, pl. 37, fig. 24.
- 1964 *Roxania utriculus* (Brocchi 1814) Anderson, p. 334, pl. 51, fig. 301.
- 1965 *Roxania utriculus* (Brocchi 1814) van Regteren Altena *et al.*, p. 48, pl. 22, fig. 209.
- 1966 *Sabatia utriculus* Brocchi, 1814 Strausz, p. 480, pl. 74, figs 36, 37.
- 1972a Roxania utriculus (Brocchi 1814) Nordsieck, p. 123, fig. 214.
- 1975 Roxania (Roxania) utriculus (Brocchi) Fekih, p. 145, pl. 42, fig. 11.
- 1978 Bulla utriculus Brocchi, 1814 Pinna & Spezia, p. 134, pl. 15, fig. 2.

- 1982c *Roxania utriculus* (Brocchi 1814) Martinell, p. 231, pl. 1, figs 24, 25.
- 1984a Roxania (Roxania) utriculus (Brocchi, 1814) A.W. Janssen, p. 373, pl. 19, fig. 2.
- 1988 Roxania utriculus (Brocchi, 1814) Thompson, p. 48, fig. 15.
- 1989 *Roxania utriculus* (Brocchi, 1814) Moths, p. 112, pl. 22, fig. 117.
- 1992 *Roxania (Roxania) utriculus* (Brocchi, 1814) Cavallo & Repetto, p. 168, fig. 487.
- 1997b *Roxania* (*R.*) *utriculus* (Brocchi, 1814) Marquet, p. 115, pl. 11, fig. 9.
- 1998a *Roxania* (*R.*) *utriculus* (Brocchi, 1814) Marquet, p. 219, fig. 192.
- 2001 *Roxania utriculus* (Brocchi, 1814) Silva, p. 589, pl. 27, figs 9, 10.
- 2005 Roxania (Roxania) utriculus (Brocchi, 1814) Schnetler, p. 164, pl. 9, fig. 20.
- 2007 *Roxania utriculus* (Brocchi, 1814) Wienrich, p. 776, pl. 171, figs 6, 7.
- 2008 Roxania (Roxania) utriculus (Brocchi, 1814) Moths & Tüxen, p. 124, pl. 18, fig. 2.
- 2008 Roxania utriculus (Brocchi, 1814) Chirli & Richard, p. 82, pl. 16, figs 9, 10.
- 2010 *Roxania utriculus* (Brocchi, 1814) Moths *et al.*, p. 91, pl. 25, fig. 9.
- 2011 *Roxania utriculus* (Brocchi, 1814) Landau *et al.*, p. 43, pl. 23, fig. 12.
- 2013 *Roxania utriculus* (Brocchi, 1814) Chirli, p. 41, pl. 10, figs 12-16.
- non 1938 Roxania utriculus Brocchi Peyrot, p. 315 [= Roxania labrella (Férussac, 1822)].

Dimensions and material – Maximum height 5.8 mm. Locality 13: NHMW 1847/0058/147/1; locality 17: NHMW 1847/0058/1559/1.

Discussion - Roxania utriculus (Brocchi, 1814) typically has spiral sculpture on the last adult whorl restricted to the extremities, with the central portion of the whorl smooth. All Miocene to Recent shells examined have this type of sculpture. However, some Miocene specimens have spiral sculpture extending across the entire last whorl. These shells from the Atlantic Burdigalian to Serravallian of the Aquitaine Basin were described as Roxania subutriculus (d'Orbigny, 1852) (see Peyrot, 1932, p. 193, no. 1401, pl. 12, figs 43-48) and those from the Burdigalian Colli Torinesi of Italy were named Roxania utriculus var. totornata Sacco, 1896. These highly sculptured shells are also present in the middle Miocene Paratethys (Berger, 1953, pl. 18, fig. 77). It is possible that these are just a form of R. utriculus, but as we have not seen striate specimens in the Turkish deposits, nor are they present in the Atlantic late Miocene Cacela assemblage, we consider them to represent a distinct species.

Roxania labrella (Férussac, 1822) from the Atlantic Langhian of the Loire Basin, France, differs from R. *utriculus* in having a more slender shell, with no apical perforation, and with an obliquely truncated apex instead

of a rounded one as in *R. utriculus*. The genus *Sabatia* (Bellardi, 1877) (type species *Sabatia uniplicata* Bellardi, 1877, by monotypy) has often been synonymised with *Roxania* Leach *in* Gray, 1847. We retain this genus for species with a fold of thickened callus pad on the parietal callus. Therefore, *S. uniplicata* from the late Miocene and Pliocene of Italy and *Sabatia callifera* (Boettger, 1907) from the middle Miocene Paratethys differ from *R. utriculus* by the thick columellar callus and prominent columellar fold characteristic of the genus.

Distribution - Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Denmark (Ravn, 1907; Moths & Tüxen, 2008), Germany (Sorgenfrei, 1958; Anderson, 1964; Moths, 1989; Wienrich, 2007; Moths et al., 2010), Netherlands (Nordsieck, 1972a; A.W. Janssen, 1984a). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Berger, 1953), Hungary (Bogsch, 1936; Strausz, 1966); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: North Sea Basin (Tortonian): Denmark (Schnetler, 2005); northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Dolfuss et al., 1904); Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, Italy (Sacco, 1896d; Venzo & Pelosio, 1963). Early Pliocene: Belgium (Marquet, 1997b, 1998a); northeastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); western Mediterranean, Estepona Basin (NHMW collection), northeastern Spain (Almera, 1907; Martinell, 1982c), Roussillon Basin, France (Chirli & Richard, 2008), Tunisia (Fekih, 1975). Earlylate Pliocene: North Sea Basin, Belgium (Nyst, 1843; Marquet, 1997b, 1998a); northeastern Atlantic, Mondego Basin, central west Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1896d; Cavallo & Repetto, 1992; Chirli, 2013). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1910). Recent: northeastern Atlantic, Shetlands, Hebrides to Canaries and the Mediterranean (Thompson, 1988).

Genus Acteocina Gray, 1847

Type species – Acteon wetherelli Lea, 1833, by original designation. Miocene, eastern United States.

Acteocina lajonkaireana (de Basterot, 1825)

Plate 53, figs 3, 4; Plate 77, fig. 9

- *1825 Bullina Lajonkaireana de Basterot, p. 22, pl. 1, fig. 25.
- 1830 Alicula volhynica Eichwald, p. 215.
- 1831 *Bulla clandestina* Dubois de Montpéreux, p. 49, pl. 1, figs 19-21.
- 1831 Bulla terebellata Dubois de Montpéreux, p. 50, pl. 1, figs 8-10.
- 1837 Bullina lajonkaireana Bast. Grateloup, p. 428, pl. 3, figs 45, 46.
- 1846 Bullina lajonkaireana de Bast. Grateloup, pl. 2, figs 45, 46.

- 1852 Bullina volhynica mihi, Eichwald, pl. 11, fig. 18.
- 1853 Bullina volhynica mihi, Eichwald, p. 308.
- 1856 Bulla Lajonkaireana Bast. Hörnes, p. 634 (partim, pl. 50, fig 9c only) [figs 9a, b = Acteocina okeni (Eichwald, 1853)].
- 1862 Bullina exerta Deshayes, p. 622, pl. 39, figs 30, 31.
- 1889 Tornatina Lajonkaireana Bast. Benoist, p. 79, pl. 5, fig. 8.
- 1895a *Tornatina Lajonkaireana* (Bast.) Cossmann, p. 81, pl. 3, figs 26, 27.
- 1896d *Tornatina lajonkaireana* (Basterot) Sacco, p. 38, pl. 3, figs 58, 59.
- 1903 *Tornatina volhynensis* Eichwald Dollfus *et al.*, p. 24, pl. 36, fig. 20.
- 1928 *Tornatina lajonkaireana* Bast. Friedberg, p. 542, pl. 35, fig. 16.
- 1928 *Tornatina lajonkaireana* var. *volhynica* Eichw. Friedberg, p. 543, pl. 35, fig. 17.
- 1932 *Tornatina Lajonkaireana* (Basterot) Peyrot, no. 1412, pl. 12, figs 1, 2, 8, 10, 11.
- Bulla lajonkaireana Bast. Kolesnikov, p. 285, pl. 33, figs 1-4.
- 1940 Bulla lajonkaireana Bast. Simionenscu & Barbu, p. 124, pl. 6, figs 54-56.
- 1952a Acteocina lajonkaireana Basterot, 1825 Glibert, p. 396, pl. 15, fig. 6.
- 1953 Acteocina lajonkaireana lajonkaireana (Basterot) – Berger, p. 104, pl. 17, figs 54-61.
- 1954 Tornatina lajonkaireana Bast. Strausz, p. 116, pl. 6, fig. 143.
- 1954 *Acteocina lajonkaireana lajonkaireana* (Basterot) – Papp, p. 59, pl. 10, figs 4-7.
- 1958 Acteocina Lajonkaireana (Basterot) Sorgenfrei, p. 348, pl. 75, fig. 258.
- 1962 Acteocina lajonkaireana Basterot Strausz, p. 153, pl. 74, figs 25, 26.
- Acteocina lajonkaireana Basterot, 1825 Strausz,
 p. 472, text-fig. 211a, pl. 74, figs 25, 26.
- 1974 *Acteocina lajonkaireana lajonkaireana* (Basterot) – Papp, p. 354, pl. 11, figs 3-7.
- 2001a Acteocina lajonkaireana (Basterot, 1825) Lozouet et al., p. 80, pl. 37, fig. 5.
- 2002 Acteocina lajonkaireana Basterot, 1825 Harzhauser, p. 127, pl. 11, fig. 18.
- 2010 Acteocina lajonkaireana (Basterot, 1825) Moths et al., p. 91, pl. 25, fig. 8, pl. 46, fig. 11.
- 2012 Acteocina lajonkaireana (Basterot 1825) d'Amico et al., p. 172, pl. 3, fig. 39.
- non 1848 Bulla Lajonkaireana Bast. S.V. Wood, p. 178, pl. 21, fig. 5 [? = Retusa obtusa (Montagu, 1803].
- non 1903 Tornatina lajonkairei [sic] Basterot Dollfus et al., p. 23, pl. 36, fig. 19 [= Acteocina okeni (Eichwald, 1853)].
- non 1921 Utriculus Lajonkaireanus (Basterot) Harmer, p. 796, pl. 63, fig. 3 [? = Retusa obtusa (Montagu, 1803].

Dimensions and material - Maximum height 3.0 mm.

Locality 17: NHMW 1847/0058/1558/2, JvdV/6, RGM 776 924/1 (ex JvdV collection), RGM 784 028/3, RGM 783 969/7, YI 427/3.

Discussion – Acteocina lajonkaireana (de Basterot, 1825) differs from the restricted Sarmatian species *Acteocina okeni* (Eichwald, 1853), with which it is often found in the Paratethys, by having a more elongate 'terebelliform' shell, by having more deeply canaliculate sutures, by having an almost straight outer lip, whereas the outer lip in *A. okeni* is pinched mid-length, by having a fold on the columella that is absent in *A. okeni*, and by the character of the protoconch, which is mamillate in *A. okeni* and clearly heterostrophic in *A. lajonkaireana*.

Distribution - Early Miocene: northeastern Atlantic (Aquitanian-Burdigalian): Aquitaine Basin, France (Peyrot, 1932; Glibert, 1962b; Lozouet et al., 2001a); Paratethys (Burdigalian): Austria, (Harzhauser, 2002). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Germany (Sorgenfrei, 1958; Moths et al., 2010). Middle Miocene: northeastern Atlantic (Langhian-Serravallian): Aquitaine Basin, France (Peyrot, 1932; Glibert, 1962b), (Langhian): Loire Basin, France (Glibert, 1952a; Glibert, 1962b); Proto-Mediterranean Sea (Burdigalian-Langhian): Colli Torinesi, Italy (Sacco, 1896d); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Berger, 1953; Papp, 1954; Glibert, 1962b), Poland (Friedberg, 1928), Hungary (Strausz, 1954, 1962, 1966), (Sarmatian): Austria (Harzhauser & Kowalke, 2002), Slovakia (Švagrovský, 1971), Romania (Simionescu & Barbu, 1940), Ukraine (Kolesnikov, 1935); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Dolfuss et al., 1903); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896d; d'Amico et al., 2012).

Acteocina voeslauensis (Berger, 1953)

Plate 53, fig. 8; Plate 77, fig. 10

- *1953 *Retusa (Retusa) mammillata voeslauensis* Berger, p. 94, pl. 16, figs 26, 27.
- 1953 Retusa (Retusa) mammillata regulbensis [sic] (J. Adams) Berger, p. 95, pl. 16, figs 28, 29 [non Retusa obtusa Montagu, 1803)].

Dimensions and material – Maximum height 3.2 mm. Localities 2 & 3: JvdV/1; locality 17: NHMW 1847/0058/1445/9, JvdV/5, RGM 776 931/1 (ex JvdV collection), RGM 776 920/3 (ex JvdV collection), RGM 783 968/24, YI 459/4.

Discussion – Berger (1953) considered *Acteocina voeslauensis* to be a subspecies of the extant European species *Retusa mammillata* (Philippi, 1836) from which it differs in its raised spire and its strongly convex spire whorls. However, the apical morphology of the shell and

the orientation of the protoconch of *A. voeslauensis* are characteristics of the genus *Acteocina* Gray, 1847 (Ángel Valdés personal communication, 2013).

The largest specimens, with very high spires, were separated by Berger (1953) as the subspecies *Retusa mammillata regulbensis* [*sic*] (Adams). This latter name is actually *Bulla regulbiensis* Kanmacher, 1798, a suppressed name according to ICZN Opinion 0.568 (ICZN 1987, p. 283) and is a subjective synonym of *Retusa obtusa* (Montagu, 1803). As both forms co-occur syntopically in the middle Miocene Badenian of the Vienna Basin, as already stated by Berger (1953), we consider them both to represent variants of *Acteocina voeslauensis* (Berger, 1953). This species differs from the middle Miocene Paratethyan species *Retusa promamillata* [*sic*] Boettger, 1907 by having a taller raised spire and slightly more elongate outlines.

Distribution – **Middle Miocene:** Paratethys (Langhian-Serravallian): Austria (Berger, 1953); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Genus Scaphander de Montfort, 1810

Type species – Bulla lignaria Linné, 1767, by original designation. Recent, European.

Scaphander dertonensis (Sacco, 1896)

Plate 53, figs 5, 6

- 1856 Bulla lignaria Linn. Hörnes, p. 616, pl. 50, fig. 1
 [non Scaphander lignarius (Linnaeus, 1758)].
- *1896d Scaphander lignarius var. dertonensis Sacc., Sacco, p. 44, pl. 3, figs 102, 103.
- Scaphander lignarius L. Friedberg, p. 546, pl.
 36, figs 3-4 [non Scaphander lignarius (Linnaeus, 1758)].
- 1932 *Scaphander lignarius* mut. *helvetica* Peyrot, p. 204, no. 1411, pl. 12, figs 25, 26.
- 1952a *Scaphander dertonensis* Sacco, 1897 [*sic*] Glibert, p. 398, pl. 13, fig. 11.
- Scaphander (Scaphander) lignarius lignarius (Linnaeus) – Berger, p. 113, pl. 21, figs 104-105 [non Scaphander lignarius (Linnaeus, 1758)].
- Scaphander lignarius L. Strausz, p. 38, 82, 116,
 pl. 9, fig. 166 [non Scaphander lignarius (Linnaeus, 1758)].
- Scaphander lignarius Linnaeus, 1766 Miosescu,
 p. 176, pl. 15, fig. 7 [non Scaphander lignarius (Linnaeus, 1758)].
- Scaphander lignarius Linné, 1766 Strausz, p. 477, pl. 75, figs 7, 8 [non Scaphander lignarius (Linnaeus, 1758)].
- 1970 Scaphander lignarius Linnaeus Bałuk, p. 119, pl. 14, figs 1, 2 [non Scaphander lignarius (Linnaeus, 1758)].
- 1998 Scaphander (Scaphander) lignarius lignarius (Linné) – Schultz, p. 76, pl. 31, fig. 10 [non

Scaphander lignarius (Linnaeus, 1758)].

Dimensions and material – Maximum height 53.1 mm. Locality 17: NHMW 1847/0058/1474/1, 1847/0058/1657/1, 1847/0058/1475/4, JvdV/4.

Discussion – We agree with Sacco (1896d) and Glibert (1952a) in separating the middle Miocene *Scaphander* species usually ascribed to the Pliocene-Recent species *S. lignarius* (Linnaeus, 1758) as a distinct species, *Scaphander dertonensis* (Sacco, 1896). Middle Miocene shells differ from Recent ones in being thicker-shelled, in having a more conical shape, the aperture is narrower and less expanded anteriorly, the spiral grooves on the last whorl are more widely spaced, the outer lip rises further above the apex adapically, and the columellar callus is a little thicker. The largest shells from Seyithasan are similar in size to the largest recorded by Glibert (1952a) from the middle Miocene Langhian of the Loire Basin.

Scaphander tarbelliana (Grateloup, 1837) (= S. grateloupi Michelotti, 1847, a junior subjective synonym of S. tarbelliana) from the Atlantic early Miocene Aquitanian and Burdigalian of the Aquitaine Basin, France and late Burdigalian-Langhian of the North Sea Basin differs from S. dertonensis in being smaller and thinner-shelled, the spiral grooves on the last whorl are much more closeset and the aperture does not rise so far above the apex adapically. The shells from the Atlantic late Miocene Tortonian of Portugal illustrated by Dollfus et al. (1903) as S. lignarius are neither the Recent species nor S. dertonensis. Numerous specimens from Cacela, Algarve, Portugal in the NHMW collection represent a fairly large but thin-shelled species. The outer lip does not rise as far above the apex as in S. dertonensis, and the aperture is far wider, especially anteriorly, where it is greatly expanded in the Portuguese shells. Moreover, the spiral sculpture is obsolete, or almost so, whereas the fine spiral grooving is well-developed in S. tarbelliana, S. dertonensis and S. lignarius.

Distribution – Middle Miocene: northeastern Atlantic (Langhian and Serravallian): Aquitaine Basin, France (Peyrot, 1932), (Langhian): Loire Basin, France (Glibert, 1952a); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Berger, 1953; Schultz, 1998), Poland (Friedberg, 1928; Bałuk, 1970), Hungary (Strausz, 1954, 1962, 1966), Romania (Moisescu, 1955); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (Fischer, 1866). Late Miocene: Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896d).

Family Retusidae Thiele, 1925b Genus *Retusa* Brown, 1827

Type species – Bulla obtusa Montagu, 1803, by subsequent designation (Iredale, 1915). Recent, Europe.

Retusa decussata Sacco, 1896

Plate 53, fig. 7

- *1896d *Retusa decussata* (Bon.) Sacco, p. 40, pl. 3, figs 83-89.
- 1975 Retusa (Retusa) decussata (Bonelli) Fekih, p. 141, pl. 40, fig. 10.
- 1984 *Retusa decussata* Sacco, 1897 [*sic*] Ferrero Mortara *et al.*, p. 285, pl. 52, figs 3, 5.
- 1992 Retusa decussata Sacco, 1897 [sic], Bonelli m.s. Cavallo & Repetto, p. 166, fig. 473.
- 2010 Retusa decussata Sacco, 1897 [sic], Bonelli m.s.
 Sosso & dell'Angelo, p. 53, unnumbered fig. p. 68, middle row left.
- 2013 *Retusa decussata* Sacco, 1897 [*sic*] Chirli, p. 47, pl. 11, figs 1-6.

Dimensions and material – Maximum height 2.8 mm. Locality 6: JvdV/4: locality 17: JvdV/1, RGM 776 930/1 (ex JvdV collection), RGM 783 941/2.

Discussion – We tentatively ascribe the Turkish shells to *Retusa decussata* Sacco, 1896. They are smaller than most Pliocene specimens (about 4 mm; Sosso & dell'Angelo, 2010) and the characteristic axial folds at the apex are less well-developed. It is possible that the Turkish shells are subadult.

Retusa perstriata Cerulli-Irelli, 1910 was described from the Mediterranean early Pleistocene. It is difficult to assess this species, as only one specimen was figured and we have found no further specimens illustrated. The specimen figured fom Monte Mario in Italy is smaller and broader than usual for *R. decussata*, the last whorl has weakly convex sides rather than straight ones or with a slight convexity mid-whorl as in *R. decussata*, and it lacks the characterisitic apical folds.

Distribution – Middle Miocene: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Early Pliocene: western Mediterranean, Estepona Basin (NHMW collection), Tunisia (Fekih, 1975). Early-late Pliocene: central Mediterranean, Italy (Sacco, 1896d; Ferrero Mortara *et al.*, 1984; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010; Chirli, 2013).

Retusa cf. subangystoma (d'Orbigny, 1852)

Plate 53, fig. 12

- cf. 1852 *Bulla subangystoma* d'Orb, d'Orbigny, p. 95 [*nom nov. pro Bulla truncatula* Brug. in Grateloup, 1847; *non Retusa truncatula* (Bruguière, 1792)].
- cf. 1953 Retusa (Cylichnina) subangystoma (Orbigny) Berger, p. 100, pl. 19, fig. 91.

Dimensions and material – Maximum height 11.8 mm. Locality 13: NHMW 1847/0058/1476/1, NHMW 1847/0058/1446/11, YI 445/8.

Discussion - This species, found in Turkey only in the

Akpinar deposits, attains quite a large height. The shell is relatively solid, cylindrical, and swollen abapically. The apical perforation is small and deep, with the adapical point of the outer lip not surpassing the apex greatly. The aperture is markedly wider in the lower half, the outer lip is flared abapically, and there is a small fold on the columella. Sculpture is not visible without magnification, and even then is extremely faint, restricted to a few very fine grooves on the base.

The shells from Turkey seem to be the same as that illustrated by Berger (1953, pl. 19, fig. 91) from the Paratethys as Retusa (Cylichnina) subangystoma (d'Orbigny, 1852). In this shell the columellar fold is clearly developed, but we are not convinced these Paratethyan and Proto-Mediterranean shells are conspecific with those illustrated from the Atlantic Miocene of France by Peyrot (1932, pl. 12, figs 34-35) and Glibert (1952a, pl. 15, fig. 5). These specimens firstly are much smaller (maximum height 4.0 mm) and more thin-shelled, and secondly show no sign of a fold on the columella. Retusa subangystoma has also been widely reported from the North Sea Basin Miocene, however, these records also require revision. The shell illustrated by Wienrich (2007, pl. 134, figs 3-4, pl. 172, fig. 5) from the Miocene of Germany is similar in size and thickness to the French shells, but seems to have the adapical tip of the outer lip raised further above the apex than in the French shells. The drawing of a shell illustrated by A.W. Janssen (1984a, pl. 19, fig. 9) from the Netherlands is again small, but seems to have a small columellar fold like the Turkish shells. A revision of this group is required.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper).

Retusa umbilicata (Montagu, 1803)

Plate 53, fig. 13; Plate 78, fig. 1

- *1803 *Bulla umbilicata* Montagu, p. 222, pl. 7, fig. 4 (ICZN opinion 549: validated under the plenary powers; *non B. umbilicata* Röding, 1798, ICZN opinion 549: suppressed under the plenary powers).
 - 1827 Volvaria subcylindrica Brown's MSS, Brown, pl. 38, figs 19, 20.
 - 1846 *Cylichna strigella* Lovén, p. 10.
 - 1896d *Cylichnina umbilicata* (Montg.) Sacco, p. 50, pl. 4, fig. 12.
- 1910 Bullinella (Cylichnina) umbilicata Mtg. Cerulli-Irelli, p. 38, pl. 4, figs 14-16.
- ? 1923 Utriculus truncatulus (Bruguière) Harmer, p. 794, pl. 63, fig. 1 [non Retusa truncatula (Bruguière, 1792)].
- Bullinella (Cylichnina) umbilicata Mtg. Patrini,
 p. 36 (partim, pl. 3, fig. 15 only) [not fig. 14 = Retusa truncatula (Bruguière, 1792)].
- 1953 *Retusa* (*Cylichnina*) *umbilicata* (Montagu) Berger, p. 17, figs 40-44.
- ?1960 Retusa (Retusa) truncatula (Brugière) [sic] Kojumdgieva & Strachimirov, p. 221, pl. 52, figs

7, 8 [non Retusa truncatula (Bruguière, 1792)].

- 1963 Retusa (Cylichnina) umbilicata (Montg.) Venzo & Pelosio, p. 136, pl. 41, figs 43, 44.
- 1975 Cylichna (Cylichnina) umbilicata Montagu Fekih, p. 144, pl. 42, fig. 9.
- 1983 Retusa (Cylichnina) subcylindrica (Brown) Aimassi & Ferrero Mortara, p. 187, pl. 2, fig. 4.
- 1988 Retusa umbilicata (Montagu, 1803) Thompson, p. 36, fig. 9.
- 1992 Cylichnina umbilicata (Montagu, 1803) Cavallo & Repetto, p. 166, fig. 475.
- 1993 *Retusa (Cylichnina) umbilicata* (Montagu, 1803) – Iljina, p. 125, pl. 15, figs 25, 26.
- 2001 *Retusa (Cylichnina) umbilicata* (Montagu, 1803) – Silva, p. 578, pl. 27, figs 11, 12.
- 2011 *Retusa umbilicata* (Montagu, 1803) Landau *et al.*, p. 43, pl. 23, fig. 16.
- 2013 *Cylichnina umbilicata* (Montagu, 1803) Chirli, p. 53, pl. 12, figs 7-12.

Dimensions and material – Maximum height 3.3 mm. Localities 2 & 3: JvdV/6; locality 6: RGM 783 600/1; locality 17: JvdV/20, RGM 776 929/1 (ex JvdV collection), RGM 784 006/2, RGM 783 965/30, YI 458/3.

Discussion – The shells recorded here as *Retusa umbilicata* (Montagu, 1803) differ from the Turkish specimens of *Retusa* cf. *subangystoma* (d'Orbigny, 1852) in being distinctly smaller in size, and in having a more cylindrical outline and a more excavated columella.

Distribution - Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Berger, 1953), ?Bulgaria (Kojumdgieva & Strachimirov, 1960), eastern Paratethys (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: central Mediterranean (Messinian), Po Basin, Italy (Venzo & Pelosio, 1963). Early Pliocene: North Sea Basin, England (Harmer, 1923), northeastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); western Mediterranean, Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, central west Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1896d; Patrini, 1930; Aimassi & Ferrero-Mortara, 1983; Cavallo & Repetto, 1992; Chirli, 2013). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1910). Recent: eastern Atlantic, Norway, Baltic Sea to Mediterranean and Madeira, West Africa and the Cape of Good Hope (Thompson, 1988).

Retusa truncatula (Bruguière, 1792) Plate 77, fig. 11

- *1792 Bulla truncatula Bruguière, p. 377.
- 1800 Bulla truncata J. Adams, p. 1, pl. 1, figs 1, 2.
- 1848 Bulla truncata Adams S.V. Wood, p. 176, pl. 21, fig. 3.
- 1856 Bulla truncata Adams Hörnes, p. 621, pl. 50, fig.
 5.

- 1890 Coleophysis effusa Monterosato, p. 188.
- 1896d *Cylichna truncatula* (Brug.) Sacco, p. 40, pl. 3, figs 78, 79.
- 1896d *Cylichna truncatula* var. *clavata* (Bon.) Sacco, p. 40, pl. 3, figs 80-82.
- 1910 *Tornatina (Retusa) truncatula* Brug. Cerulli-Irelli, p. 34, pl. 3, figs 69-72.
- 1910 *Tornatina (Retusa) truncatula* var. *clavata* Bon. Cerulli-Irelli, p. 34, pl. 3, fig. 73.
- 1928 Tornatina truncatula Brug. Friedberg, p. 544, pl. 36, figs 1, 2.
- Bullinella (Cylichnina) umbilicata Mtg. Patrini,
 p. 36 (partim, pl. 3, fig. 14 only) [non Cylichnina umbilicata (Montagu, 1803)].
- 1932 *Tornatina (Retusa) truncatula* Bruguière Peyrot, p. 209, no. 1414, pl. 12, figs 52, 53.
- 1938 Tornatina (Retusa) pseudotruncatula Peyrot, p. 317.
- 1952a Retusa (Retusa) truncatula Bruguière, 1792 Glibert, p. 393, pl. 15, fig. 3.
- 1953 *Retusa (Retusa) truncatula truncatula* (Bruguière) – Berger, p. 88, pl. 16, figs 8-14.
- 1953 Retusa (Retusa) truncatula truncata (J. Adams) Berger, p. 90, pl. 16, figs 17, 18.
- 1954 *Retusa truncatula* Brug. Strausz, p. 38, 82, 116, pl. 9, fig. 168.
- 1966 *Retusa truncatula* Bruguière, 1792 Strausz, p. 474, pl. 74, figs 27-29.
- 1963 Retusa (Retusa) truncatula (Brugn.) [sic] Venzo & Pelosio, p. 136, pl. 41, fig. 42.
- 1970 *Retusa truncatula* (Bruguière) Bałuk, p. 119, pl. 14, fig. 7.
- 1975 Retusa (Retusa) truncatula (Bruguières) [sic] Fekih, p. 141, pl. 34, fig. 15.
- 1982c Retusa (Retusa) truncatula (Bruguière, 1789 [sic]) – Martinell, p. 232, pl. 1, figs 28-29.
- 1983 *Retusa (Retusa) truncatula* (Bruguière) Aimassi & Ferrero Mortara, p. 187, pl. 2, fig. 1.
- 1984a *Retusa truncatula* (Bruguière) Martinell & Domènech, p. 7, pl. 2, fig. 5.
- 1985 Retusa (Retusa) truncatula (Bruguière) Atanacković, p. 190, pl. 42, figs 13, 14.
- 1988 Retusa truncatula (Bruguière, 1792) Thompson, p. 34, fig. 8.
- 1990 *Retusa (Retusa) truncatula* (Bruguière) Brambilla *et al.*, p. 42, pl. 10, fig. 2.
- 1992 Retusa truncatula (Bruguière, 1792) Cavallo & Repetto, p. 166, fig. 474.
- 1993 *Retusa (Retusa) truncatula* (Bruguière, 1792) Iljina, p. 124, pl. 15, figs 19-24.
- 2001 *Retusa truncatula* (Bruguière) Oliverio & Tringali, p. 131, figs 31-34, 52.
- 2001 *Retusa (Retusa) truncatula* (Bruguière, 1792) Silva, p. 577, pl. 27, figs 5, 7, 8.
- 2002 *Retusa truncatula* (Bruguière, 1792) Harzhauser, p. 126, pl. 11, fig. 19.
- 2011 *Retusa truncatula* (Bruguière, 1792) Landau *et al.*, p. 43, pl. 23, fig. 16.
- 2012 *Retusa truncatula* (Bruguière 1792) d'Amico *et al.*, p. 171, pl. 3, fig. 38.

- 2013 *Retusa truncatula* (Bruguière 1792) Chirli, p. 49, pl. 11, figs 11-18.
- non 1923 Utriculus truncatulus (Bruguière) Harmer, p. 794, pl. 63, fig. 1 [? = Cylichnina umbilicata (Montagu, 1803)].
- non 1960 Retusa (Retusa) truncatula (Brugière) [sic] Kojumdgieva & Strachimirov, p. 221, pl. 52, figs 7-8 [? = Cylichnina umbilicata (Montagu, 1803)].

Dimensions and material – Maximum height 2.00 mm. Localities 2 & 3: JvdV/5; locality 6: JvdV/1; localities 7 & 8: JvdV/4; locality 17: NHMW 1847/0058/1700/9, JvdV/18, RGM 784 009/2, RGM 783 925/50+, YI 438/4.

Discussion – *Discussion* – The shells recorded widely in the fossil literature as *Retusa truncatula* (Bruguière, 1792), represent either a species complex or an unusually long-lived and widely distributed species. The shell from Turkey illustrated here is somewhat squatter than most specimens identified as *R. truncatula*, but fits well within the range of forms figured by Berger (1953, figs 8-14) for Miocene shells and by Oliverio & Tringali (2001, figs 31-34) for Recent shells.

Two further closely similar European Recent species occur; *Retusa minutissima* (Monterosato, 1878) is very small, most specimens are about 2 mm in height, and has prominent axial ridges on the spire whorls; and *R. obtusa* (Montagu, 1803) has a shorter last whorl and the aperture attaches at three-quarters shell height, lower than in *R. mamillata* and *R. minutissima*.

The specimens figured by Kojumdgieva & Strachimirov (1960, pl. 52, figs 7-8) as *Retusa* (*Retusa*) truncatula do not have a truncated apex and the whorl sides are convex. These specimens are more likely to represent *Cylichnina umbilicata* (Montagu, 1803). Similarly, the specimen figured by Berger (1963) as *Retusa truncatula subtruncatula* (d'Orbigny, 1852) from the Badenian of the Vienna Basin is a different species. It is most probably also not conspecific with the early Miocene *Retusa subtruncatula*, which was based on an inadequate description (Peyrot, 1932).

Distribution - Early Miocene: Paratethys (Burdigalian): Austria, (Harzhauser, 2002). Middle Miocene: northeastern Atlantic (Langhian): Aquitaine Basin, France (Peyrot, 1932), (Langhian): Loire Basin, France (Peyrot, 1938; Glibert, 1952a); Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Berger, 1953), Poland (Friedberg, 1928; Bałuk, 1970), Hungary (Strausz, 1954, 1966), Bosnia (Atanackovič, 1985), eastern Paratethys (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian) Cacela Basin, Portugal (NHMW collection); Proto-Mediterranean Sea (Tortonian and Messinian) Po Basin, Italy (Sacco, 1896d; Venzo & Pelosio, 1963; d'Amico et al., 2012). Early Pliocene: North Sea Basin, England (Wood, 1848), northeastern Atlantic, Guadalquivir Basin, Spain (Landau et al., 2011); western Mediterranean, Estepona Basin, Spain (NHMW

collection), northeastern Spain (Martinell, 1982c; Martinell & Domènech, 1984a); central Mediterranean, Tunisia (Fekih, 1975). **Early-late Pliocene**: northeastern Atlantic, Mondego Basin, central west Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1896d; Patrini, 1930; Aimassi & Ferrero Mortara, 1983; Cavallo & Repetto, 1992; Chirli, 2013). **Early Pleistocene**: central Mediterranean, Italy (Cerulli-Irelli, 1910). **Early-late Pleistocene**: central Mediterranean, Italy (Brambilla *et al.*, 1990). **Recent**: northeastern Atlantic, British Isles, Norway, Baltic Sea to Canary Islands and Mediterranean (Thompson, 1988).

Genus Pyrunculus Pilsbry, 1895b

Type species – Bulla pyriformis A. Adams, 1850, by monotypy. Recent, China seas.

Pyrunculus elongatus (Eichwald, 1830)

Plate 53, figs 10, 11; Plate 77, fig. 12

- *1830 Bulla elongata Eichwald, p. 214.
- 1831 Bulla ovulata Broc. Dubois de Montpéreux, p. 446, pl. 1, figs 13, 14 (non Roxania ovulata Lamarck, 1804).
- 1837 Bulla conulus Desh. Grateloup, p. 415, pl. 3, figs
 4, 5 [non Cylichna conulus (Deshayes, 1824)].
- 1847 Bulla conulus Desh. Grateloup, pl. 2, figs 4, 5 [non Cylichna conulus (Deshayes, 1824)].
- 1852 Bulla elongata mihi, Eichwald, pl. 11, fig. 15.
- 1852 Bulla subconulus d'Orb., d'Orbigny, p. 95 (nom nov. pro Bulla conulus Desh. in Grateloup, 1847, non Deshayes, 1824).
- 1853 Bulla elongata mihi, Eichwald, p. 304.
- 1856 Bulla conulus Desh. Hörnes, p. 620, pl. 50, fig. 4 [non Cylichna conulus (Deshayes, 1824)].
- 1896d Cylichnina elongata (Eichw.) Sacco, p. 50, pl. 4, figs 13, 14.
- 1902 *Cylichnina parangistoma* Boettger, p. 180.
- 1903 Bullinella (Cylichnina) elongata Eichwald Dollfus et al., p. 23, pl. 36, fig. 17.
- Bullinella elongata Eichw. Friedberg, p. 543, pl. 36, fig. 6.
- 1932 Bullinella (Cylichnina) elongata Eichwald Peyrot, no. 1399, pl. 13, figs 53, 54.
- 1934 *Retusa (Cylichnina) parangistoma* (Boettger) Zilch, p. 277, pl. 22, fig. 18.
- 1952b *Retusa (Cylichnina) elongata* Eichwald Glibert, p. 143, pl. 10, fig. 18.
- 1953 *Retusa (Cylichnina) elongata* (Eichwald) Berger, p. 97, pl. 17, figs 33-35.
- 1956 *Retusa (Cylichna) elongata* Eichwald Csepreghy-Meznerics, p. 423, pl. 12, figs 15-18.
- 1956 *Retusa (Cylichnina) elongata* (Eichwald 1830) Rasmussen, p. 103, pl. 10, fig. 3.
- 1958 Retusa elongata (Eichwald) Sorgenfrei, p. 345, pl. 74, fig. 254.
- 1962 *Retusa (Cylichnina) elongata* Eichwald Strausz, p. 154, text-fig. 173a, pl. 74, figs 30, 31.

- 1962 *Retusa (Cylichnina) elongata parangistoma* Berger [*sic*] Strausz, p. 154, text-fig. 173c.
- 1964 *Retusa elongata* (Eichwald 1830) Anderson, p. 335, pl. 51, fig. 303.
- 1966 *Retusa* (*Cylichnina*) *elongata* Eichwald, (1830)
 1853 Strausz, p. 474, text-fig. 212a, pl. 74, figs 30, 31.
- 1966 Retusa (Cylichnina) elongata parangistoma Boettger, 1901 [sic] – Strausz, p. 475, text-fig. 212b.
- 1972a Retusa (Pyrunculus) elongata (Eichwald, 1830) Nordsieck, p. 124, pl. 32, fig. 217.
- 1984a Retusa (Cylichnina) elongata (Eichwald, 1830) A.W. Janssen, p. 378, pl. 19, figs 10-11.
- 1984 Pyrunculus elongatus (Eichwald, 1850 [sic]) –
 Švagrovský, pl. 3, fig. 7.
- 1989 Cylichnia [sic] elongata (v. Eichwald, 1830) Moths, p. 112, pl. 22, fig. 120.
- 1993 *Retusa (Cylichnina) elongata* (Eichwald, 1830) Iljina, p. 125, pl. 15, figs 29-31.
- ?2005 Retusa (Cylichnina) elongata elongata (Eichwald, 1830) – Schnetler, p. 130, pl. 9, fig. 23.
- 2007 *Retusa* (*Cylichnina*) *elongata* (Eichwald, 1830) Wienrich, p. 778, pl. 134, figs 1, 2, pl. 172, figs 3, 4.
- 2010 *Cylichnina elongata* (Eichwald, 1830) Moths *et al.*, p. 92, pl. 25, fig. 11.

Dimensions and material – Maximum height 3.6 mm. Locality 6: JvdV/3; locality 13: JvdV/3, localities 7 & 8: JvdV/30; locality 17: NHMW 1847/0058/1699/5; JvdV/18, RGM 776 934/1 (ex JvdV collection), RGM 776 935/1 (ex JvdV collection), RGM 784 000/2, RGM 783 966/12, YI 445/8, 450/3.

Discussion – The elongate pear-shaped outline suggests this species should be placed in the genus Pyrunculus Pilsbry, 1895, although anatomical characters are required to assign species to this genus with certainty (see Tringali & Oliverio, 2001). Pyrunculus elongatus (Eichwald, 1830) is either extraordinarily widespread and longlived, or simply a dumping ground for 'Pyrunculus-like' shells. Typical P. elongatus, as seen on Plate 53, fig. 10, is common in the middle Miocene of the Paratethys. The Paratethyan species P. parangistoma (Boettger, 1902) is probably a synonym of P. elongatus. The more elongate, bullet-shaped, sculptured shells from the Paratethys included by Berger (1953, pl. 17, fig. 33) in P. elongatus correspond fully to those from Turkey illustrated here on Plate 53, fig. 11. We doubt that these are conspecific with P. elongatus, but a decision must await a revision of this group.

The Recent Mediterranean species *Pyrunculus hoernesii* (Weinkauff, 1866) is closely similar in shape, but differs in having a more flattened apex and a shorter columella. Other pear-shaped species are *Pyrunculus conuloideus* (S.V. Wood, 1851) from the Pliocene North Sea Basin, which differs from *P. elongatus* in being less elongate, with a more rounded apex, and in having a narrower umbilicus and a less curved outer lip. Marquet (1997b) considered the Pliocene North Sea Basin shells to be a subspecies of P. elongatus. However, although these species are closely similar, it is not clear whether they form a direct phylogenetic lineage and it is probably wiser to separate the two at full species level. Cylichnina subangystoma (d'Orbigny, 1852), recorded from the Atlantic middle Miocene Langhian of France (Glibert, 1952a) and the North Sea Basin Miocene (A.W Janssen, 1984a; Wienrich, 2007) has a more cylindrical shell than those of the genus *Pyrunculus*, the apex is less angular, the umbilicus is wider and the columella is less excavated. The specimen illustrated by Schnetler (2005, pl. 9, fig. 23) from the North Sea Basin late Miocene of Denmark is far more globose than any specimen of P. elongatus seen, and, in our opinion, is unlikely to be this species.

Distribution - Early Miocene: northeastern Atlantic (Burdigalian): Aquitaine Basin, (Peyrot, 1932); Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896d). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Belgium (Glibert, 1952b), Netherlands (Nordsieck, 1972a; A.W. Janssen, 1984a), Denmark (Rasmussen, 1956), Germany (Sorgenfrei, 1958; Anderson, 1964; Moths, 1989; Wienrich, 2007; Moths et al., 2010). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Hörnes, 1856; Berger, 1953), Poland (Friedberg, 1928), Hungary (Csepreghy-Meznerics, 1956; Strausz, 1962, 1966), eastern Paratethys (Iljina, 1993); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (Dollfus et al., 1903); Proto-Mediterranean Sea (Tortonian): Po Basin, Italy (Sacco, 1896d).

Genus *Volvulella* Newton, 1891 = *Rhizorus* of authors, not of de Montfort, 1810 (see Harry, 1967, p. 133).

Type species – Bulla acuminata Bruguière, 1792, by subsequent designation (Adams, 1862). Recent, Europe.

Volvulella acuminata (Bruguière, 1792) Plate 78, fig. 2

- *1792 Bulla acuminata Bruguière, p. 376.
- 1843 Bulla acuminata Brug. Nyst, p. 457, pl. 39, fig.11.
- 1848 Bulla acuminata Brug. S.V. Wood, p. 174, pl. 21, fig. 7.
- 1878 Bulla acuminata Brug. Nyst, pl. 28, fig. 5.
- 1881 Bulla acuminata Brug. Nyst, p. 135.
- 1896d Volvula acuminata (Brug.) Sacco, p. 42, pl. 3, figs 91-93.
- 1907 Volvula acuminata Brug. Ravn, p. 366, pl. 8, fig. 12.
- 1910 Volvula acuminata Brug. Cerulli-Irelli, p. 35, pl. 3, figs 75-78.
- 1925 Volvulella acuminata (Bruguière) Harmer, p. 799, pl. 63, fig. 7.

- 1952 Volvula acuta Grat. Csepreghy-Meznerics, p. 228, pl. 14, figs 18-22 [non Volvulella acuta (Grateloup, 1827)].
- 1953 Volvula acuminata (Bruguiere) Berger, p. 103, pl. 17, figs 52, 53.
- 1958 *Rhizorus acuminatus* (Brugiére [*sic*]) Sorgenfrei, p. 344, pl. 74, fig. 253.
- 1960b Volvula acuminata Bruguière, 1789 Glibert, p. 23, pl. 4, fig. 28.
- 1962 *Rhizorus acuminatus* Bruguiere, 1792 Strausz, p. 155, text fig. 174, pl. 75, figs 5, 6.
- 1964 *Rhizorus acuminatus* (Bruguiere 1792) Anderson, p. 336, pl. 51, fig. 304.
- 1965 *Rhizorus acuminatus* (Bruguière 1792) van Regteren Altena *et al.*, p. 48, pl. 21, fig. 207.
- 1966 *Rhizorus acuminatus* Bruguière, 1792 Strausz, p. 476, text fig. 213, pl. 75, figs 5, 6.
- 1972a *Rhizorus acuminatus* Bruguière, 1792 Nordsieck, p. 124, pl. 32, fig. 218.
- 1975 Volvulella acuminata (Bruguières [sic]) Fekih, p. 141, pl. 42, fig. 17.
- 1984a Volvulella (Volvulella) acuminata (Bruguière, 1792) A.W. Janssen, p. 380, pl. 18, fig. 13.
- 1988 *Rhizorus acuminatus* (Bruguière, 1792) Thompson, p. 38, fig. 10.
- 1989 Volvulella acuminata (Bruguiere [sic], 1792) Moths, p. 112, pl. 22, fig. 120.
- 1992 Volvulella acuminata (Bruguière, 1792) Cavallo & Repetto, p. 166, fig. 477.
- 1997 *Rhizorus acuminatus* (Brugiere) [*sic*] Ruiz Muñoz, p. 188, pl. 41, fig. 14.
- 1997 Volvulella acuminata (Bruguière, 1792) Marquet, p. 113, pl. 11, fig. 7.
- 2001 *Volvulella acuminata* (Bruguière, 1792) Silva, p. 579, pl. 17, fig. 6.
- 2007 Volvulella (Volvulella) acuminata (Bruguiere, 1792) Wienrich, p. 779, pl. 134, fig. 6, pl. 173, figs 2, 3.
- 2010 Volvulella acuminata (Bruguière, 1792) Sosso & dell'Angelo, p. 50, unnumbered fig. p. 68 mid-row right.
- 2010 Volvulella (Volvulella) acuminata (Bruguière, 1792) Moths et al., p. 93, pl. 25, fig. 13.
- 2011 Volvulella acuminata (Bruguière, 1792) Landau et al., p. 43, pl. 23, fig. 18.
- 2013 Volvulella acuminata (Bruguière, 1792) Chirli,
 p. 56, pl. 12, figs 18-23.
- non 1837 Bulla acuminata Brug. Grateloup, p. 427, pl. 3, figs 43, 44 [= Volvulella acuta (Grateloup, 1827)].
- non 1847 Bulla acuminata Brug. Grateloup, pl. 2, figs 43-44 [= Volvulella acuta (Grateloup, 1827)].

Dimensions and material – Maximum height 3.5 mm. Localities 2 & 3: JvdV/3; locality 13: JvdV/2; locality 17: NHMW 1847/0058/1701/2, JvdV/16, RGM 784 011/2, RGM 783 980/13, YI 430/5.

Discussion – Like Retusa truncatula (Bruguière, 1792), discussed above, Volvulella acuminata (Bruguière, 1792) is either a species complex or an unusually long-lived and widely distributed species. The shell from Turkey illustrated here has quite an elongate apical rostration, not unlike the Recent specimen figured by Thompson (1988, fig. 10). However, other fossil and Recent shells have a shorter apex (see Wienrich, 2007, pl. 134, figs 2, 3). Similarly, the slenderness and height of the shells in both fossil and Recent populations is variable. We provisionally consider them to be a single taxon.

This distinctive little species is widespread in the Mediterranean, northeastern Atlantic and North Sea Basin assemblages from the middle Miocene, and today occurs in the Atlantic from Norway southwards to Angola and throughout the Mediterranean. Interestingly, *Volvulella acuminata* is not present in the early to middle Miocene Aquitaine Basin of France. It is replaced by *Volvulella acuta* (Grateloup, 1827), which is more cylindrical, less convex, with a straighter aperture and a longer rostration.

Distribution - Early Miocene: Proto-Mediterranean Sea (Burdigalian): Colli Torinesi, Italy (Sacco, 1896d). Early-middle Miocene: North Sea Basin (late Burdigalian-Langhian): Netherlands (Nordsieck, 1972a; A.W. Janssen, 1984a), Denmark (Ravn, 1907), Germany (Sorgenfrei, 1958; Anderson, 1964; Wienrich, 2007; Moths et al., 2010). Middle Miocene: Paratethys (Langhian-Serravallian): Austria (Berger, 1953), Hungary (Strausz, 1962, 1966); Proto-Mediterranean Sea (Serravallian) Karaman Basin, Turkey (this paper). Late Miocene: northeastern Atlantic (Tortonian): Cacela Basin, Portugal (NHMW collection). Early Pliocene: North Sea Basin, England (Wood, 1848; Harmer, 1925), Belgium (Nyst, 1843; Glibert, 1960b; Marquet, 1997); northeastern Atlantic, Guadalquivir Basin, Spain (Ruiz Muñoz, 1997; Landau et al., 2011); western Mediterranean, Estepona Basin (NHMW collection), Tunisia (Fekih, 1975). Early-late Pliocene: northeastern Atlantic, Mondego Basin, central west Portugal (Silva, 2001); central Mediterranean, Italy (Sacco, 1896d; Cavallo & Repetto, 1992; Sosso & dell'Angelo, 2010; Chirli, 2013). Early Pleistocene: central Mediterranean, Italy (Cerulli-Irelli, 1910). Recent: eastern Atlantic, Norway to Angola, into Mediterranean (Thompson, 1988).

Suborder Sacoglossa von Ihering, 1876 Superfamily Oxynooidea Stoliczka, 1868 Family Juliidae E.A. Smith, 1885 Subfamily Juliinae E.A. Smith, 1885 Genus *Julia* Gould, 1862

Type species – Julia exquisita Gould, 1862, by original designation. Recent, Indo-West Pacific.

Julia girondica Cossmann & Peyrot, 1914 Plate 53, figs 14, 15

*1914 *Julia girondica* Cossmann & Peyrot, 1914, p. 62, no. 472, pl. 12, figs 19-22.

- 2001a Julia girondica Cossmann & Peyrot, 1914 Lozouet et al., p. 83, text-fig. 19a-c, pl. 37, fig. 7.
- non 1979 Julia aff. girondica Cossmann & Peyrot, 1914 R. Janssen, p. 78, fig. 3.

Dimensions and material – Maximum diameter 5.8 mm. Locality 17: NHMW 1847/0058/1478/1, 1847/0058/1479/1, 1847/0058/1480/15, JvdV/50+, RGM 783 967/50+, YI 431/7.

Discussion – Julia girondica Cossmann & Peyrot, 1914 is not uncommon in the sandy deposits at Seyithasan. The maximum diameter is almost double that recorded for the Atlantic early Miocene shells from France (maximum diameter about 3 mm; Cossmann & Peyrot, 1914; Lozouet *et al.*, 2001a). Many Turkish specimens have a colour pattern preserved consisting of narrow lines of dots radiating from the apex.

The specimen illustrated by R. Janssen (1979, fig. 3) from the Oligocene of Gaas was considered to be a distinct species by Lozouet *et al.* (2001a).

Distribution – Early Miocene: northeastern Atlantic (Aquitanian): Aquitaine Basin, (Cossmann & Peyrot, 1914; Lozouet *et al.*, 2001a). Middle Miocene: Proto-Mediterranean Sea (Serravallian) Karaman Basin, Turkey (this paper).

Julia nov. sp. Plate 53, fig. 16

Dimensions and material – Maximum diameter 9.3 mm. Locality 17: NHMW 1847/0058/1481/1.

Description – Single left valve present, large, thick shelled, surface smooth. Width greater than height, anterior and dorsal margins strongly rounded. Ventral margin straight with weak concavity in posterior portion. Posterior tip short, blunt, protruding only slightly beyond short, moderately acute umbo. Lunular concavity short and deep. Socket-like hinge area slightly broadened in left valve, thinning rapidly anteriorly. Traces of large subcircular adductor muscle scar in anterior third clearly visible.

Discussion – Although *Julia* nov. sp. is represented by a single valve from the Seyithasan assemblage, it clearly represents an undescribed, large, thick-shelled *Julia* species. The most closely similar European Neogene congener is *Julia douvillei* Cossmann & Peyrot, 1914 from the late Oligocene, Chattian of the Aquitaine Basin, France. The left valve of this species, as figured by Cossmann & Peyrot (1914), differs from the Turkish shell in its clearly more elongate, protruding posterior tip, which has a comparable outline to that of the Recent Pacific species *Julia exquisita* Gould, 1862. In this species the ventral margin is straight to weakly convex, whilst the Turkish shell has a slight concavity and has a stout posterior tip. The umbo

of the left valve of *J. douvillei* is more acutely shaped. The right valve of *J. douvillei* is less elongate and closer in outline to that of the Turkish shell, except that it has a rounded ventral margin.

Aside from these morphological differences, the large stratigraphic gap between the Oligocene Atlantic and the middle Miocene eastern Proto-Mediterranean shells suggests a separation at species level. As only a single left valve is available and nothing can be said about the intraspecific variability of this species we refrain from describing it formally as a new species.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian) Karaman Basin, Turkey (this paper).

Subfamily Bertheliniinae Beets, 1949 Genus *Berthelinia* Crosse, 1875

Type species – Berthelinia elegans Crosse, 1875, by monotypy. Middle Eocene, France.

Berthelinia nov. sp. Plate 78, figs 3-4

Dimensions and material – Maximum diameter 940 μ m. Localities 2 & 3: RGM 783 948/1; locality 6: RGM 783 994/3; localities 7 & 8: RGM 783 961/1; locality 13: JvdV/3, RGM 776 849/1 (ex JvdV collection); locality 17: RGM 783 963/7, RGM 784 065/1, RGM 783 244/1.

Description – Shell small, stout, trigonal-trapezoid, with distinct close-set growth lines. Umbo sub-central, maximum convexity extending from umbo diagonally to postero-ventral margin. Anterior margin well rounded. Ventral margin straight, passing rapidly into straight to weakly rounded posterior margin, with flat to slightly concave postero-dorsal field. Dorsal margin straight, somewhat angulate at umbo.

Discussion – The stout trigonal-trapezoid outline of the left valve is comparable to that of the French Oligocene species *Berthelinia oligocaenica* R. Janssen, 1979, which differs mainly in its more elongate shape and less prominent growth lines. The protoconch of the Turkish species is in a rather central position compared to the more anterior position in the Oligocene species. The Eocene type species is clearly separated by its more quadratic-trapezoidal outline. Juvenile shells of the middle Miocene Paratethyan species *Candinia krachi* (Bałuk & Jakubowski, 1968) could be mistaken for the Turkish species, but are distinctly more quadrate in outline.

Distribution – **Middle Miocene**: Paratethys (Langhian-Serravallian): Poland (Bałuk & Jakubowski, 1968); Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey (this paper). Clade Thecosomata de Blainville, 1824 Superfamily Limacinoidea Gray, 1847 Family Limacinidae Gray, 1847 Genus *Heliconoides* d'Orbigny, 1834

Type species – Heliconoides inflata (d'Orbigny, 1834), by subsequent designation H. Adams & A. Adams, 1858. Recent, tropics, subtropics.

Heliconoides inflata (d'Orbigny, 1834)

Figure 29 (1a-b)

- *1834 *A*[*llanta*] [*sic*] *inflata* d'Orb., d'Orbigny, pl. 12, figs 16-19.
- 1835 Atlanta inflata d'Orb. d'Orbigny, p. 174.
- 1925 Spirialis miorostralis Kautsky, p. 202.
- 1991 *Limacina miorostralis* Kautsky, 1925) Zorn, p. 21, pl. 2, figs 5-6.
- 1999 *Limacina inflata* (d'Orbigny, 1836 [sic]) A.W. Janssen, p. 12.
- 2004 *Heliconoides inflata*(d'Orbigny, 1836 [*sic*]) type A-A.W. Janssen, p. 109, pl. 2, figs 1-3.
- 2012 *Heliconoides inflata* (d'Orbigny, 1834) A.W. Janssen, p. 288, pl. 2, figs 4-6 (with additional synonyms).

Material and dimensions – Locality 12: RGM 396 663/1 (ex JvdV collection), H = 0.84 mm.

Description - See A.W. Janssen (2004, 2012).

Discussion – A single adult specimen is available, belonging to form A, without irregular curvature of the last whorl, as distinguished by A.W. Janssen (2004). *Spirialis miorostralis'* Kautsky was considered to be a separate species for a long time, but is nowadays considered to represent no more than a form of *Heliconoides inflata*, as discussed by Cahuzac & Janssen (2010).

Distribution – Late Oligocene: northeastern Atlantic, Aquitaine Basin; North Sea Basin, Germany; central Mediterranean, Malta. Early-middle Miocene: northeastern Atlantic, North Sea Basin (late Burdigalian-Langhian): Denmark, Germany, Netherlands, Belgium. Middle Miocene: Paratethys (Langhian-Serravallian): Poland, Austria, Romania, Hungary; central and eastern Proto-Mediterranean Sea, Malta, (Serravallian): Karaman Basin, Turkey; Indo-Pacific, Australia. Late Miocene: Caribbean, Dominican Republic. Pliocene: western and central Mediterranean, Spain, France, Italy; northeastern Atlantic, Açores; Caribbean, Jamaica; Indo-Pacific, Philippines, Japan. Pleistocene to Recent: tropics and subtropics, worldwide. Superfamily Cavolinioidea Gray, 1850 Family Creseidae Rampal, 1973 Genus *Styliola* Gray, 1847

Type species – 'Styliole' *recta* de Blainville, 1827 = *Styliola subula* (Quoy & Gaimard, 1827), by original designation. Recent, tropics, subtropics.

Styliola subula (Quoy & Gaimard, 1827)

Figure 29 (2)

- *1827 Cleodora subula, Quoy & Gaimard, p. 233, pl. 8, figs D1-D3.
- 1999 Styliola subula (Quoy & Gaimard, 1827) A.W. Janssen, p. 18, text-fig. 3, pl. 3, figs 7-9 (with neo-type designation).
- 2012 Styliola subula (Quoy & Gaimard, 1827) A.W. Janssen, p. 317, pl. 5, fig. 4; pl. 23, fig. 11 (with additional synonyms).

Material and dimensions – Locality 13: RGM 396 650/1 juvenile (ex JvdV collection), H = 1.20 mm.

Description – A single juvenile specimen was found, not yet demonstrating the oblique groove characterising more adult specimens. Identification is possible by the circular transverse section and the pointed, slightly separated protoconch.

Discussion – This is one of the most long-ranging pteropod species (Late Oligocene to Recent) and nowadays is one of the abundant species in tropical and subtropical oceans.

Distribution – Late Oligocene-early Miocene: northeastern Atlantic, Aquitaine Basin; North Sea Basin, Germany; central Mediterranean, Malta; Middle-late Miocene: central and easter Proto-Mediterranean Sea: Malta, (Serravallian): Karaman Basin, Turkey; Indo-Pacific Basin, South Australia, Indonesia; Pliocene: northeastern Atlantic, Açores; western Mediterranean, Spain, Italy; Caribbean, Jamaica, Dominican Republic; Indo-Pacific Basin, Philippines, Japan; Pleistocene-Recent: worldwide in tropical and subtropical assemblages.

Family Cavoliniidae Gray, 1850 Genus *Diacrolinia* A.W. Janssen, 1995

Type species – *Hyalaea aurita* Bellardi, 1873, by original designation. Miocene, Italy.

Diacrolinia larandaensis A.W. Janssen, 1999 Figure 29 (5a-e, 6)

- 1977 Cavolinia aurita (Bellardi, 1873) Robba, p. 611, pl. 24, fig. 6 (non Bellardi) (excl. synonymy).
- *1999 *Diacrolinia larandaensis* sp. nov., A.W. Janssen, p. 14, fig. 4a-e.

- ?1999 Cavoliniinae sp. indet. A.W. Janssen, p. 12.
- 2012 Diacrolinia larandaensis Janssen, 1999 A.W. Janssen, p. 507.

Material and dimensions – Locality 17: RGM 396 666 (holotype H = 5,56 mm, ex JvdV collection); locality 12: RGM 396 652/? 1 fragment, 396 668/? 2 fragments (ex JvdV collection).

Description - See A.W. Janssen (1999).

Discussion – Apart from the poor specimens from Turkey, this species is known from a single specimen (paratype) from the Serravallian of Ricca-Diano d'Alba (northern Italy) published by Robba (1977) as *Cavolinia aurita* (*non* Bellardi, 1873).

The two fragments referred to by A.W. Janssen (1999) as Cavoliniinae sp. indet. are now considered to probably represent the ventral shell parts of this species. One of them is illustrated herein (Fig. 29-6). It has oblique grooves running from the apex towards the sides of the apertural margin and ending in tooth-like projections that seem to correlate with the dorsal shell part, together between dorsal and ventral shell parts forming a kind of closing mechanism, less complicated in structure than that seen in species of *Cavolinia*.

Distribution – **Middle Miocene**: Proto-Mediterranean Sea (Serravallian): Karaman Basin, Turkey, northern Italy.

Genus Vaginella Daudin, 1800

Type species – *Vaginella depressa* Daudin, 1800, by monotypy. Miocene, France.

Vaginella lapugyensis Kittl, 1886

Figure 29 (3a-d, 4a-b)

- *1886 *Vaginella Lapugyensis* n.f., Kittl, pp. 52, 72, pl. 2, figs 4-5.
- 1999 Vaginella lapugyensis Kittl, 1886 A.W. Janssen, p. 12.
- 2012 Vaginella lapugyensis Kittl, 1886 A.W. Janssen,
 p. 426, pl. 14, fig. 12, pl. 17, figs 5-7, pl. 18, figs 1-2 (with additional synonymy).

Material and dimensions – Locality 6: RGM 396 661/3, RGM 396 673/1 (H = 1.66 mm; locality 9: RGM 396 665/4; locality 12: RGM 396 662/1; locality 13: RGM 396 651/2, RGM 396 653/1, 2 fragments; locality 17: RGM 396 667/4, RGM 396 674/1 (H = 5.81 mm); locality 19: RGM 396 659/4 (all ex JvdV collection); locality 6: RGM 396 664/7 fragments (ex P. Hessel collection). all specimens are more or less damaged or juvenile.

Description and discussion – See A.W. Janssen (2012) and references therein.

Distribution – Middle Miocene: (Langhian-Serravallian), Paratethys, Poland, Czech Republic, Romania; central and eastern Proto-Mediterranean Sea, Italy, Malta, Cyprus, (Serravallian): Karaman Basin, Turkey, Egypt; Caribbean, Costa Rica [? as Vaginella bicostata (Gabb, 1881)]; Indo-Pacific Basin, S. Australia (? as Vaginella bicarinata Tate, 1887),



Figure 29. 1a-b. *Heliconoides inflata* (d'Orbigny, 1834), RGM 396 663, a: apical view, b: apertural view; 2. *Styliola subula* (Quoy & Gaimard, 1827), RGM 396 650, frontal view; 3a-d. *Vaginella lapugyensis* Kittl, 1886, RGM 396 674, a: frontal view, b: right lateral view; c: protoconch, frontal view, d: protoconch right lateral view; 4. *Vaginella lapugyensis* Kittl, 1886, RGM 396 673, a: protoconch, frontal view, b: protoconch (left or right ?) lateral view; 5. *Diacrolinia larandaensis* A.W. Janssen, 1999, RGM 396 666 (holotype), a: dorsal view, b: left lateral view, c: protoconch, ventral view; 6. *?Diacrolinia larandaensis* A.W. Janssen, 1999, RGM 396 668a, ventral view. Bar = 1 mm (illustrations by A.W. Janssen).

3 Geological and palaeobiogeographic distribution of the Karaman molluscan assemblage

The importance of the Karaman assemblages in the understanding of Atlanto-Mediterranean Miocene palaeobiogeography cannot be overstated, for although extensive Atlantic, North Sea Basin and Paratethyan assemblages are known and have been thoroughly studied during the last century, middle Miocene Mediterranean assemblages are not well represented, with the present notable exception.

This hiatus of information in the Mediterranean has led to an impression of an endemic and both geographically and biogeographically isolated middle Miocene (Langhian and early Serravallian/Badenian) Paratethyan fully marine fauna, quite distinct from the faunas known from the middle Miocene north-eastern Atlantic frontage represented by the assemblages of the Aquitaine and Loire Basins. The Karaman material, dated as late Serravalian (Corić et al., 2012), is paramount for testing whether the uniqueness of Paratethyan assemblages is real or is merely an artefact caused by this gap in our knowledge. We note that we refer only to the fully marine Badenian faunas of the Paratethys, corresponding to the Langhian and early Serravallian. The subsequent Sarmatian period in the Paratethys, corresponding to the late Serravallian, was undoubtedly represented by highly endemic faunas (Harzhauser & Piller, 2007).

Erünal-Erentöz (1956, 1958) recognised the importance of the Neogene central Anatolian assemblages and considered them to have strong Mediterranean affinities. She went on to comment that the Thracian assemblages of western Turkey had mixed Paratethyan and Mediterranean influences (Erünal-Erentöz, 1956, p. 49). From the palaeogeographical map by Erünal-Erentöz (1956, opposite p. 34) it is apparent that, in the present day Turkish region, the author contemplated the existence of two connections between the Mediterranean and the Paratethys: one located in the present-day Bosporus region, connecting the Mediterranean with the Central Paratethys, in the Thracian region, and a second one in the Turkish far east, through the Van region towards Iran, connecting the Proto-Mediterranean with the Eastern Paratethys.

Dealing with the palaeobiogeography, Erünal-Erentöz (1956, p. 50) highlighted the difficulties associated with stratigraphic correlation between the various Mediterranean Miocene basins. Nevertheless, she recognised that the closest correlations are between the Karaman assem-

blages and those of the Vienna Basin and the Piedmont region. She went on to suggest that a more detailed study of the eastern Mediterranean Miocene would probably define an eastern Mediterranean palaeobiogeographical unit. Having said this, she stressed an equal affinity between the Karaman faunas and those of the Atlantic Loire and Aquitaine Basins.

The basis of any palaeobiogeographical study fundamentally relies on the systematic characterisation of the faunas of the study region. The systematic study of the Karaman assemblages performed by Erünal-Erentöz (1956, 1958) for her doctoral thesis presented to the Faculté des Sciences de l'Université de Paris relied heavily on comparison of the Turkish material with French Mediterranean and Atlantic assemblages, as this possibly introduced an Atlanto-Mediterranean bias into her identifications. Species originally identified by Erünal-Erentöz (1958) as middle Miocene Atlantic species occurring in the Aquitaine and Loire Basins such as Aporrhais uttingerianus, Pyrene (Macrurella) nassoides, Galeodes ornata and Nassa subventricosa are identified here as A. dactylifera, Orthurella convexula, Melongena jaapi nov. sp. and Nassarius doliolum, respectively. All of these species are now regarded as occurring only in the Karaman Basin and in the Paratethys, thus weakening the Western Mediterranean and Atlantic affinities of the Central Anatolian middle Miocene gastropod faunas highlighted by Erünal-Erentöz (1958).

During the course of the present systematic study, a total of 437 gastropod species were recorded. This represents a significant increase in specific diversity compared with the 75 gastropod species on which Erünal-Erentöz (1958) based her palaeobiogeographical considerations.

The occurrences of all Karaman gastropod species in the middle Miocene of the Atlantic basins, in the more diverse and well known assemblages (Aquitaine and Loire), as well as in the North Sea Basin and the Paratethys region have been plotted in the Appendix. In order to achieve the most reliable palaeobiogeographical results, the assemblages selected should be confined to the narrowest stratigraphical slice possible. We therefore stress that whilst these species may occur in the Atlanto-Mediterranean area outside this time slice, they have only been recorded in the palaeobiogeographical distribution column if they are present during the middle Miocene.

From the analysis of the data in the Appendix it is evident that the late Serravallian Karaman assemblage shows a very strong affinity with the fully marine Langhian-early

- Figure 30. Affinities between Karaman and the middle Miocene assemblages in the Atlanto-Mediterranean area. Palaeogeographical data adapted from (see also Fig. 31, below): Proto-Mediterranean and Paratethys regions, Rögl (1998); English Channel and North Sea Basin, Van Vliet-Lanöe *et al.* (2002) and Gibbard & Lewin (2003). As discussed in the text, the high number of shared species in the Paratethys corresponds to the Langhian and early Serravallian (= Badenian) and not to the late Serravallian (= Sarmatian), when the Badenian-Sarmatian Extinction Event had eliminated most of the marine species (Harzhauser & Piller, 2007).
- Figure 31. Tentative palaeogeographical reconstruction of the northeastern Atlantic, Proto-Mediterranean and Paratethyan regions during the middle Miocene (middle Serravallian/ early Sarmatian). Palaeogeographical data adapted from: Proto-Mediterranean and Paratethys regions, Rögl (1998); English Channel and North Sea Basin, Van Vliet-Lanöe *et al.* (2002) and Gibbard & Lewin (2003).



Figure 30.



Figure 31.

Serravallian/Badenian assemblage of the Paratethyan region (Figure 30). If we consider only the species in common to at least two basins (*i.e.* excluding endemics and species left in open nomenclature), 72.9% of the 329 species found in Turkey occur also in the Badenian Paratethys.

This is not, however, the case when we compare the number of Karaman taxa in common with the coeval Sarmatian Paratethys, which is very low (1.6 %). At that time (shown also in Figure 30), the Paratethys was already disconnected from the Mediterranean and had developed a highly endemic gastropod fauna. Therefore, the Karaman assemblage shows a high correlation with the slightly older Paratethyan fully marine Badenian assemblage, corresponding to the Langhian and early Serravallian, but not with the coeval late Serravallian/Sarmatian assemblage.

As expected, based purely on the geographical distance between the Miocene Atlantic basins and the study area analysed here, the further the basin is located from Karaman, the lower the number of shared species: Karaman/ Aquitaine Basin = 28.8%; Karaman/Loire Basin = 20.9% and Karaman/North Sea Basin = 14.6%. If we consider the palaeogeographical relationships between Karaman and these Atlantic Miocene basins, the shared species can easily be explained by the connections between the western Proto-Mediterranean and the Atlantic. The number of species shared decreases steadily as one moves westwards and northwards, along the Atlantic façade of western Europe, away from Karaman. It is interesting to note that this drop is gradual, as based on the palaeobiogeographical model of Silva & Landau (2007) and Monegatti & Raffi (2007), one would expect a dramatic drop at the boundary between the Miocene European West-African Province and the Miocene Boreal-Celtic Province, *i.e.* between the Loire Basin and the North Sea Basin.

Although the palaeogeographical maps of Rögl (1998, 2001) for the late Serravallian (early Sarmatian) show a connection between the eastern Proto-Mediterranean and the Paratethys only to the east of the region of Karaman, via a reduced connection along the Bitlis and the Anatolian Fault zones (Figure 31), the prevailing palaeobiogeographical model is that of a relatively isolated and endemic Paratethys. According to Rögl (1998, 2001), the main connection between the Paratethys and the Proto-Mediterranean Sea via the Trans-Tethyan Trench corridor in Slovenia was already closed during the late Badenian. The excellent faunistic correlation between the two areas documented herein casts doubts on such restricted conditions and possibly supports the hypothesis of Horvat (2003) and Bartol et al. (2011) that this connection remained active up until the end of the Badenian.

This view was developed in part based on the conclusion reached by Erünal-Erentöz (1956) that the character of the Karaman assemblage was mainly Mediterranean. However, until now, very little could be said about the character of the middle Miocene Mediterranean, as the mesogean assemblages used by Erünal-Erentöz to compare her Karaman material with were not middle Miocene in age. Unfortunately, with the exception of Karaman, no significant middle Miocene outcrops are known from the Mediterranean area.

This detailed study of the Karaman gastropod assemblage shows that the middle Miocene Paratethyan fauna was not as isolated as previously thought, and had a much closer affinity to that of the eastern Proto-Mediterranean as suggested by Harzhauser *et al.* (2002).

4 Conclusions and implications

Palaeoenvironments

The fossil assemblages and the sediments they occur in suggest that the rocks studied here in the Karaman Basin were all deposited in soft-bottom habitats. The fully marine layers at Seyithasan represent sandy bottom habitats, possibly with sea-grass communities, as suggested by the abundance of *Persististrombus* and *Agapilia/Smaragdia*. A few coral-bearing intervals are present at Seyithasan, but generally speaking coral is uncommon in the shell-bearing layers, apart from small colonial corals that are found attached to many of the larger gastropods such as *Persististrombus*. The assemblage suggests deposition in the shallow sub-tidal zone. The common presence of echinoids such as *Clypeaster* further supports the fully marine, shallow subtidal, sandy bottom character of these palaeoenvironments.

At the base of the Seyithasan section and at the southwest bank of Gödet River, across from Tilkikaya, brackish-water assemblages crop out in small lenses. In these the typically brackish genera Granulolabium, Terebralia, Holandriana and Melanopsis predominate. They are found together with species such as Schilderia transsylvanica and Hexaplex (Trunculariopsis) rudis, which are more abundant in the fully marine layers, but in the brackish layers they are represented by smaller, dwarfed specimens. These may represent lagoonal environments. The clayey sediments at Akpinar correspond to shelf environments, and reflect slightly deeper marine conditions than those represented at Seyithasan. The rarity in the Akpinar assemblages of large herbivorous gastropods such as *Persististrombus* supports this interpretation. Also, the more diverse nannofossil assemblage found in the Akpinar sediments suggests a more open marine environment (Ćorić et al., 2012). The Lale deposits show characteristics in between those of Akpınar and Seyithasan. There is an almost complete absence of taxa associated with rocky bottoms, such as Haliotidae, patellid and littorinid gastropods and Polyplacophora in all the Karaman deposits.

The assemblage

The systematic portion of this work results in a detailed monograph of the gastropods found in the middle Miocene Serravallian of the Karaman Basin, Turkey, based on the historical collections in the Naturalis Biodiversity Center (Leiden, The Netherlands), the JvdV private collection and that of and the Naturhistorisches Museum Wien (Vienna, Austria) and new collections made by the authors during two field trips to Karaman during 2011 and 2012, now housed in the Maden Tetkik ve Arama (Ankara, Turkey), and the YI collection, also in Ankara. A total of 437 species is recorded, belonging to 252 genera. During the course of this work four genera and 41 species are described as new. Of the 437 species, 377 were identified to species level and 60 were left in open nomenclature.

This study revealed that 56 species or 12.8% are endemic to the Karaman assemblages. This figure may be high

due to this study being more detailed and dealing with many of the smaller species that are often poorly covered in the classical literature. Of the endemics, very few have moderate-sized or large shells, with the notable exceptions of *Melongena jaapi* nov. sp., *Euthriofusus anatolicus* (Toula, 1901) and some of the *Clavatula* species, which in Karaman can reach a large size.

Two groups of endemics are of particular interest, the nassariids and the clavatulids. The endemic nature of nassariids has been highlighted in recent papers dealing with the family in the European Neogene assemblages (*i.e.* Gürs, 2002; Harzhauser & Kowalke, 2004; Landau *et al.*, 2009b). The same is true of the nassariids at Karaman. Of the 22 species of Nassariidae present in the assemblage, eight (36%) are endemic, 12 (54.5%) only occur in Karaman and the Paratethys, two are shared between Karaman and the Aquitaine and Loire basins respectively and one species is common to Karaman and the North Sea Basin. The strong similarity between the nassariid assemblage at Karaman and in the middle Miocene Paratethys further supports the strong affinity between the Karaman and Paratethys faunas.

Species of the second group, the clavatulids, are even more strongly endemic. This endemism has also been noted by Vera-Peláez (2002) for the early Pliocene of the western Mediterranean and adjacent Atlantic assemblages of southern Spain. Of the 14 species in Karaman (one left in open nomenclature), seven (50%) are endemic, four (28.5%) are shared with the Paratethys, and only one species is also found in the Aquitaine Basin. No clavatulids are shared with areas further to the North in the Loire or North Sea basins.

Other groups show a particularly strong connection with the Paratethys. A good example are the Cancellariidae, which have been reviewed recently by Cahuzac et al. (2004) and Harzhauser & Landau (2012). Of the 18 species present in Karaman, only two are endemic, but 13 (72.2 %) are shared with the Paratethys, five (27.7%) with the Aquitaine Basin and only one each with the Loire and North Sea basins, respectively. A further example are the Muricinae. The subfamily is represented in Karaman by 28 species, of which two (7.1%) are endemic, 19 (67.8%) are shared with the Paratethys, eight (28.6%) with the Aquitaine Basin and only six (21.4%) and three (10.7%) with the Loire and North Sea Basins, respectively. The endemic character of these groups could be a useful tool for defining the palaeobiogeography of middle Miocene Atlanto-Proto-Mediterranean gastropods.

Even in the notoriously long-lived and cosmopolitan group of Tonnoidea, reviewed recently by Landau *et al.* (2004b, 2009a), of the 15 species (two left in open nomenclature) that occur in Karaman, none is endemic, but 12 (80%) also occur in the middle Miocene Paratethys, six (40%) in the Aquitaine Basin and only one in the Loire Basin, but interestingly five species (33.3%) are shared with the North Sea Basin.

Based on this study, we conclude that the Paratethys fauna in the middle Miocene was not an isolated fauna, but had strong affinities with that of the eastern Proto-Mediterranean, as represented in the Karaman assemblage.

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7 Appendix

Palaeogeographical and geochronological distributions of the species identified in the middle Miocene Karaman Basin gastropod assemblages – Broken line in geochronological distribution signifies probably occurrence, but with no reliable record available. In the palaeobiogeographical distribution, black dots represent occurrences, circles with question mark possible occurrences and taxa left with open nomenclature, open circles signify no record known. NSB = North Sea Basin, LOR = Loire Basin, AQT = Aquitaine Basin, PTT = Paratethys.



No.	NSB	Children and and and and and and and and and an	A Contraction	F	Palaeobiogeographical distribution	Geod	chronologica	al distrib	oution	
	28	R 2	and the	S	Species	Oligocene	Miocene	Pliocene	Pleist	Holo
	3	No la	2 A	1 PC		early late	early mid. late	early late		
NSB	LOR	AQT	Karaman	PTT	Mesalia cochleata (Brocchi, 1814)					
	•				Vermicularia milleti (Deshaves, 1839)					
•		•			Petaloconchus intortus (Lamarck, 1818)					
		•	•		Thylacodes arenarius (Linnaeus, 1758)					
-	-	-	•		Truncatella subcylindrica (Linné, 1767)					
			•	•	Obtusella taurominima (Sacco, 1895)					
			•		Rissoa clotho Hörnes, 1856					
			•		Pusillina philippi (Aradas & Maggiore, 1844)					
			?		Pusillina cf. inconspicua (Alder, 1844)					
			?		Pusillina sp.					
			•	•	Alvania critica Boettger, 1907					
•	•	•	•	•	Alvania lachesis (de Basterot, 1825)					
			•	•	Alvania miocenica Sacco, 1895					
			•		Alvania perregularis (Sacco, 1895)					
			•	•	Alvania productilis Boettger, 1907					
			?		Alvania ci. punctura (Montagu, 1803)					
			•		Alvania iransiens (Sacco, 1895)					
					<i>Bissoing subconcideg</i> (Grateloup, 1847)					
					Rissoina subconolaeu (Graceloup, 1847)					
					Rissoina (Zehinella) extranea (Fichw 1830)					
		0			Rissoina (Z.) obsoleta Hörnes 1856					
		0	0	- T	Rissoina (Z.) of decussata (Montagu 1803)					
	•	•	ě		Stossicia multicingulata (Boettger, 1887)					
			•		Hvala vitrea (Montagu, 1803)					
			•		Pseudonoba striata (Hörnes, 1856)					
			•		Erentoezia akpinarensis nov. sp.					
			•		Rhombostoma? meesi nov. sp.					
			•		Rhombostoma? daani nov. sp.					
			•	L I	Caecum clarkii Carpenter, 1858		= =	.		_
			•		Caecum subannulatum de Folin, 1870					
			•		Parastrophia asturiana (de Folin, 1870)					
			•		Elachisinia hoernesi (Boettger, 1902)					
			•	L I	Elachisina rolani nov. sp.					
			•		Elachisina gofasi nov. sp.					
			•		Discopsis reductus (Rolan & Rubio, 1990)					
			•		<i>Circulus miotaurinousis</i> (Socoo, 1806)					
				•	Circulus miotaurinensis (Sacco, 1890) Circulus planorhillus (Dujardin, 1837)					
					<i>Circulus striatus</i> (Philippi, 1836)					
					Circulus supranitidus (Wood, 1842)					
•	•	•	•		Idioraphe defrancei (de Basterot, 1825)					
			•		Idioraphe minima (Boettger, 1907)					
			•	•	Megatyloma auingeri (Boettger, 1902)					
			•		Solariorbis punctatocarinatus nov. sp.					
			•	•	Solariorbis woodi (Hörnes, 1856)				4	
1		0	•		Persististrombus inflexus (Eichwald, 1830)					
			•		Aporrhais dactylifera (Boettger, 1902)					
			•		Aporrhais pespelecani (Linnaeus, 1758)					
•	•	•	•		Calyptraea chinensis (Linnaeus, 1758)					
	•	•	•	•	Crepidula gibbosa Defrance, 1818					
•	•	•	•	•	Crepidula unguiformis Lamarck, 1822					
			•	•	<i>Cymenorytis brandenburgi</i> (Boettger, 1907)					
•	0	•	•	•	xenophora deshayesi (Michelotti, 1847)					



2. 2. 2.	NSB				Palaeobiogeographical distribution	/	Geod	chroi	nologica	al dis	strib	oution	
	×	R		S	Species	Oligo	cene	M	iocene	Plioc	ene	Pleist	Holo
	S_	19	2-14	1 Ale		early	late	early	mid. late	early	late		
NSB	LOR	AQI	Karaman	PIT	Epitonium trevelvanum (Johnston, 1841)								
			•		<i>Cirsotrema pumiceum</i> (Brocchi, 1814)								
•	0	0	•		Amaea (Acrilla) kimakowiczi (Boettger, 1896)								
	•	•	?		Acrilloscala sp.								
•	0	0	•		Acirsa lanceolata (Brocchi, 1814)								
			•		Aclis ascaris (Turton, 1819)								
			?		Eulima cf. jaskiewiczi Bałuk, 1995								
			•		Campylorhaphion famelicum (Watson, 1883)								
			?		Vitreolina sp.								
			?		<i>Melanella</i> sp.								
		•	•		Bolinus brandaris torularius (Lamarck, 1822)								•
		•	•	•	Bolinus submuticus (Grateloup, 1845)								
		-	•		Hexaplex (Trunc.) austriacus (Tourn., 1875)								
	•	0	•		Hexaplex (Trunc.) rudis (Borson, 1821)								
				•	Chicometer (Trunc.) turonensis (Dujardin, 1837)								
•	•				Ptermotus granulifarus (Grataloun, 1833)							1	
		•			Dermomurar (Trialatella) kilikiensis nov sp					1			
					Homalocantha heptagonata (Bronn 1831)				□				
					Ocinebring bicgudata (Borson, 1821)								
				•	Ocinebrina dertonensis (Mayer in Bell., 1873)								
			•		Ocinebrina kojumdgievae (Bałuk, 1995)								
			•		Ocinebrina perparva nov. sp.								
			•		Ocinebrina polonica (Bałuk, 1995)								
			?		Ocinebrina sp.								
			•		Pteropurpura delbosiana (Grateloup, 1845)								
•	\bigcirc	•	•		Vitularia linguabovis (de Basterot, 1825)					•			
			•		Stramonita haemostomoides (H. & A., 1882)								
•	0	0		•	Orania cheilotoma (Hoernes & Auinger, 1890)								
			•	•	Janssenia echinulata (Pusch, 1837)								
			•		Cathymorula exilis (Hornes, 1852)								
	•	0	•		Cathymorula sismonaal (Doderlein, 1862)								
	•	0			Muricopsis (M) aristata (Procedi 1814)								
					Murricopsis (M.) Cristata (Brocchi, 1814) Murricol sandbergeri (Hörnes 1856)								
					Favartia suboblonga (d'Orbigny 1852)							1	
		-			Substervnotus graniferus (Michelotti, 1841)								
	•	0			Typhinellus labiatus (de Cristof, & Jan, 1832)								
	-	-	•		Coralliophila scarrosa (Bellardi, 1873)								
			•		Coralliophila sp.								
•	0	•	•	•	Babylonia eburnoides (Mathéron, 1842)					4			
		•	•		Euthria curvirostris (Grateloup, 1833)								
			•		Euthria puschi (Andrzejowski, 1830)								
			•		Euthriofusus anatolicus (Toula, 1901)								
•	0	•	•		Metula submitraeformis (d'Orbigny, 1852)					•			
			•		Pisania striata (Gmelin, 1791)	1							-
		0	•		Anna exsculpta (Dujardin, 1837)					•		1	
			•		Monostiolum? nov.sp.	1						1	
		_	•		Europhos connectens (Bellardi, 1882)	1							
	-	•	•		Europnos polygonus (Brocchi, 1814)								
		0			Nassarius specialiis (Nyst, 1845)	1				1		1	
					Nassarius glatus gavage Fringel Frontige 1059	1							
					Nassarius harbarossai poy sp							1	
					ivassarias varvarossai nov. sp.								



N.C.	NSB		Barton In	~	Palaeobiogeographical distribution		Geod	chronologic	al d	istrik	oution	
	X	Res 2	and the	S	Species	Oligo	cene	Miocene	Plio	cene	Pleist	Holo
Va	S-	200	2-14	See.		early	late	early mid. lat	e early	late	 	
NSB	LOR	AQT	Karaman	PTT	Ziba goniophora (Bellardi, 1850)							
				- 	Pusia baluki nov. sp.							
			•		Pusia pyramidella (Brocchi, 1814)							
			•	•	Vexillum transsvlvanica (Boettger, 1902)							
			•		Costellaria cupressina (Brocchi, 1814)							
			•		Costellaria nov. sp.?							
			•		Thala obsoleta (Brocchi, 1814)							
			•		Conomitra karamanensis nov. sp.							
			•		Aneurystoma afenestrata (Sacco, 1894)							
		•	•		Bivetiella dertonensis (Bellardi, 1841)							
			•		Contortia bellardii (Michelotti, 1847)							
			•	•	Contortia callosa (Hörnes, 1854)							
	•	•	•		Contortia contorta (de Basterot, 1825)							
		•	•		Sveltia dertovaricosa Sacco, 1894							
			•		Calcarata calcarata (Brocchi, 1814)						4	
			•	•	Solatia exwestiana (Sacco, 1894)							
			•	•	Petitina inermis (Pusch, 1837)							
			•	•	Trigonostoma exgeslini (Sacco, 1894)							
			•	•	Ventrilia imbricata (Hornes, 1854)					1		
			•	•	Ovilia excassidea (Sacco, 1894)							
				•	Scalptia dertocosticillata (Sacco, 1894)							
			•		Scalptia polonica (Pusch, 1857)							
					Scalptia scrobiculaia (Homes, 1854)							
		•		•	Scalptia ² problematica pov. sp							
					Tritonoharna alanhaui nov. sp.							
					Kalloconus berghausi (Michelotti 1847)							
		•			Kalloconus hungaricus (H & A 1879)							
					Lautoconus hitorosus (Fontannes, 1880)							
					Monteiroconus antiguus (Lamarck, 1810)							
	-	•	ė	•	Monteiroconus daciae (H. & A., 1879)							
		•	•		Monteiroconus mercati (Brocchi, 1814)							
		•	•		Plagioconus puschi (Michelotti, 1847)							
		•	•	•	Varioconus pelagicus (Brocchi, 1814)							
					Varioconus erunalerentoezae nov. sp.							
			•		Varioconus karamanensis (EErentöz, 1958)							
			•		Varioconus subraristriatus (P. da Costa, 1866)							
			•		Varioconus taurinensis (Bell. & Mich., 1840)				-	•		
•		٠	•		Conolithes dujardini (Deshayes, 1845)							
			0		Asthenotoma sp.							
		•	•		Bathytoma cataphracta (Brocchi, 1814)						4	
					Genota rudolfi (Toula, 1901)							
			•	•	Genota pseudoelisae nov. sp.							
			•	•	Microdrillia teretiaeformis A.W. Janssen, 1972							
			•	•	Clathurella casilorica Boettger, 1906							
					Clathuralla an							
			(?)		Clainurella sp.							
			?		Plaurotomoidaes and strombillus (Duj., 1837)							
					Plaurotomoides sp							
					Agathotoma angusta (Bellardi 1847)							
					Agathotoma perforata (Brusing 1877)							
		•			Bela halavatsi (Boettger 1902)							
					Bela hispidula (Bellardi 1847)							
			-		ben maphana (benardi, 1047)							1


S.S.C.	NSB	200			Palaeobio	geograph	nical distribu	tion	(Geoc	hronolo	ogica	al dis	trib	utior	l
	X	S.S.S.	A			Spec	ies	\searrow	Oligo	cene	Mioce	ene	Plioce	ne	Pleis	t Holo
NSB	LOR	AOT	Karaman	PTT				_	early	late	early mid	. late	early l	ate		
	LOIN	Ast		• A	Ammonicera r	ota (Forbes	& Hanl., 1853) s.l.			_					
			•	• 0	Omalogyra ate	omus (Philip	ppi, 1841) s.l.									
		•	•	• <i>P</i>	Pyramidella p	licosa Bron	n, 1838			1				_		
	•	•	•	• L	longchaeus ur	nisulcatus (I	Dujardin, 1837)								
			•	S	Syrnola sp.							ı				
			•	• Λ	Visosyrnola co	oncava (Boe	ettger, 1907)									
			•	• 1	Megastomia co	onoidea (Br	rocchi, 1814)									
			•	0	Odostomia fus	ulus Monte	erosato, 1878									
				• 0	Odostomia eli.	sabethae Bo	oettger, 1907				_					
			•	0	Odostomia erj	aveciana B	rusina, 1869									
			•	0	Odostomia uni	identata (M	ontagu, 1803)							_		
			?	0	<i>Odostomia</i> sp.							4				
				• P	Pyramistomia	deubeli (Bo	oettger, 1902)									
			•	0	Chrysallida en	naciata (Br	usina, 1866)									
			?	0	<i>Chrysallida</i> cf	. fenestrata	(Jeffreys, 184	8)				9				
			•	• (Chrysallida lo	ngula Boett	tger, 1907									
			•	0	Chrysallida m	<i>ajae</i> nov. sp) .									
			•	C	Chrysallida ob	otusa (Brow	rn, 1827)									
			•	C	Chrysallida su	<i>turalis</i> (Phi	lippi, 1844)									
		0	•	T	Furbonilla gas	<i>taldi</i> auct. (?Semper, 1861)								
			•	T	<i>furbonilla</i> cf.	superstructe	a Boettger, 190)7								
	•	0	•	T	furbonilla lan	<i>ceae</i> (Libas	si, 1859)									
		0	•	T	Furbonilla mio	ocrassulata	(Sacco, 1892)									
			•	T	furbonilla plic	opupoides (S	Sacco, 1892)									
		0	•	E	Eulimella scill	ae (Scacchi	, 1835)							_		
			•	E	Eulimella ceru	llii (Cossm	ann, 1915)									
•	•	•		• 0	lathrella clat	hrata (Phili	ippi 1844)									
	0	0	•	N.	Aonotygma el	ata (von Ko	benen, 1882)									
			•	A	Inisocycla poi	<i>inteli</i> (De Fo	olin, 1868)									
			•	A	Inisocycla niti	idissima (M	lontagu, 1803)									
					Tenrya wareni	<i>i</i> nov. sp.										
	•	•	?	R	<i>dissopsetia</i> ? sp	p.	1000				•					
					Acteon' semis	triatus (Fer	ussac, 1822)									
				- 2	Acteon subpu	inctulatus B	Soettger, 1902									
					Acteon proble	ematicus no	ov. sp.									
					lingicula exili Pingigula lagy	icata (Eich	1, 1029									
					lingicula idev Zingicula min	ar (Gratelou	(1830)									
			0		Ingiculu mine	hydatis mio	.p, 1656)	- 1053								
					tvs latesulcat	a (Boettger	\cdot 1902)	, 1955								
					Aicratys fragi	lissimus por	, 1902) V sn									
					Philine catena	(Montagu	1803)									
			2		Philine aff int	ricata Mont	terosato 1884									
				• P	Philine scabra	(Müller 17	776)					1				
				P	Philine sevitho	sanensis no	ov. sp.									
		•	•		Cylichna clath	rata (Defra	nce, 1825)]				
	0	•		• 0	Cylichna subc	vlindrica (d	'Orbigny, 185	2)								
•	0	0			Roxania utricu	ulus (Brocch	ni, 1814)	-/								
•	•	•		• A	Acteocina laio	nkaireana (de Basterot, 18	325)								
				• A	Acteocina voes	slauensis (B	Berger, 1953)	· /								
			•	• 5	Scaphander de	ertonensis (S	Sacco, 1896)									
			•	R	Retusa decusso	ata Sacco, 1	896									
			?	R	Retusa cf. sub	angystoma	(d'Orbigny, 18	352)								
				• <i>R</i>	Retusa umbilic	ata (Monta	igu, 1803)	^ 								
	1	1				`										1



Systematics and palaeobiogeography of the gastropods of the middle Miocene (Serravallian) Karaman Basin, Turkey

Fissurellidae

- 1. Lucapinella clypeata (Grateloup, 1828), NHMW 1874/0058/0924, locality 17, Seyithasan, maximum diameter 7.6 mm [p. 23].
- 2. *Diodora gibberula* (Lamarck, 1822), RGM 794 072 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, maximum diameter 10.3 mm [p. 24].

Trochidae

- 3. *Clanculus (Clanculopsis) cruciatus* (Linnaeus, 1758), RGM 794 088 (ex JvdV collection), locality 17, Seyithasan, height 12.2 mm [p. 25].
- 4. Jujubinus celinae (Andrzejowski, 1833), NHMW 1874/0058/0929, locality 17, Seyithasan, height 7.4 mm [p. 25].
- Jujubinus celinae (Andrzejowski, 1833), NHMW 1874/0058/0931, localities 7 & 8, Akboğazi, Lale RiverRiver, height 12.5 mm [p. 25].
- 6. Jujubinus hoernesianus Sacco, 1896, NHMW 1874/0058/0932, locality 13, Pinarlar Yaylasi, Akpinar, height 5.5 mm [p. 26].
- 7. Gibbula catenularis (Eichwald, 1830), NHMW 1874/0058/0935, locality 17, Seyithasan, height 15.2 mm [p. 27].
- 8. *Paroxystele orientale* (Cossmann & Peyrot, 1917), NHMW 1874/0058/0937, localities 7 & 8, Akboğazi, Lale RiverRiver, height 18.5 mm [p. 28].

Turbinidae

- 9. Bolma meynardi (Michelotti, 1847), NHMW 1874/0058/1044, locality 17, Seyithasan, maximum diameter 62.2 mm [p. 30].
- 10. Bolma meynardi (Michelotti, 1847), NHMW 1874/0058/1045, locality 17, Seyithasan, maximum diameter 54.8 mm [p. 30].
- 11. Bolma meynardi (Michelotti, 1847), NHMW 1874/0058/1046, locality 17, Seyithasan, maximum diameter 57.3 mm [p. 30].
- 12. Bolma meynardi (Michelotti, 1847), operculum, NHMW 1874/0058/1043, locality 13, Pinarlar Yaylası, Akpınar, maximum diameter 22.7 mm [p. 30].





Turbinidae

1. Ormastralium carinatum (Borson, 1821), RGM 794 558 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 37.3 mm [p. 32].

Trochidae

- 2. Gibbula sp. NHMW 1874/0058/0934, localities 7 & 8, Akboğazi, Lale RiverRiver, height 9.3 mm [p. 26].
- 3. Calliostoma miliare (Brocchi, 1814), RGM 794 559 (ex JvdV collection), locality 17, Seyithasan, height 11.7 mm [p. 34].
- 4. Gibbula cf. sagus (Defrance, 1828), NHMW 1874/0058/0940, locality 17, Seyithasan, height 21.7 mm [p. 26].
- 5. Gibbula cf. sagus (Defrance, 1828), NHMW 1874/0058/0941, locality 17, Seyithasan, height 16.8 mm [p. 26].

Phasianellidae

6. Tricolia eichwaldi (Hörnes, 1855), NHMW 1847/0058/1282, locality 17, Seyithasan, height 5.3 mm [p. 34].

Neritidae

- 7. *Nerita asperata* (Dujardin, 1837), RGM 794 519, locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, maximum diameter 21.1 mm [p. 35].
- 8. *Nerita asperata* (Dujardin, 1837), RGM 794 520, locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, maximum diameter 16.9 mm [p. 35].
- 9. *Theodoxus grateloupianus* (Férussac, 1823), RGM 794 050 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, maximum diameter 16.0 mm [p. 35].
- Theodoxus grateloupianus (Férussac, 1823), RGM 794 051 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, maximum diameter 14.1 mm [p. 35].
- 11. Agapilia picta (Férussac, 1823), NHMW 1874/0058/0947, locality 17, Seyithasan, maximum diameter 8.9 mm [p. 36].
- 12. Agapilia picta (Férussac, 1823), NHMW 1874/0058/0948, locality 17, Seyithasan, maximum diameter 7.3 mm [p. 36].
- 13. Agapilia picta (Férussac, 1823), NHMW 1874/0058/0949, locality 17, Seyithasan, maximum diameter 6.9 mm [p. 36].
- 14. Agapilia picta (Férussac, 1823), NHMW 1874/0058/0950, locality 17, Seyithasan, maximum diameter 6.8 mm [p. 36].

Phenacolepadidae

15. Phenacolepas ancyliformis (Grateloup, 1828), RGM 783 573, locality 17, Seyithasan, maximum diameter 5.0 mm [p. 38].



Melanopsidae

- 1. *Melanopsis impressa* Krauss, 1852, RGM 794 049 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 30.7 mm [p. 38].
- Melanopsis impressa Krauss, 1852, RGM 794 076 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 36.8 mm [p. 38].
- 3. *Melanopsis glandicula* Sandberger, 1870, RGM 794 071 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 26.1 mm [p. 39].

Thiaridae

4. *Holandriana patula* (Bellardi & Michelotti, 1840), RGM 794 075 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 23.9 mm [p. 39].

Cerithiidae

- 5. Thericium ataturki nov. sp., holotype, NHMW 1874/0058/0956, locality 17, Seyithasan, height 11.1 mm [p. 40].
- 6. Thericium ataturki nov. sp., paratype 1, RGM 783 934, locality 17, Seyithasan, height 12.7 mm [p. 40].
- 7. Thericium miocenicum (Vignal, 1911), NHMW 1874/0058/0960, locality 17, Seyithasan, height 28.1 mm [p. 40].
- 8. Thericium miospinosum (Sacco, 1895), NHMW 1874/0058/0962, locality 17, Seyithasan, height 77.5 mm [p. 41].
- 9. Thericium rubiginosum (Eichwald, 1830), NHMW 1874/0058/1503, locality 17, Seyithasan, height 15.5 mm [p. 42].
- 10. *Thericium vulgatum* (Bruguière, 1792), RGM 794 070 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 20.4 mm [p. 42].
- 11. ?Thericium sp., RGM 783 844, locality 13, Pinarlar Yaylasi, Akpinar, height 23.6 mm [p. 44].



Batillariidae

- 1. *Batillaria? pupaeformis* (de Basterot, 1825), NHMW 1847/0058/1651, locality 17a, Seyithasan 'brackish level', height 13.1 mm [p. 44].
- 2. *Batillaria*? *pupaeformis* (de Basterot, 1825), RGM 794 067 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 9.2 mm [p. 44].
- 3. *Granulolabium bicinctum* (Brocchi, 1814), RGM 794 073 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 10.0 mm [p. 45].
- 4. *Granulolabium bicinctum* (Brocchi, 1814), RGM 794 074 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 16.1 mm [p. 45].
- Tiaracerithium eceae nov. sp., holotype, RGM 783 998 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 16.3 mm [p. 47].
- 6. *Tiaracerithium eceae* nov. sp., **paratype 6**, NHMW 1847/0058/1652, locality 17a, Seyithasan 'brackish level', height 17.5 mm [p. 47].

Dialidae

- 7. Gibborissoia angulosa nov. sp., holotype, RGM 783 974 (RGM collection), locality 17, Seyithasan, height 8.7 mm [p. 49].
- 8. Gibborissoia angulosa nov. sp., YI 468 (YI collection), locality 17, Seyithasan, height 7.9 mm [p. 49].
- 9. Gibborissoia varicosa (de Basterot, 1825), RGM 783 939 (RGM collection), locality 17, Seyithasan, height 6.7 mm [p. 49].
- 10. Gibborissoia cf. denudata (Hilber, 1879), NHMW 1874/0058/0998, locality 17, Seyithasan, height 9.5 mm [p. 50].

Potamididae

- 11. Terebralia lignitarum (Eichwald, 1830), NHMW 1874/0058/0980, locality 17, Seyithasan, maximum diameter 43.2 mm [p. 51].
- 12. Terebralia duboisi (Hörnes, 1855), NHMW 1874/0058/0983, locality 17, Seyithasan, height 38.1 mm [p. 53].
- 13. *Potamides nodosoplicatus* (Hörnes, 1855), RGM 794 068 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 10.7 mm [p. 54].
- 14. *Potamides nodosoplicatus* (Hörnes, 1855), RGM 794 069 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 9.1 mm [p. 54].

Modulidae

15. Modulus basteroti Benoist, 1874, NHMW 1847/0058/1572, locality 17a, Seyithasan 'brackish level', height 7.5 mm [p. 57].



Potamididae

- 1. Bittium reticulatum (da Costa, 1778), NHMW 1874/0058/0985, locality 17, Seyithasan, height 8.9 mm [p. 55].
- 2. Bittium reticulatum (da Costa, 1778), NHMW 1874/0058/0986, locality 13, Pinarlar Yaylasi, Akpinar, height 12.0 mm [p. 55].
- 3. Bittium reticulatum (da Costa, 1778), NHMW 1874/0058/0987, locality 13, Pinarlar Yaylasi, Akpinar, height 11.8 mm [p. 55].
- 4. Bittium reticulatum (da Costa, 1778), NHMW 1874/0058/0988, locality 13, Pinarlar Yaylasi, Akpinar, height 10.8 mm [p. 55].
- 5. Bittium sp., NHMW 1874/0058/0992, locality 17, Seyithasan, height 9.5 mm [p. 56].
- 6. Bittium sp., NHMW 1874/0058/0993, locality 17, Seyithasan, height 7.5 mm [p. 56].
- 7. Bittium sp., NHMW 1874/0058/0994, locality 17, Seyithasan, height 7.6 mm [p. 56].

Siliquariidae

8. *Tenagodus* (*Tenagodus*) obtusus (Schumacher, 1817), NHMW 1874/0058/0999, locality 13, Pinarlar Yaylasi, Akpinar, height 40.4 mm [p. 58].

Turritellidae

- 9. Ptychidia vindobonensis (Handmann, 1882), NHMW 1874/0058/1001, locality 13, Pinarlar Yaylası, Akpinar, height 59.7 mm [p. 58].
- 10. Oligodia bicarinata (Eichwald, 1830), NHMW 1874/0058/1004, locality 17, Seyithasan, height 64.9 mm [p. 61].
- 11. *Helminthia vermicularis* (Brocchi, 1814), RGM 794 063 (ex JvdV collection), locality 13, Pınarlar Yaylası, Akpınar, height 122.0 mm [p. 62].
- 12. *Mesalia cochleata* (Brocchi, 1814), RGM 794 566 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, subadult, height 24.6 mm [p. 64].
- 13. Mesalia cochleata (Brocchi, 1814), NHMW 1874/0058/1009, locality 17, Seyithasan, height 29.8 mm [p. 64].
- 14. Mesalia cochleata (Brocchi, 1814), NHMW 1874/0058/1010, locality 17, Seyithasan, height 23.3 mm [p. 64].

Vermetidae

- 15. Petaloconchus intortus (Lamarck, 1818), NHMW 1874/0058/1011, locality 13, Pinarlar Yaylasi, Akpinar, height 42.2 mm [p. 65].
- Tylacodes arenarius (Linnaeus, 1758) with two specimens of Petaloconchus intortus (Lamarck, 1818) attached on the left, NHMW 1874/0058/1093, locality 17, Seyithasan, maximum diameter 43.6 mm [p. 66].

Turritellidae

17. Vermicularia milleti (Deshayes, 1839), NHMW 1874/0058/1669, locality 13, Pinarlar Yaylası, Akpinar, height 10.3 mm [p. 65].



Rissoidae

- 1. Rissoa clotho Hörnes, 1856, NHMW 1874/0058/1026, locality 17, Seyithasan, height 3.5 mm [p. 68].
- 2. Pusillina philippi (Aradas & Maggiore, 1844), NHMW 1874/0058/1015, locality 17, Seyithasan, height 3.3 mm [p. 69].
- 3. Alvania critica Boettger, 1907, NHMW 1874/0058/1017, locality 17, Seyithasan, height 2.5 mm [p. 70].
- 4. Alvania lachesis (de Basterot, 1825), NHMW 1874/0058/1019, locality 17, Seyithasan, height 3.4 mm [p. 70].
- 5. Alvania miocenica Sacco, 1895, NHMW 1874/0058/1021, locality 17, Seyithasan, height 3.0 mm [p. 71].
- 6. Alvania perregularis (Sacco, 1895), NHMW 1874/0058/1023, locality 17, Seyithasan, height 3.4 mm [p. 72].
- 7. Alvania productilis Boettger, 1907, NHMW 1874/0058/1024, locality 17, Seyithasan, height 2.9 mm [p. 73].
- 8. Alvania transiens (Sacco, 1895), NHMW 1874/0058/1372, locality 17, Seyithasan, height 3.7 mm [p. 73].
- 9. Rissoina subconoidea (Grateloup, 1846), NHMW 1874/0058/1028, locality 13, Pinarlar Yaylasi, Akpinar, height 7.9 mm [p. 75].
- 10. Rissoina vindobonensis Sacco, 1895, NHMW 1874/0058/1030, locality 17, Seyithasan, height 4.3 mm [p. 75].
- Rissoina (Zebinella) extranea (Eichwald, 1830), NHMW 1874/0058/1031, locality 13, Pinarlar Yaylasi, Akpinar, height 7.5 mm [p. 76].
- 12. Rissoina (Zebinella) obsoleta Hörnes, 1856, NHMW 1874/0058/1032, locality 17, Seyithasan, height 12.3 mm [p. 76].
- 13. Rissoina (Zebinella) cf. decussata (Montagu, 1803), NHMW 1874/0058/1036, locality 17, Seyithasan, height 5.4 mm [p. 77].
- 14. Stossicia multicingulata (Boettger, 1887), RGM 794 166 (ex JvdV collection), locality 17, Seyithasan, height 5.0 mm [p. 77].



Iravadiidae

- 1. Pseudonoba striata (Hornes, 1856), NHMW 1874/0058/1038, locality 17, Seyithasan, height 4.5 mm [p. 78].
- 2. Rhombostoma? meesi nov. sp., holotype, NHMW 1847/0058/1484, locality 17, Seyithasan, height 7.5 mm [p. 80].

Elachisinidae

- 3. *Elachisinia hoernesi* (Boettger, 1902), NHMW 1874/0058/1098, localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 3.6 mm [p. 82].
- 4. Hyala vitrea (Montagu, 1803), RGM 783 945, locality 17, Seyithasan, height 2.6 mm [p. 78].
- 5. Tornus karamanensis nov. sp., holotype RGM 783 978, locality 17, Seyithasan, maximum diameter 2.5 mm [p. 84].
- 6. Tornus karamanensis nov. sp., paratype 1 RGM 783 979, locality 17, Seyithasan, maximum diameter 2.3 mm [p. 84].

Vitrinellidae

- 7. Circulus miotaurinensis (Sacco, 1896), NHMW 1874/0058/1095, locality 17, Seyithasan, maximum diameter 3.0 mm [p. 85].
- 8. *Circulus supranitidus* (Wood, 1842), NHMW 1874/0058/1096, localities 7 & 8, Akboğazi, Lale RiverRiver, maximum diameter 1.8 mm [p. 87].
- 9. Idioraphe defrancei (de Basterot, 1825), NHMW 1874/0058/1097, locality 17, Seyithasan, maximum diameter 1.5 mm [p. 87].
- 10. Idioraphe minima (Boettger, 1907), RGM 783 943, locality 17, Seyithasan, maximum diameter 1.5 mm [p. 88].
- 11. Megatyloma auingeri (Boettger, 1902), NHMW 1847/0058/1483, locality 17, Seyithasan, maximum diameter 2.1 mm [p. 88].
- 12. Solariorbis woodi (Hörnes, 1856), NHMW 1874/0058/1099, locality 17, Seyithasan, maximum diameter 3.0 mm [p. 89].



Strombidae

Persististrombus inflexus (Eichwald, 1830), NHMW 1874/0058/1392, locality 17, Seyithasan, height 100.1 mm [p. 89].
Persististrombus inflexus (Eichwald, 1830), NHMW 1874/0058/1393, locality 17, Seyithasan, height 77.4 mm [p. 89].
Persististrombus inflexus (Eichwald, 1830), NHMW 1874/0058/1394, locality 17, Seyithasan, height 67.9 mm [p. 89].
Persististrombus inflexus (Eichwald, 1830), NHMW 1874/0058/1395, locality 17, Seyithasan, height 93.4 mm [p. 89].
Persististrombus inflexus (Eichwald, 1830), NHMW 1874/0058/1395, locality 17, Seyithasan, height 93.4 mm [p. 89].
Persististrombus inflexus (Eichwald, 1830), NHMW 1874/0058/1396, locality 17, Seyithasan, height 69.0 mm [p. 89].
Persististrombus inflexus (Eichwald, 1830), NHMW 1874/0058/1397, locality 17, Seyithasan, height 69.0 mm [p. 89].
Persististrombus inflexus (Eichwald, 1830), NHMW 1874/0058/1398, locality 17, Seyithasan, height 60.8 mm [p. 89].
Persististrombus inflexus (Eichwald, 1830), NHMW 1874/0058/1398, locality 17, Seyithasan, height 60.8 mm [p. 89].
Persististrombus inflexus (Eichwald, 1830), NHMW 1874/0058/1399, locality 17, Seyithasan, height 60.8 mm [p. 89].



Aporrhaidae

1. Aporrhais dactylifera (Boettger, 1902), NHMW 1874/0058/1102, locality 13, Pinarlar Yaylası, Akpinar, height 30.0 mm [p. 92].

- 2. Aporrhais dactylifera (Boettger, 1902), NHMW 1874/0058/1103, locality 13, Pinarlar Yaylasi, Akpinar, height 28.5 mm [p. 92].
- 3. Aporrhais dactylifera (Boettger, 1902), NHMW 1874/0058/1104, locality 13, Pinarlar Yaylasi, Akpinar, height 30.2 mm [p. 92].
- 4. Aporrhais pespelecani (Linnaeus, 1758), NHMW 1874/0058/1106, locality 17, Seyithasan, height 31.9 mm [p. 93].
- 5. Aporrhais pespelecani (Linnaeus, 1758), NHMW 1874/0058/1107, locality 17, Seyithasan, height 28.9 mm [p. 93].
- 6. Aporrhais pespelecani (Linnaeus, 1758), NHMW 1874/0058/1108, locality 17, Seyithasan, height 28.8 mm [p. 93].

Calyptraeidae

- 7. Calyptraea chinensis (Linnaeus, 1758), NHMW 1874/0058/1111, locality 17, Seyithasan, height 31.7 mm [p. 95].
- 8. Crepidula gibbosa Defrance, 1818, NHMW 1874/0058/1113, locality 13, Pinarlar Yaylasi, Akpinar, height 16.9 mm [p. 96].
- 9. Crepidula gibbosa Defrance, 1818, NHMW 1874/0058/1114, locality 13, Pinarlar Yaylasi, Akpinar, height 15.5 mm [p. 96].
- 10. Crepidula unguiformis Lamarck, 1822, NHMW 1874/0058/1116, locality 17, Seyithasan, height 20.2 mm [p. 96].

Xenophoridae

11. Xenophora deshayesi (Michelotti, 1847), RGM 794 546 (ex JvdV collection), locality 17, Seyithasan, height 82.6 mm [p. 97].

12. Xenophora deshayesi (Michelotti, 1847), NHMW 1874/0058/1062, locality 17, Seyithasan, height 49.2 mm [p. 97].



Xenophoridae

- 1. Xenophora italica (Grateloup, 1845), NHMW 1874/0058/1064, locality 17, Seyithasan, height 60.0 mm [p. 99].
- 2. Xenophora italica (Grateloup, 1845), NHMW 1874/0058/1065, locality 17, Seyithasan, height 76.2 mm [p. 99].
- 3. Xenophora italica (Grateloup, 1845), NHMW 1874/0058/1079, locality 13, Pinarlar Yaylasi, Akpinar, height 53.8 mm [p. 99].
- 4. Xenophora sp. A, NHMW 1874/0058/1041, locality 13, Pınarlar Yaylası, Akpınar, height 40.0 mm [p. 100].



Naticidae

- 1. Cochlis curta (Erünal-Erentöz, 1958), NHMW 1874/0058/1346, locality 13, Pinarlar Yaylası, Akpınar, height 28.0 mm [p. 100].
- 2. Cochlis sp. 2, NHMW 1874/0058/1349, locality 13, Pinarlar Yaylasi, Akpinar, height 33.4 mm [p. 101].
- 3. Cochlis sp. 2, NHMW 1874/0058/1350, locality 13, Pinarlar Yaylasi, Akpinar, height 27.5 mm [p. 101].
- 4. Cochlis sp. 3, NHMW 1874/0058/1353, locality 17, Seyithasan, height 32.6 mm [p. 102].
- 5. Cochlis sp. 3, NHMW 1874/0058/1354, locality 17, Seyithasan, height 28.7 mm [p. 102].
- 6. Tectonatica tectula (Sacco, 1890), NHMW 1874/0058/1362, locality 17, Seyithasan, height 5.1 mm [p. 102].
- 7. Polinices redemptus (Michelotti, 1847), NHMW 1874/0058/1356, locality 17, Seyithasan, height 35.0 mm [p. 105].
- 8. Neverita olla (de Serres, 1829), NHMW 1874/0058/1360, locality 17, Seyithasan, height 15.7 mm [p. 107].
- 9. *Euspira helicina helicina* (Brocchi, 1814), NHMW 1874/0058/1365, locality 13, Pinarlar Yaylası, Akpınar, height 24.2 mm [p. 103].





Naticidae

- 1. *Euspira helicina helicina* (Brocchi, 1814), NHMW 1874/0058/1367, locality 13, Pınarlar Yaylası, Akpınar, height 32.0 mm [p. 103].
- Euspira helicina helicina (Brocchi, 1814), NHMW 1874/0058/1368, locality 13, Pinarlar Yaylası, Akpınar, height 14.3 mm [p. 103].
- 3. *Euspira helicina helicina* (Brocchi, 1814), NHMW 1874/0058/1369, locality 13, Pinarlar Yaylasi, Akpinar, height 18.3 mm [p. 103].
- 4. Euspira guillemini (Payraudeau, 1826), NHMW 1874/0058/1505, locality 17, Seyithasan, height 6.4 mm [p. 103].
- 5. Sinum striatum (de Serres, 1829), NHMW 1847/0058/1658, locality 17, Seyithasan, maximum diameter 28.6 mm [p. 110].

Triviidae

- 6. Trivia antiquosphaera Sacco, 1894, NHMW 1874/0058/1285, locality 13, Pinarlar Yaylasi, Akpinar, height 4.8 mm [p. 111].
- 7. Niveria dautzenbergi (Schilder, 1932), NHMW 1874/0058/1286, locality 13, Pinarlar Yaylasi, Akpinar, height 6.4 mm [p. 112].
- 8. Niveria dimidiatoaffinis (Sacco, 1894), NHMW 1874/0058/1287, locality 13, Pinarlar Yaylasi, Akpinar, height 8.8 mm [p. 112].

Eratoidae

- 9. Erato subcypraeola d'Orbigny, 1852, NHMW 1874/0058/1290, locality 13, Pinarlar Yaylasi, Akpinar, height 5.6 mm [p. 113].
- 10. Erato subcypraeola d'Orbigny, 1852, NHMW 1874/0058/1291, locality 13, Pinarlar Yaylasi, Akpinar, height 5.2 mm [p. 113].
- 11. Erato transiens Boettger, 1884, NHMW 1874/0058/1295, locality 13, Pinarlar Yaylasi, Akpinar, height 10.6 mm [p. 114].
- 12. Erato transiens Boettger, 1884, NHMW 1874/0058/1298, locality 17, Seyithasan, height 8.1 mm [p. 114].
- 13. Erato transiens Boettger, 1884, NHMW 1874/0058/1299, locality 17, Seyithasan, height 7.5 mm [p. 114].
- 14. Erato transiens Boettger, 1884, NHMW 1874/0058/1300, locality 17, Seyithasan, height 8.9 mm [p. 114].
- 15. Hespererato cf. cocconii Schilder, 1933, NHMW 1874/0058/1301, locality 13, Pinarlar Yaylasi, Akpinar, height 6.1 mm [p. 115].
- 16. Hespererato cf. cocconii Schilder, 1933, NHMW 1874/0058/1302, locality 13, Pinarlar Yaylasi, Akpinar, height 6.9 mm [p. 115].



Cypraeidae

1. Schilderia transsylvanica (Schilder, 1927), NHMW 1847/0058/1305, locality 17, Seyithasan, height 22.6 mm [p. 115].

2. Schilderia transsylvanica (Schilder, 1927), NHMW 1847/0058/1306, locality 17, Seyithasan, height 22.6 mm [p. 115].

3. Schilderia transsylvanica (Schilder, 1927), NHMW 1847/0058/1307, locality 17, Seyithasan, height 19.0 mm [p. 115].

4. Schilderia transsylvanica (Schilder, 1927), NHMW 1847/0058/1308, locality 17, Seyithasan, height 21.5 mm [p. 115].

5. Schilderia labrocostata (Schilder, 1925), NHMW 1847/0058/1519, locality 17, Seyithasan, height 24.2 mm [p. 117].

6. Schilderia labrocostata (Schilder, 1925), NHMW 1847/0058/1520, locality 17, Seyithasan, height 24.5 mm [p. 117].

7. Zonarina hoernesiana (Sacco, 1894), NHMW 1847/0058/1521, locality 17, Seyithasan, height 35.9 mm [p. 117].





Cypraeidae

- 1. Zonarina hoernesiana (Sacco, 1894), RGM 794 054 (ex JvdV collection), locality 17, Seyithasan, height 35.5 mm [p. 117].
- 2. Zonarina hoernesiana (Sacco, 1894), RGM 794 055 (ex JvdV collection), locality 17, Seyithasan, height 31.3 mm [p. 117].
- 3. Zonarina sp., NHMW 1847/0058/1528, locality 13, Pinarlar Yaylasi, Akpinar, height 47.3 mm [p. 121].
- 4. Zonarina cf. dertamygdaloides (Sacco, 1894), NHMW 1847/0058/1686, locality 13, Pinarlar Yaylası, Akpınar, height 32.1 mm [p. 122].





Cypraeidae

- 1. Zonarina provincialis (Mathéron, 1842), NHMW 1847/0058/1316, locality 13, Pinarlar Yaylası, Akpinar, height 43.2 mm [p. 118].
- Zonarina provincialis (Mathéron, 1842), NHMW 1847/0058/1317, locality 13, Pinarlar Yaylasi, Akpinar, height 41.6 mm [p. 118].
- 3. Zonarina cf. tauroporcellus (Sacco, 1894), NHMW 1847/0058/1327, locality 17, Seyithasan, height 47.6 mm [p. 120].
- 4. Zonarina cf. tauroporcellus (Sacco, 1894), NHMW 1847/0058/1328, locality 17, Seyithasan, height 44.9 mm [p. 120].



Cypraeidae

- 1. Zonarina phyletica (Schilder, 1923), RGM 794 540 (ex JvdV collection), locality 17, Seyithasan, height 61.1 mm [p. 120].
- 2. Zonarina phyletica (Schilder, 1923), NHMW 1847/0058/1337, locality 17, Seyithasan, height 60.8 mm [p. 120].
- 3. ?Zonarina phyletica (Schilder, 1923), JvdV collection, locality 13, Pınarlar Yaylası, Akpınar, height 78.0 mm [p. 120].



Tonnidae

1. Malea orbiculata (Brocchi, 1814), RGM 794 541 (ex JvdV collection), locality 17, Seyithasan, height 55.6 mm [p. 123].

Cassidae

- 2. Cassis postmamillaris Sacco, 1890, NHMW 1847/0058/0687, locality 17, Seyithasan, height 106.0 mm [p. 123].
- 3. Cassis postmamillaris Sacco, 1890, NHMW 1847/0058/0689, locality 17, Seyithasan, height 105.5 mm [p. 123].
- 4. Cassis postmamillaris Sacco, 1890, NHMW 1847/0058/0698, locality 17, Seyithasan, height 98.5 mm [p. 123].
- 5. *Cypraecassis cypraeiformis* (Borson, 1820), NHMW 1847/0058/0644, locality 13, Pinarlar Yaylasi, Akpinar, height 42.3 mm [p. 124].
- 6. Semicassis laevigata (Defrance, 1817), NHMW 1847/0058/0649, locality 13, Pinarlar Yaylasi, Akpinar, height 58.1 mm [p. 125].


Ranellidae

- 1. *Charonia lampas* (Linnaeus, 1758), RGM 794 543 (ex JvdV collection), locality 13, Pinarlar Yaylası, Akpınar, height 74.1 mm [p. 126].
- 2. Charonia lampas (Linnaeus, 1758), NHMW 1847/0058/0655, locality 13, Pinarlar Yaylası, Akpinar, height 68.0 mm [p. 126].
- 3. Charonia lampas (Linnaeus, 1758), NHMW 1847/0058/0654, locality 13, Pinarlar Yaylasi, Akpinar, height 27.8 mm [p. 126].
- 4. Cymatium sp., RGM 794 542 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 74.1 mm [p. 126].
- 5. Monoplex corrugatus (Lamarck, 1816), NHMW 1847/0058/0656, locality 13, Pinarlar Yaylasi, Akpinar, height 54.6 mm [p. 127].
- 6. Monoplex corrugatus (Lamarck, 1816), NHMW 1847/0058/0657, locality 17, Seyithasan, height 53.8 mm [p. 127].
- 7. Monoplex corrugatus (Lamarck, 1816), NHMW 1847/0058/0658, locality 17, Seyithasan, height 45.5 mm [p. 127].
- 8. Monoplex heptagonus (Brocchi, 1814), NHMW 1847/0058/0662, locality 13, Pinarlar Yaylasi, Akpinar, height 33.8 mm [p. 128].
- 9. Monoplex heptagonus (Brocchi, 1814), NHMW 1847/0058/0663, locality 13, Pinarlar Yaylasi, Akpinar, height 34.6 mm [p. 128].
- 10. Monoplex heptagonus (Brocchi, 1814), NHMW 1847/0058/0664, locality 13, Pinarlar Yaylasi, Akpinar, height 33.1 mm [p. 128].
- 11. *Monoplex parthenopeus* (von Salis Marschlins, 1793), RGM 794 066 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 49.6 mm [p. 128].
- 12. Monoplex parthenopeus (von Salis Marschlins, 1793), NHMW 1847/0058/0667, locality 17, Seyithasan, height 74.4 mm [p. 128].
- 13. Monoplex sp., RGM 794 557 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 33.9 mm [p. 129].



Ranellidae

- 1. Turritriton kobelti (von Maltzan, 1884), NHMW 1847/0058/0670, locality 13, Pinarlar Yaylasi, Akpinar, height 18.8 mm [p. 129].
- 2. Turritriton kobelti (von Maltzan, 1884), NHMW 1847/0058/0671, locality 13, Pinarlar Yaylasi, Akpinar, height 20.1 mm [p. 129].
- 3. Turritriton kobelti (von Maltzan, 1884), NHMW 1847/0058/0672, locality 13, Pinarlar Yaylasi, Akpinar, height 19.2 mm [p. 129].
- 4. Sassia apenninica (Sassi, 1827), NHMW 1847/0058/0673, locality 13, Pinarlar Yaylasi, Akpinar, height 28.4 mm [p. 130].
- 5. Sassia turrita (Eichwald, 1830), NHMW 1847/0058/0675, locality 13, Pinarlar Yaylasi, Akpinar, height 41.6 mm [p. 130].
- 6. Sassia turrita (Eichwald, 1830), NHMW 1847/0058/0676, locality 13, Pinarlar Yaylası, Akpınar, height 36.8 mm [p. 130].
- 7. Sassia turrita (Eichwald, 1830), NHMW 1847/0058/0677, locality 13, Pinarlar Yaylasi, Akpinar, height 31.2 mm [p. 130].
- 8. Sassia turrita (Eichwald, 1830), NHMW 1847/0058/0678, locality 13, Pinarlar Yaylasi, Akpinar, height 32.2 mm [p. 130].

Bursidae

9. Aspa marginata (Gmelin, 1791), NHMW 1847/0058/0680, locality 13, Pinarlar Yaylası, Akpınar, height 42.9 mm [p. 131].

Personidae

- 10. Distorsio cancellina (Lamarck, 1803), NHMW 1847/0058/0682, locality 13, Pinarlar Yaylasi, Akpinar, height 70.4 mm [p. 132].
- 11. *Distorsio cancellina* (Lamarck, 1803), RGM 794 544 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 59.6 mm [p. 132].
- 12. *Distorsio cancellina* (Lamarck, 1803), NHMW 1847/0058/0683, locality 13, Pinarlar Yaylasi, Akpinar, juvenile, height 35.0 mm [p. 132].

Ficidae

13. Ficus condita (Brongniart, 1823), NHMW 1847/0058/0685, locality 13, Pinarlar Yaylasi, Akpinar, height 52.3 mm [p. 132].



Triphoridae

- 1. ?Epetrium sp., NHMW 1874/0058/1118, locality 13, Pinarlar Yaylası, Akpinar, height 7.2 mm [p. 134].
- 2. ?Epetrium sp., NHMW 1874/0058/1119, locality 13, Pinarlar Yaylasi, Akpinar, height 8.0 mm [p. 134].
- 3. Triphora (s. lat.) sp., NHMW 1874/0058/1121, locality 17, Seyithasan, height 6.4 mm [p. 134].
- 4. Strobiligera sp., NHMW 1874/0058/1123, locality 17, Seyithasan, height 8.9 mm [p. 135].

Cerithiopsidae

- 5. Cerithiella sp., NHMW 1874/0058/1467, locality 17, Seyithasan, height 12.7 mm [p. 135].
- 6. *Cerithiopsis (s. lat.)* cf. *bilineata* (Hörnes, 1848), RGM 776 940 (ex JvdV collection), localities 7 & 8, Akboğazi, Lale RiverRiver, maximum diameter 3.2 mm [p. 136].

Epitoniidae

- 7. Epitonium cf. pliosubappenninum (Sacco, 1891), NHMW 1874/0058/1124, locality 17, Seyithasan, height 5.4 mm [p. 138].
- 8. Epitonium miofrondiculoides (Sacco, 1891), NHMW 1874/0058/1125, locality 17, Seyithasan, height 7.3 mm [p. 138].
- 9. Epitonium pulchellum (Bivona, 1832), NHMW 1874/0058/1126, locality 17, Seyithasan, height 3.8 mm [p. 139].
- 10. Epitonium trevelyanum (Johnston, 1841), NHMW 1874/0058/1127, locality 17, Seyithasan, height 8.7 mm [p. 139].
- 11. Cirsotrema pumiceum (Brocchi, 1814), NHMW 1874/0058/1128, locality 17, Seyithasan, height 22.2 mm [p. 140].
- 12. Amaea (Acrilla) kimakowiczi (Boettger, 1896), NHMW 1874/0058/1129, locality 13, Pınarlar Yaylası, Akpınar, height 31.7 mm [p. 140].
- 13. Acrilloscala sp., NHMW 1874/0058/1131, locality 17, Seyithasan, height 5.9 mm [p. 141].
- 14. Acirsa lanceolata (Brocchi, 1814), NHMW 1874/0058/1132, locality 13, Pinarlar Yaylasi, Akpinar, height 15.3 mm [p. 141].

Eulimidae

- 15. Eulima cf. jaskiewiczi (Bałuk, 1995), NHMW 1874/0058/1134, locality 17, Seyithasan, height 10.9 mm [p. 141].
- Campylorhaphion famelicum (Watson, 1883), NHMW 1874/0058/1379, locality 13, Pinarlar Yaylasi, Akpinar, height 14.3 mm [p. 143].



Muricidae

- 1. Bolinus brandaris torularius (Lamarck, 1822), NHMW 1847/0058/0716, locality 17, Seyithasan, height 87.8 mm [p. 144].
- 2. Bolinus submuticus (Grateloup, 1846), NHMW 1847/0058/0518, locality 13, Pinarlar Yaylasi, Akpinar, height 46.3 mm [p. 144].
- 3. *Bolinus submuticus* (Grateloup, 1846), NHMW 1847/0058/0520, localities 7 & 8, Akboğazi, Lale RiverRiver, height 50.9 mm [p. 144].
- 4. *Hexaplex (Trunculariopsis) austriacus* (Tournouër, 1875), NHMW 1847/0058/0783, locality 17, Seyithasan, height 73.0 mm [p. 145].
- 5. Hexaplex (Trunculariopsis) rudis (Borson, 1821), NHMW 1847/0058/0524, locality 17, Seyithasan, height 45.6 mm [p. 146].
- 6. Hexaplex (Trunculariopsis) rudis (Borson, 1821), NHMW 1847/0058/0525, locality 17, Seyithasan, height 41.1 mm [p. 146].
- 7. Hexaplex (Trunculariopsis) rudis (Borson, 1821), NHMW 1847/0058/0527, locality 17, Seyithasan, height 47.6 mm [p. 146].
- 8. Hexaplex (Trunculariopsis) rudis (Borson, 1821), NHMW 1847/0058/0528, locality 17, Seyithasan, height 44.7 mm [p. 146].
- 9. Hexaplex (Trunculariopsis) rudis (Borson, 1821), NHMW 1847/0058/0527, locality 17, Seyithasan, height 29.0 mm [p. 146].
- 10. *Hexaplex (Trunculariopsis) turonensis* (Dujardin, 1837), NHMW 1847/0058/0806, locality 17, Seyithasan, height 81.6 mm [p. 147].
- 11. Chicoreus (Triplex) aquitanicus (Grateloup, 1833), NHMW 1847/0058/0817, locality 17, Seyithasan, height 90.2 mm [p. 147].
- 12. Pterynotus granuliferus (Grateloup, 1833), NHMW 1847/0058/0530, locality 17, Seyithasan, height 56.8 mm [p. 148].
- 13. *Pterynotus granuliferus* (Grateloup, 1833), NHMW 1847/0058/0532, locality 13, Pinarlar Yaylasi, Akpinar, height 46.8 mm [p. 148].



Muricidae

- 1. Dermomurex (Trialatella) kilikiensis nov. sp., holotype, NHMW 1847/0058/0534, locality 13, Pinarlar Yaylasi, Akpinar, height 17.0 mm [p. 149].
- 2. *Dermomurex (Trialatella) kilikiensis* nov. sp., **paratype 1**, NHMW 1847/0058/0535, locality 13, Pinarlar Yaylasi, Akpinar, height 15.8 mm [p. 149].
- 3. Homalocantha heptagonata (Bronn, 1831), RGM 794 553 (ex JvdV collection), locality 17, Seyithasan, height 55.5 mm [p. 150].
- 4. Ocinebrina bicaudata (Borson, 1821), NHMW 1847/0058/0540, locality 17, Seyithasan, height 19.6 mm [p. 150].
- 5. Ocinebrina dertonensis (Mayer in Bellardi, 1873), NHMW 1847/0058/0541, locality 17, Seyithasan, height 27.0 mm [p. 151].
- 6. Ocinebrina kojumdgievae (Bałuk, 1995), NHMW 1847/0058/0543, locality 17, Seyithasan, height 33.3 mm [p. 151].
- 7. Ocinebrina perparva nov. sp., holotype, NHMW 1847/0058/0881, locality 17, Seyithasan, height 12.2 mm [p. 152].
- 8. Ocinebrina perparva nov. sp., paratype 1, NHMW 1847/0058/0882, locality 17, Seyithasan, height 11.2 mm [p. 152].
- 9. Ocinebrina perparva nov. sp., paratype 2, NHMW 1847/0058/0883, locality 17, Seyithasan, height 12.3 mm [p. 152].
- Ocinebrina polonica (Bałuk, 1995), NHMW 1847/0058/0544, localities 7 & 8, Akboğazi, Lale RiverRiver, height 19.0 mm [p. 153].
- 11. Ocinebrina polonica (Bałuk, 1995), NHMW 1847/0058/0545, localities 7 & 8, Akboğazi, Lale River, height 19.1 mm [p. 153].
- 12. *Ocinebrina* sp., NHMW 1847/0058/1441, localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 25.2 mm [p. 153].
- Pteropurpura delbosiana (Grateloup, 1846), NHMW 1847/0058/0548, locality 13, Pinarlar Yaylasi, Akpinar, height 52.4 mm [p. 153].
- Pteropurpura delbosiana (Grateloup, 1846), NHMW 1847/0058/0549, locality 13, Pinarlar Yaylasi, Akpinar, height 62.5 mm [p. 153].



Muricidae

- Pteropurpura delbosiana (Grateloup, 1846), NHMW 1847/0058/0550, locality 13, Pinarlar Yaylasi, Akpinar, height 56.1 mm [p. 153].
- 2. Vitularia linguabovis (de Basterot, 1825), NHMW 1847/0058/0555, locality 17, Seyithasan, height 56.9 mm [p. 154].
- 3. Vitularia linguabovis (de Basterot, 1825), NHMW 1847/0058/0556, locality 17, Seyithasan, height 44.9 mm [p. 154].
- 4. *Stramonita haemostomoides* (Hoernes & Auinger, 1882), NHMW 1847/0058/0572, locality 13, Pinarlar Yaylası, Akpınar, height 43.1 mm [p. 155].
- 5. Orania cheilotoma (Hoernes & Auinger, 1890), NHMW 1847/0058/0574, localities 7 & 8, Akboğazi, Lale River, subadult, height 11.8 mm [p. 156].
- Orania cheilotoma (Hoernes & Auinger, 1890), RGM 794 085 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, subadult, height 15.7 mm [p. 156].
- 7. Janssenia echinulata (Pusch, 1837), RGM 794 086 (ex JvdV collection), locality 17, Seyithasan, height 35.0 mm [p. 157].
- 8. Janssenia echinulata (Pusch, 1837), RGM 794 087 (ex JvdV collection), locality 17, Seyithasan, height 33.8 mm [p. 157].
- 9. *Cathymorula exilis* (Hörnes, 1852), RGM 794 552 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 24.8 mm [p. 158].
- 10. Cathymorula sismondai (Doderlein, 1862), NHMW 1847/0058/0576, locality 17, Seyithasan, height 39.6 mm [p. 159].
- 11. Cathymorula sismondai (Doderlein, 1862), RGM 794 550 (ex JvdV collection), locality 17, Seyithasan, height 33.3 mm [p. 159].



Muricidae

- 1. Daphnellopsis tournoueri Lozouet, Ledon & Lesport, 1993, RGM 794 060 (ex JvdV collection), locality 17, Seyithasan, height 18.1 mm [p. 159].
- 2. Muricopsis (Muricopsis) cristata (Brocchi, 1814), NHMW 1847/0058/0579, locality 17, Seyithasan, height 23.4 mm [p. 160].
- 3. Murexsul sandbergeri (Hörnes, 1856), NHMW 1847/0058/0581, locality 13, Pinarlar Yaylası, Akpinar, height 34.2 mm [p. 160].
- Murexsul sandbergeri (Hörnes, 1856), RGM 794 551 (ex JvdV collection), locality 13, Pinarlar Yaylası, Akpınar, height 35.8 mm [p. 160].
- 5. Favartia suboblonga (d'Orbigny, 1852), NHMW 1847/0058/0583, locality 13, Pinarlar Yaylasi, Akpinar, height 14.1 mm [p. 161].
- 6. Subpterynotus graniferus (Michelotti, 1841), NHMW 1847/0058/0585, locality 17, Seyithasan, height 53.4 mm [p. 162].
- 7. Subpterynotus graniferus (Michelotti, 1841), NHMW 1847/0058/0586, locality 17, Seyithasan, height 47.4 mm [p. 162].
- 8. *Typhinellus labiatus* (Cristofori & Jan, 1832), NHMW 1847/0058/0591, locality 13, Pinarlar Yaylasi, Akpinar, height 17.9 mm [p. 162].
- 9. *Typhinellus labiatus* (Cristofori & Jan, 1832), NHMW 1847/0058/0592, locality 13, Pinarlar Yaylasi, Akpinar, height 20.3 mm [p. 162].
- 10. Coralliophila scarrosa (Bellardi, 1873), NHMW 1847/0058/0596, locality 13, Pinarlar Yaylasi, Akpinar, height 14.6 mm [p. 163].
- 11. Coralliophila scarrosa (Bellardi, 1873), NHMW 1847/0058/0598, locality 17, Seyithasan, height 14.6 mm [p. 163].
- 12. Coralliophila sp., NHMW 1847/0058/0599, locality 17, Seyithasan, height 24.8 mm [p. 163].



Babyloniidae

1. Babylonia eburnoides (Mathéron, 1842), NHMW 1847/0058/0836, locality 17, Seyithasan, height 32.2 mm [p. 164].

Buccinidae

- 2. Euthria curvirostris (Grateloup, 1833), NHMW 1847/0058/0838, locality 13, Pinarlar Yaylasi, Akpinar, height 40.5 mm [p. 165].
- 3. Euthria curvirostris (Grateloup, 1833), NHMW 1847/0058/0839, locality 13, Pinarlar Yaylasi, Akpinar, height 44.1 mm [p. 165].
- 4. *Euthria puschi* (Andrzejowski, 1830), RGM 794 062 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 4.3 mm [p. 165].
- Euthria puschi (Andrzejowski, 1830), RGM 794 554 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 43.6 mm. Colour pattern preserved [p. 165].
- Euthriofusus anatolicus (Toula, 1902), RGM 794 560 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 81.8 mm. Specimen with double row of spines at shoulder [p. 166].
- 7. Euthriofusus anatolicus (Toula, 1902), NHMW 1847/0058/0844, locality 13, Pinarlar Yaylasi, Akpinar, height 71.1 mm [p. 166].
- 8. *Pisania striata* (Gmelin, 1791), RGM 794 081 (ex JvdV collection), locality 6, hill slopes in forest west-northwest of Lale, height 25.6 mm [p. 168].
- 9. *Pisania striata* (Gmelin, 1791), NHMW 1847/0058/0888, locality 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 21.5 mm [p. 168].
- 10. Anna exsculpta (Dujardin, 1837), NHMW 1847/0058/0889, locality 17, Seyithasan, height 18.6 mm [p. 168].
- 11. Anna exsculpta (Dujardin, 1837), NHMW 1847/0058/0979, locality 17, Seyithasan, height 18.6 mm [p. 168].
- Europhos polygonus (Brocchi, 1814), RGM 794 555 (ex JvdV collection), locality 13, Pinarlar Yaylası, Akpinar, height 28.2 mm [p. 170].
- Europhos connectens (Bellardi, 1882), RGM 794 563 (ex JvdV collection), locality 13, Pinarlar Yaylası, Akpinar, height 21.5 mm [p. 172].

Nassariidae

- 14. Nassarius doliolum (Eichwald, 1830) forma tonsura (Hilber, 1897), NHMW 1847/0058/0732, locality 17, Seyithasan, height 22.6 mm [p. 181].
- 15. Nassarius doliolum (Eichwald, 1830) forma tonsura (Hilber, 1897), NHMW 1847/0058/0733, locality 17, Seyithasan, height 20.7 mm [p. 181].
- 16. Nassarius doliolum (Eichwald, 1830) forma tonsura (Hilber, 1897), NHMW 1847/0058/0734, locality 17, Seyithasan, height 19.9 mm [p. 181].
- 17. Nassarius spectabilis (Nyst, 1845), NHMW 1847/0058/0765, locality 13, Pinarlar Yaylası, Akpinar, height 19.3 mm [p. 172].



Nassariidae

- 1. Nassarius gilii nov. sp., holotype, NHMW 1847/0058/0767, locality 13, Pinarlar Yaylasi, Akpinar, height 28.3 mm [p. 173].
- 2. Nassarius gilii nov. sp., paratype 1, NHMW 1847/0058/0768, locality 13, Pinarlar Yaylasi, Akpinar, height 27.1 mm [p. 173].
- 3. *Nassarius elatus gayeae* (Erünal-Erentöz, 1958), NHMW 1847/0058/0770, localities 7 & 8, Akboğazi, Lale River, height 12.1 mm [p. 174].
- Nassarius elatus gayeae (Erünal-Erentöz, 1958), NHMW 1847/0058/1455, locality 13, Pinarlar Yaylası, Akpınar, height 11.8 mm [p. 174].
- Nassarius elatus gayeae (Erünal-Erentöz, 1958), NHMW 1847/0058/1456, locality 13, Pinarlar Yaylası, Akpınar, height 8.9 mm [p. 174].
- 6. *Nassarius barbarossai* nov. sp., **holotype**, NHMW 1847/0058/1375, localities 7 & 8, Akboğazi, Lale River, height 11.5 mm [p. 174].
- 7. Nassarius erunalae nov. sp., holotype, NHMW 1847/0058/1453, localities 7 & 8, Akboğazi, Lale River, height 8.1 mm [p. 175].
- 8. Nassarius erunalae nov. sp., paratype 1, NHMW 1847/0058/1454, localities 7 & 8, Akboğazi, Lale River, height 8.0 mm [p. 175].
- 9. Nassarius erentoezae nov. sp., holotype, NHMW 1847/0058/0736, localities 7 & 8, Akboğazi, Lale River, height 11.3 mm [p. 176].
- Nassarius erentoezae nov. sp., paratype 1, NHMW 1847/0058/0737, localities 7 & 8, Akboğazi, Lale River, height 9.8 mm [p. 176].
- 11. Nassarius poelensis (Hilber, 1879), NHMW 1847/0058/1377, localities 7 & 8, Akboğazi, Lale River, height 12.3 mm [p. 177].
- 12. Nassarius coloratus (Eichwald, 1830), NHMW 1847/0058/0773, localities 7 & 8, Akboğazi, Lale River, height 14.5 mm [p. 178].
- 13. Nassarius edlaueri (Beer-Bistrický, 1958), NHMW 1847/0058/0776, locality 17, Seyithasan, height 13.3 mm [p. 178].
- 14. Nassarius edlaueri (Beer-Bistrický, 1958), NHMW 1847/0058/0777, locality 17, Seyithasan, height 12.3 mm [p. 178].
- 15. Nassarius schoenni (Hoenes & Auinger, 1882), NHMW 1847/0058/1462, locality 18, hillsides east of Tarlaören, height 10.7 mm [p. 178].



Nassariidae

- 1. Nassarius schoenni (Hoenes & Auinger, 1882), RGM 776 932 (ex JvdV collection), locality 18, hillsides east of Tarlaören, height 11.7 mm [p. 178].
- 2. Nassarius doliolum (Eichwald, 1830), NHMW 1847/0058/0891, locality 17, Seyithasan, height 33.9 mm [p. 180].
- 3. Nassarius doliolum (Eichwald, 1830), NHMW 1847/0058/0892, locality 17, Seyithasan, height 22.7 mm [p. 180].
- 4. Nassarius asperulus (Brocchi, 1814), RGM 776 923 (ex JvdV collection), locality 17, Seyithasan, height 8.9 mm [p. 181].
- 5. Nassarius serraticosta (Hörnes, 1852), RGM 776 926 (ex JvdV collection), locality 17, Seyithasan, height 6.4 mm [p. 181].
- 6. Nassarius pseudoserrulus nov. sp., holotype, NHMW 1847/0058/0730, locality 13, Pinarlar Yaylasi, Akpinar, height 7.4 mm [p. 182].
- 7. Nassarius pseudoserrulus nov. sp., paratype 1, NHMW 1847/0058/0731, locality 13, Pinarlar Yaylasi, Akpinar, height 7.3 mm [p. 182].
- 8. Nassarius granularis (Borson, 1820), NHMW 1847/0058/0905, locality 13, Pinarlar Yaylasi, Akpinar, height 8.6 mm [p. 183].
- 9. Nassarius intersulcatus (Hilber, 1879), NHMW 1847/0058/1468, locality 17, Seyithasan, height 5.7 mm [p. 183].
- 10. Nassarius pascaleae nov. sp., holotype, NHMW 1847/0058/0898, locality 13, Pinarlar Yaylasi, Akpinar, height 18.8 mm [p. 183].
- 11. Nassarius pascaleae nov. sp., paratype 1, NHMW 1847/0058/0900, locality 17, Seyithasan, height 22.6 mm [p. 183].
- 12. Nassarius pascaleae nov. sp., paratype 2, NHMW 1847/0058/0901, locality 17, Seyithasan, height 20.0 mm [p. 183].
- 13. Nassarius pascaleae nov. sp., paratype 3, NHMW 1847/0058/0971, locality 17, Seyithasan, height 20.0 mm [p. 183].
- 14. Nassarius pascaleae nov. sp., paratype 4 NHMW 1847/0058/0972, locality 17, Seyithasan, height 20.0 mm [p. 183].
- 15. Nassarius larandicus nov. sp., holotype, NHMW 1847/0058/0895, locality 13, Pinarlar Yaylasi, Akpinar, height 14.9 mm [p. 184].



Nassariidae

- 1. *Nassarius larandicus* nov. sp., **paratype 1**, NHMW 1847/0058/0896, locality 13, Pınarlar Yaylası, Akpınar, height 15.8 mm [p. 184].
- Nassarius larandicus nov. sp., paratype 2, NHMW 1847/0058/1457, locality 13, Pinarlar Yaylasi, Akpinar, height 17.0 mm [p. 184].
- 3. *Nassarius larandicus* nov. sp., **paratype 3**, NHMW 1847/0058/1458, locality 13, Pinarlar Yaylasi, Akpinar, height 14.0 mm [p. 184].
- Nassarius larandicus nov. sp., paratype 4, NHMW 1847/0058/1459, locality 13, Pinarlar Yaylasi, Akpinar, height 13.0 mm [p. 184].
- Naytiopsis karreri (Hoernes & Auinger, 1882), NHMW 1847/0058/0741, localities 7 & 8, Akboğazi, Lale River, height 8.9 mm [p. 185].
- Naytiopsis hypertropha (Boettger, 1906), NHMW 1847/0058/0742, localities 7 & 8, Akboğazi, Lale River, height 10.6 mm [p. 186].
- 7. *Cyllenina ancillariaeformis* (Grateloup, 1834), RGM 794 052 (ex JvdV collection), locality 18, hillsides east of Tarlaören, height 13.6 mm [p. 187].
- 8. *Cyllenina ancillariaeformis* (Grateloup, 1834), RGM 794 053 (ex JvdV collection), locality 18, hillsides east of Tarlaören, height 13.8 mm [p. 187].
- 9. Cyllene desnoyersi (de Basterot, 1825), NHMW 1847/0058/1656, locality 17, Seyithasan, height 14.0 mm [p. 186].

Columbellidae

- 10. Columbella rustica (Linnaeus, 1758), NHMW 1847/0058/0748, locality 13, Pinarlar Yaylasi, Akpinar, height 10.9 mm [p. 187].
- 11. Costoanachis terebralis (Grateloup, 1834), NHMW 1847/0058/0749, localities 7 & 8, Akboğazi, Lale River, height 5.6 mm [p. 188].
- 12. Mitrella borsoni (Bellardi, 1848), NHMW 1847/0058/0750, localities 7 & 8, Akboğazi, Lale River, height 9.5 mm [p. 189].
- 13. Mitrella cf. borsoni (Bellardi, 1848), NHMW 1847/0058/0752, locality 13, Pinarlar Yaylasi, Akpinar, height 7.2 mm [p. 189].
- 14. *Mitrella fallax* (Hoernes & Auinger, 1880), NHMW 1847/0058/0754, locality 13, Pinarlar Yaylasi, Akpinar, height 16.3 mm [p. 189].
- 15. *Mitrella fallax* (Hoernes & Auinger, 1880), NHMW 1847/0058/0756, localities 7 & 8, Akboğazi, Lale River, height 14.5 mm [p. 189].
- Mitrella fallax (Hoernes & Auinger, 1880), NHMW 1847/0058/0757, localities 7 & 8, Akboğazi, Lale River, height 18.0 mm [p. 189].



Columbellidae

- 1. *Mitrella* aff. *inedita* (Bellardi *in* Sacco, 1890), NHMW 1847/0058/0759, locality 13, Pınarlar Yaylası, Akpınar, height 21.7 mm [p. 190].
- Mitrella aff. inedita (Bellardi in Sacco, 1890), NHMW 1847/0058/0760, locality 13, Pinarlar Yaylasi, Akpinar, height 14.5 mm [p. 190].
- Mitrella aff. inedita (Bellardi in Sacco, 1890), NHMW 1847/0058/0761, locality 13, Pinarlar Yaylasi, Akpinar, height 14.1 mm [p. 190].
- 4. Mitrella kostejana (Boettger, 1906), NHMW 1847/0058/0763, locality 17, Seyithasan, height 6.9 mm [p. 190].
- 5. Mitrella kostejana (Boettger, 1906), NHMW 1847/0058/0906, locality 17, Seyithasan, height 6.2 mm [p. 190].
- 6. Mitrella linguloides (Bellardi in Sacco, 1890), NHMW 1847/0058/0908, locality 17, Seyithasan, height 28.0 mm [p. 191].
- 7. Mitrella linguloides (Bellardi in Sacco, 1890), NHMW 1847/0058/0909, locality 17, Sevithasan, height 26.0 mm [p. 191].
- 8. Mitrella polonica (Pusch, 1837), NHMW 1847/0058/0911, locality 17, Seyithasan, height 14.2 mm [p. 191].
- 9. Mitrella polonica (Pusch, 1837), NHMW 1847/0058/0912, locality 17, Seyithasan, height 15.7 mm [p. 191].
- 10. Mitrella semicaudata (Bellardi, 1848), NHMW 1847/0058/0914, locality 13, Pinarlar Yaylasi, Akpinar, height 14.0 mm [p. 192].
- 11. Mitrella teres (Bellardi, 1890), NHMW 1847/0058/0916, locality 17, Seyithasan, height 10.3 mm [p. 192].
- 12. Orthurella convexula Sacco, 1904, NHMW 1847/0058/0953, locality 13, Pinarlar Yaylasi, Akpinar, height 40.2 mm [p. 193].
- 13. Orthurella convexula Sacco, 1904, NHMW 1847/0058/0954, locality 13, Pinarlar Yaylasi, Akpinar, height 40.2 mm [p. 193].
- 14. Orthurella convexula Sacco, 1904, NHMW 1847/0058/0918, locality 13, Pinarlar Yaylasi, Akpinar, height 40.2 mm [p. 193].
- p. 199



Melongenidae

- 1. Melongena jaapi nov. sp., holotype, NHMW 1847/0058/0823, locality 17, Seyithasan, height 87.4 mm [p. 195].
- 2. Melongena jaapi nov. sp., paratype 1, NHMW 1847/0058/0822, locality 17, Seyithasan, height 88.6 mm [p. 195].
- 3. Melongena jaapi nov. sp., paratype 2, NHMW 1847/0058/0824, locality 17, Seyithasan, height 94.2 mm [p. 195].
- 4. Melongena jaapi nov. sp., paratype 3, NHMW 1847/0058/0825, locality 17, Seyithasan, height 94.4 mm [p. 195].
- 5. Melongena jaapi nov. sp., paratype 4, NHMW 1847/0058/0826, locality 17, Seyithasan, height 98.4 mm [p. 195].
- 6. Melongena jaapi nov. sp., paratype 7, NHMW 1847/0058/0827, locality 17, Seyithasan, height 107.1 mm [p. 195].

Fasciolariidae

7. Pseudolatirus ligusticus (Bellardi, 1884), NHMW 1847/0058/1696, locality 13, Pinarlar Yaylasi, Akpinar, height 15.8 mm [p. 200].

8. Pseudolatirus ligusticus (Bellardi, 1884), NHMW 1847/0058/1697, locality 13, Pınarlar Yaylası, Akpınar, height 15.4 mm [p. 200].



Fasciolariidae

- 1. Aurantilaria tarbelliana (Grateloup, 1846), JvdV collection, locality 17, Seyithasan, height 170.0 mm [p. 197].
- 2. Tarantinaea hoernesii (Seguenza, 1875), NHMW 1847/0058/0921, locality 13, Pinarlar Yaylasi, Akpinar, height 43.5 mm [p. 198].
- 3. Tarantinaea hoernesii (Seguenza, 1875), NHMW 1847/0058/1465, locality 13, Pinarlar Yaylasi, Akpinar, height 51.3 mm [p. 198].
- 4. Polygona vermeiji nov. sp., holotype, NHMW 1847/0058/0923, locality 13, Pinarlar Yaylasi, Akpinar, height 16.9 mm [p. 199].
- 5. *Polygona vermeiji* nov. sp., **paratype 1**, RGM 776 852 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 17.9 mm [p. 199].
- 6. *Aptyxis* aff. *palatinus* (Strausz, 1954), NHMW 1847/0058/1466, localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 29.3 mm [p. 200].
- 7. Streptochetus ornatus (d'Orbigny, 1852), NHMW 1847/0058/1089, locality 17, Seyithasan, height 87.1 mm [p. 201].
- 8. Streptochetus ornatus (d'Orbigny, 1852), NHMW 1847/0058/1089, locality 17, Seyithasan, height 84.0 mm [p. 201].
- 9. Streptochetus ornatus (d'Orbigny, 1852), NHMW 1847/0058/1089, locality 17, Seyithasan, height 79.7 mm [p. 201].



Volutidae

- 1. Lyria taurinia (Michelotti, 1847), NHMW 1847/0058/0341, locality 17, Seyithasan, height 66.3 mm [p. 202].
- 2. Athleta ficulina (Lamarck, 1811), NHMW 1847/0058/0313, locality 13, Pinarlar Yaylasi, Akpinar, height 60.1 mm [p. 203].
- 3. Athleta rarispina (Lamarck, 1811), NHMW 1847/0058/0325, locality 17, Seyithasan, height 46.8 mm [p. 205].

Harpidae

4. Oniscidia cythara (Brocchi, 1814), NHMW 1847/0058/0344, locality 17, Seyithasan, height 34.4 mm [p. 206].

Olividae

- 5. Anazola vindobonensis (Csepreghy-Meznerics, 1954), NHMW 1847/0058/0347, locality 17, Seyithasan, height 29.4 mm [p. 220].
- 6. Anazola vindobonensis (Csepreghy-Meznerics, 1954), NHMW 1847/0058/0348, locality 17, Seyithasan, height 28.0 mm [p. 220].
- 7. Strephona dufresnei (de Basterot, 1825), RGM 794 565 (ex JvdV collection), locality 17, Seyithasan, height 21.1 mm [p. 221].
- 8. Strephona dufresnei (de Basterot, 1825), NHMW 1847/0058/0350, locality 17, Seyithasan, height 22.5 mm [p. 221].
- 9. Amalda glandiformis (Lamarck, 1810), NHMW 1847/0058/0352, locality 13, Pinarlar Yaylasi, Akpinar, height 31.9 mm [p. 222].
- 10. Amalda glandiformis (Lamarck, 1810), NHMW 1847/0058/0353, locality 13, Pinarlar Yaylasi, Akpinar, height 39.4 mm [p. 222].

Marginellidae

- 11. Volvarina mitrella (Risso, 1826), NHMW 1847/0058/0358, localities 7 & 8, Akboğazi, Lale River, height 12.7 mm [p. 207].
- 12. Volvarina mitrella (Risso, 1826), NHMW 1847/0058/0359, localities 7 & 8, Akboğazi, Lale River, height 11.3 mm [p. 207].
- 13. Volvarina mitrella (Risso, 1826), NHMW 1847/0058/0360, localities 7 & 8, Akboğazi, Lale River, height 10.5 mm [p. 207].
- 14. Volvarina oblongata (Sacco, 1890, ex Bellardi ms), NHMW 1847/0058/0363, locality 17, Seyithasan, height 6.2 mm [p. 208].
- 15. Volvarina oblongata (Sacco, 1890, ex Bellardi ms), NHMW 1847/0058/0364, locality 17, Seyithasan, height 6.4 mm [p. 208].

Cystiscidae

16. Gibberula conoidea (Sacco, 1890, ex Bellardi ms), NHMW 1847/0058/0366, locality 17, Seyithasan, height 2.4 mm [p. 208].



Mitridae

- 1. Episcomitra brevis (Bellardi, 1887), RGM 794 082 (ex JvdV collection), locality 17, Seyithasan, height 13.6 mm [p. 209].
- 2. Episcomitra fusiformis (Brocchi, 1814), NHMW 1847/0058/0369, locality 13, Pinarlar Yaylasi, Akpinar, height 58.2 mm [p. 209].
- 3. *Episcomitra oblongula* (Bellardi, 1887), RGM 794 562 (ex JvdV collection), locality 17, Seyithasan, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene; height 30.8 mm [p. 210].
- 4. Cancilla planicostata (Bellardi, 1877), NHMW 1847/0058/0371, locality 13, Pinarlar Yaylasi, Akpinar, height 36.2 mm [p. 211].
- 5. Cancilla planicostata (Bellardi, 1877), NHMW 1847/0058/0372, locality 13, Pinarlar Yaylası, Akpınar, height 42.4 mm [p. 211].
- 6. Cancilla planicostata (Bellardi, 1877), NHMW 1847/0058/0373, locality 13, Pinarlar Yaylasi, Akpinar, height 30.8 mm [p. 211].
- 7. Cancilla planicostata (Bellardi, 1877), NHMW 1847/0058/0374, locality 13, Pinarlar Yaylasi, Akpinar, height 37.1 mm [p. 211].
- 8. Cancilla planicostata (Bellardi, 1887), NHMW 1847/0058/0375, locality 13, Pinarlar Yaylasi, Akpinar, height 40.3 mm [p. 211].
- Cancilla praescrobiculata (Toldo, 1889), NHMW 1847/0058/0379, locality 13, Pinarlar Yaylasi, Akpinar, height 62.4 mm. 9b detail of sculpture of spire whorls [p. 212].
- 10. *Cancilla praescrobiculata* (Toldo, 1889), NHMW 1847/0058/0380, locality 13, Pinarlar Yaylasi, Akpinar, height 73.9 mm [p. 212].
- 11. Cancilla praescrobiculata (Toldo, 1889), RGM 794 083 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 83.6 mm [p. 212].
- 12. Cancilla suballigata (Bellardi, 1877), NHMW 1847/0058/0382, locality 13, Pinarlar Yaylasi, Akpinar, height 27.8 mm [p. 212].
- 13. Cancilla suballigata (Bellardi, 1877), NHMW 1847/0058/0383, locality 13, Pinarlar Yaylasi, Akpinar, height 23.0 mm [p. 212].



Mitridae

- 1. Ziba goniophora (Bellardi, 1850), NHMW 1847/0058/0387, locality 17, Seyithasan, height 21.6 mm [p. 213].
- 2. Ziba goniophora (Bellardi, 1850), NHMW 1847/0058/0388, locality 17, Seyithasan, height 22.1 mm [p. 213].

Costellariidae

- 3. Pusia baluki nov. sp., holotype, NHMW 1847/0058/0390, locality 17, Seyithasan, height 14.8 mm [p. 214].
- 4. Pusia baluki nov. sp., paratype 7, NHMW 1847/0058/0391, locality 17, Seyithasan, height 18.2 mm [p. 214].
- 5. Pusia baluki nov. sp., paratype 8, NHMW 1847/0058/0392, locality 17, Seyithasan, height 16.0 mm [p. 214].
- 6. Pusia baluki nov. sp., NHMW 1847/0058/0393, locality 17, Seyithasan, height 15.5 mm [p. 214].
- 7. Pusia pyramidella (Brocchi, 1814), NHMW 1847/0058/0394, localities 7 & 8, Akboğazi, Lale River, height 20.9 mm [p. 215].
- 8. Pusia pyramidella (Brocchi, 1814), NHMW 1847/0058/0395, localities 7 & 8, Akboğazi, Lale River, height 22.2 mm [p. 215].
- 9. Pusia pyramidella (Brocchi, 1814), NHMW 1847/0058/0397, locality 13, Pinarlar Yaylasi, Akpinar, height 19.7 mm [p. 215].
- 10. Pusia transsylvanica (Boettger, 1902), NHMW 1847/0058/0399, locality 17, Seyithasan, height 12.3 mm [p. 216].
- 11. Pusia transsylvanica (Boettger, 1902), NHMW 1847/0058/0400, locality 17, Seyithasan, height 8.3 mm [p. 216].
- 12. Pusia transsylvanica (Boettger, 1902), NHMW 1847/0058/0401, locality 17, Seyithasan, height 8.7 mm [p. 216].
- Costellaria cupressina (Brocchi, 1814), RGM 794 084 (ex JvdV collection), locality 12, slopes east-northeast of Akpınar village, height 22.3 mm [p. 217].
- Costellaria nov. sp.?, RGM 794 056 (ex JvdV collection), locality 9, Tilkikaya, south of Basharman, slopes east of Gödet River, height 29.2 mm [p. 218].

Volutomitridae

- 15. Conomitra karamanensis nov. sp., holotype, NHMW 1847/0058/0402, Pinarlar Yaylasi, Akpinar, height 6.0 mm [p. 219].
- 16. Conomitra karamanensis nov. sp., paratype 1, NHMW 1847/0058/0403, Pinarlar Yaylasi, Akpinar, height 6.0 mm [p. 219].
- 17. Conomitra karamanensis nov. sp., paratype 2, NHMW 1847/0058/0404, Pinarlar Yaylasi, Akpinar, height 5.4 mm [p. 219].

Costellariidae

- 18. Thala obsoleta (Brocchi, 1814), NHMW 1847/0058/0408, locality 17, Seyithasan, height 6.8 mm [p. 218].
- 19. Thala obsoleta (Brocchi, 1814), NHMW 1847/0058/0409, locality 17, Seyithasan, height 5.7 mm [p. 218].



Cancellariidae

- 1. Aneurystoma afenestrata (Sacco, 1894), NHMW 1847/0058/0410, locality 17, Seyithasan, height 23.4 mm [p. 224].
- Aneurystoma afenestrata (Sacco, 1894), RGM 794 089 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 20.8 mm [p. 224].
- 3. *Bivetiella dertonensis* (Bellardi, 1841), RGM 794 545 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 24.8 mm [p. 224].
- 4. Contortia bellardii (Michelotti, 1847), NHMW 1847/0058/0413, locality 13, Pinarlar Yaylasi, Akpinar, height 21.3 mm [p. 226].
- 5. Contortia callosa (Hörnes, 1854), NHMW 1847/0058/0414, locality 13, Pinarlar Yaylasi, Akpinar, height 30.3 mm [p. 226].
- 6. Contortia callosa (Hörnes, 1854), NHMW 1847/0058/0415, locality 13, Pinarlar Yaylasi, Akpinar, height 28.3 mm [p. 226].
- 7. Contortia contorta (de Basterot, 1825), NHMW 1847/0058/0463, localities 7 & 8, Akboğazi, Lale River, height 15.1 mm [p. 226].
- 8. Contortia contorta (de Basterot, 1825), NHMW 1847/0058/0977, localities 7 & 8, Akboğazi, Lale River, height 17.2 mm [p. 226].
- 9. Sveltia dertovaricosa Sacco, 1894, NHMW 1847/0058/0465, locality 17, Seyithasan, height 32.1 mm [p. 228].
- 10. Calcarata calcarata (Brocchi, 1814), NHMW 1847/0058/0469, locality 13, Pinarlar Yaylasi, Akpinar, height 22.9 mm [p. 229].
- 11. Solatia exwestiana (Sacco, 1894), 1894, RGM 794 077 (ex JvdV collection), locality 17, Seyithasan, height 28.9 mm [p. 230].
- 12. Petitina inermis (Pusch, 1837), NHMW 1847/0058/0473, locality 17, Seyithasan, height 46.6 mm [p. 230].
- 13. Petitina inermis (Pusch, 1837), RGM 794 549 (ex JvdV collection), locality 17, Seyithasan, height 27.0 mm [p. 230].


Cancellariidae

- 1. Trigonostoma exgeslini (Sacco, 1894), NHMW 1847/0058/0476, locality 17, Seyithasan, height 18.9 mm [p. 231].
- 2. *Trigonostoma exgeslini* (Sacco, 1894), NHMW 1847/0058/0478, locality 17, Seyithasan, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene; height 22.7 mm [p. 231].
- 3. Ventrilia imbricata (Hörnes, 1854), RGM 794 547 (ex JvdV collection), locality 17, Seyithasan, height 35.4 mm [p. 231].
- 4. Ventrilia imbricata (Hörnes, 1854), RGM 794 548 (ex JvdV collection), locality 17, Seyithasan, height 40.7 mm [p. 231].
- 5. *Scalptia polonica* (Pusch, 1837), RGM 794 064 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 35.3 mm [p. 233].
- 6. *Scalptia dertocosticillata* (Sacco, 1894), RGM 794 078 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 31.3 mm [p. 232].
- 7. Scalptia dertocosticillata (Sacco, 1894), RGM 794 079 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 17.5 mm [p. 232].
- 8. Scalptia scrobiculata (Hörnes, 1854), NHMW 1847/0058/1555, locality 17, Seyithasan, height 26.5 mm [p. 233].
- 9. Ovilia excassidea (Sacco, 1894), NHMW 1847/0058/0479, locality 17, Seyithasan, height 28.2 mm [p. 232].
- 10. Scalptia spinosa (Grateloup, 1827), NHMW 1847/0058/0483, locality 13, Pinarlar Yaylasi, Akpinar, height 19.5 mm [p. 233].



Cancellariidae

- 1. Scalptia? problematica nov. sp., holotype, NHMW 1847/0058/0488, locality 17, Seyithasan, height 17.9 mm [p. 234].
- 2. Tritonoharpa alanbeui nov. sp., holotype, NHMW 1847/0058/0486, locality 17, Seyithasan, height 16.9 mm [p. 234].
- 3. Tritonoharpa alanbeui nov. sp., YI 435, locality 17, Seyithasan, height 17.0 mm [p. 234].
- 4. Tritonoharpa alanbeui nov. sp., paratype 5, RGM 794 061 (ex JvdV collection), locality 17, Seyithasan, height 11.5 mm [p. 234].

Conidae

- 6. Kalloconus berghausi (Michelotti, 1847), NHMW 1847/0058/0490, locality 17, Seyithasan, height 40.9 mm. Specimen with depressed spire [p. 236].
- 7. Kalloconus berghausi (Michelotti, 1847), NHMW 1847/0058/0491, locality 17, Seyithasan, height 45.2 mm [p. 236].
- 8. Kalloconus berghausi (Michelotti, 1847), NHMW 1847/0058/0496, locality 17, Seyithasan, height 45.2 mm [p. 236].
- 9. Kalloconus hungaricus (Hoernes & Auinger, 1879), NHMW 1847/0058/0417, locality 17, Seyithasan, height 58.8 mm [p. 238].
- 10. Kalloconus hungaricus (Hoernes & Auinger, 1879), NHMW 1847/0058/0420, locality 17, Seyithasan, height 46.5 mm [p. 238].



Conidae

- 1. Kalloconus hungaricus (Hoernes & Auinger, 1879), NHMW 1847/0058/0418, locality 17, Seyithasan, height 52.2 mm [p. 238].
- 2. Lautoconus bitorosus (Fontannes, 1880), NHMW 1847/0058/0432, locality 17, Seyithasan, height 70.2 mm [p. 239].
- 3. Lautoconus bitorosus (Fontannes, 1880), NHMW 1847/0058/0433, locality 17, Seyithasan, height 63.4 mm [p. 239].
- 4. Lautoconus bitorosus (Fontannes, 1880), NHMW 1847/0058/0435, locality 17, Seyithasan, height 58.0 mm [p. 239].
- 5. Monteiroconus antiquus (Lamarck, 1810), NHMW 1847/0058/0441, locality 17, Seyithasan, height 139.2 mm [p. 241].
- 6. *Monteiroconus antiquus* (Lamarck, 1810), JvdV collection, locality 13, Pınarlar Yaylası, Akpınar, height 129.0 mm (photograph JvdV) [p. 241].
- 7. Monteiroconus daciae (Hoernes & Auinger, 1879), NHMW 1847/0058/0448, locality 17, Seyithasan, height 78.4 mm. Apical view [p. 242].



Conidae

- 1. Monteiroconus daciae (Hoernes & Auinger, 1879), NHMW 1847/0058/0445, locality 17, Seyithasan, height 80.7 mm [p. 242].
- 2. Monteiroconus mercati (Brocchi, 1814), NHMW 1847/0058/0605, locality 17, Seyithasan, height 100.0 mm [p. 244].
- 3. Monteiroconus mercati (Brocchi, 1814), NHMW 1847/0058/0610, locality 17, Seyithasan, height 77.1 mm [p. 244].
- 4. Monteiroconus mercati (Brocchi, 1814), NHMW 1847/0058/0611, locality 17, Seyithasan, height 63.3 mm [p. 244].
- 5. Plagioconus puschi (Michelotti, 1847), NHMW 1847/0058/0497, locality 13, Pinarlar Yaylasi, Akpinar, height 69.3 mm [p. 245].
- 6. Varioconus pelagicus (Brocchi, 1814), NHMW 1847/0058/0624, locality 17, Seyithasan, height 73.5 mm [p. 247].
- 7. Varioconus pelagicus (Brocchi, 1814), NHMW 1847/0058/0625, locality 17, Seyithasan, height 53.2 mm [p. 247].



Conidae

- 1. Varioconus erunalerentoezae nov. sp., paratype 1 NHMW 1847/0058/0974, locality 17, Seyithasan, height 46.8 mm [p. 248].
- 2. Varioconus erunalerentoezae nov. sp., paratype 2 NHMW 1847/0058/0975, locality 17, Seyithasan, height 45.5 mm [p. 248].
- 3. Varioconus erunalerentoezae nov. sp., paratype 3 NHMW 1847/0058/0976, locality 17, Seyithasan, height 43.9 mm [p. 248].
- 4. Varioconus erunalerentoezae nov. sp., paratype 4 NHMW 1847/0058/0978, locality 17, Seyithasan, height 42.4 mm [p. 248].
- 5. Varioconus karamanensis (Erünal-Erentöz, 1958), 1847/0058/1550, locality 17, Seyithasan, height 41.6 mm [p. 249].
- 6. Varioconus karamanensis (Erünal-Erentöz, 1958), 1847/0058/1551, locality 17, Seyithasan, height 42.6 mm [p. 249].
- 7. Varioconus subraristriatus (Pereira da Costa, 1866), NHMW 1847/0058/0600, locality 17, Seyithasan, height 79.5 mm [p. 250].
- 8. Varioconus subraristriatus (Pereira da Costa, 1866), NHMW 1847/0058/0601, locality 17, Seyithasan, height 86.2 mm [p. 250].



Conidae

- 1. Conilithes dujardini (Deshayes, 1845), NHMW 1847/0058/0500, locality 17, Seyithasan, height 36.0 mm [p. 252].
- 2. Conilithes dujardini (Deshayes, 1845), NHMW 1847/0058/0501, locality 17, Seyithasan, height 46.7 mm [p. 252].
- 3. Conilithes dujardini (Deshayes, 1845), NHMW 1847/0058/0502, locality 17, Seyithasan, height 45.4 mm. Detail of spire [p. 252].
- 4. Varioconus taurinensis (Bellardi & Michelotti, 1840), NHMW 1847/0058/0510, locality 17, Seyithasan, height 29.5 mm [p. 251].
- 5. Varioconus taurinensis (Bellardi & Michelotti, 1840), NHMW 1847/0058/0511, locality 17, Seyithasan, height 28.2 mm [p. 251].
- 6. Varioconus taurinensis (Bellardi & Michelotti, 1840), NHMW 1847/0058/0984, locality 17, Seyithasan, height 31.1 mm [p. 251].
- 7. *Kalloconus berghausi* (Michelotti, 1847), NHMW 1847/0058/0490, locality 17, Seyithasan, height 40.9 mm. Apical view [p. 236].
- 8. Kalloconus hungaricus (Hoernes & Auinger, 1879), NHMW 1847/0058/0417, locality 17, Seyithasan, height 58.8 mm. Apical view [p. 238].
- 9. Lautoconus bitorosus (Fontannes, 1880), NHMW 1847/0058/0433, locality 17, Seyithasan, height 63.4 mm. Apical view [p. 239].
- 10. *Monteiroconus antiquus* (Lamarck, 1810), NHMW 1847/0058/0441, locality 17, Seyithasan, height 139.2 mm. Apical view [p. 241].
- 11. Monteiroconus daciae (Hoernes & Auinger, 1879), NHMW 1847/0058/0445, locality 17, Seyithasan, height 80.7 mm. Apical view [p. 242].
- 12. Monteiroconus mercati (Brocchi, 1814), NHMW 1847/0058/0610, locality 17, Seyithasan, height 77.1 mm. Apical view [p. 244].
- 13. Plagioconus puschi (Michelotti, 1847), NHMW 1847/0058/0497, locality 17, Seyithasan, height 69.3 mm. Apical view [p. 245].
- 14. Varioconus pelagicus (Brocchi, 1814), NHMW 1847/0058/0624, locality 17, Seyithasan, height 73.5 mm. Apical view [p. 247].
- 15. Varioconus erunalerentoezae nov. sp., paratype 1 NHMW 1847/0058/0974, locality 17, Seyithasan, height 46.8 mm [p. 248].
- 16. Varioconus karamanensis (Erünal-Erentöz, 1958), 1847/0058/1392, locality 17, Seyithasan, height 42.4 mm [p. 249].
- 17. Varioconus subraristriatus (Pereira da Costa, 1866), NHMW 1847/0058/0600, locality 17, Seyithasan, height 79.5 mm. Apical view [p. 250].
- 18. Conilithes dujardini (Deshayes, 1845), NHMW 1847/0058/0500, locality 17, Seyithasan, height 36.0 mm. Apical view [p. 252].
- 19. Varioconus taurinensis (Bellardi & Michelotti, 1840), NHMW 1847/0058/0984, locality 17, Seyithasan, height 31.1 mm [p. 251].





Conidae

- 1. *Kalloconus berghausi* (Michelotti, 1847), NHMW 1847/0058/0490, locality 17, Seyithasan, height 40.9 mm. Apical view [p. 236].
- 2. *Kalloconus hungaricus* (Hoernes & Auinger, 1879), NHMW 1847/0058/0417, locality 17, Seyithasan, height 58.8 mm. Apical view [p. 238].
- 3. Lautoconus bitorosus (Fontannes, 1880), NHMW 1847/0058/0433, locality 17, Seyithasan, height 63.4 mm. Apical view [p. 239].
- 4. *Monteiroconus antiquus* (Lamarck, 1810), NHMW 1847/0058/0441, locality 17, Seyithasan, height 139.2 mm. Apical view [p. 241].
- 5. *Monteiroconus daciae* (Hoernes & Auinger, 1879), NHMW 1847/0058/0445, locality 17, Seyithasan, height 80.7 mm. Apical view [p. 242].
- 6. Monteiroconus mercati (Brocchi, 1814), NHMW 1847/0058/0610, locality 17, Seyithasan, height 77.1 mm. Apical view [p. 244].
- 7. Plagioconus puschi (Michelotti, 1847), NHMW 1847/0058/0497, locality 17, Seyithasan, height 69.3 mm. Apical view [p. 245].
- 8. Varioconus pelagicus (Brocchi, 1814), NHMW 1847/0058/0624, locality 17, Seyithasan, height 73.5 mm. Apical view [p. 247].
- 9. Varioconus erunalerentoezae nov. sp., paratype 1 NHMW 1847/0058/0974, locality 17, Seyithasan, height 46.8 mm [p. 248].
- 10. Varioconus karamanensis (Erünal-Erentöz, 1958), 1847/0058/1392, locality 17, Seyithasan, height 42.4 mm [p. 249].
- 11. Varioconus subraristriatus (Pereira da Costa, 1866), NHMW 1847/0058/0600, locality 17, Seyithasan, height 79.5 mm. Apical view [p. 250].
- 12. Conilithes dujardini (Deshayes, 1845), NHMW 1847/0058/0500, locality 17, Seyithasan, height 36.0 mm. Apical view [p. 252].
- 13. Varioconus taurinensis (Bellardi & Michelotti, 1840), NHMW 1847/0058/0984, locality 17, Seyithasan, height 31.1 mm [p. 251].

Borsoniidae

- Bathytoma cataphracta (Brocchi, 1814), RGM 794 556 (ex JvdV collection), locality 12, slopes east-northeast of Akpinar village, height 40.8 mm [p. 256].
- 15. Genota rudolfi (Toula, 1902), NHMW 1847/0058/1137, locality 13, Pinarlar Yaylasi, Akpinar, height 48.0 mm [p. 258].
- 16. Genota rudolfi (Toula, 1902), NHMW 1847/0058/1138, locality 13, Pinarlar Yaylasi, Akpinar, height 47.5 mm [p. 258].



Borsoniidae

- 1. Genota pseudoelisae nov. sp., holotype, NHMW 1847/0058/1143, locality 17, Seyithasan, height 42.0 mm [p. 258].
- 2. Genota pseudoelisae nov. sp., paratype 1, NHMW 1847/0058/1144, locality 17, Seyithasan, height 39.5 mm [p. 258].
- 3. Microdrillia teretiaeformis A.W. Janssen, 1972, NHMW 1847/0058/1146, locality 17, Seyithasan, height 8.9 mm [p. 259].

Clathurellidae

- 4. Clathurella casilorica Boettger, 1906, NHMW 1847/0058/1148, locality 17, Seyithasan, height 9.6 mm [p. 260].
- 5. Clathurella casilorica Boettger, 1906, NHMW 1847/0058/1149, locality 17, Seyithasan, height 8.6 mm [p. 260].
- 6. Clathurella pouweri nov. sp., holotype, NHMW 1847/0058/1151, locality 13, Pinarlar Yaylasi, Akpinar, height 19.2 mm [p. 260].
- 7. Clathurella pouweri nov. sp., paratype 1, NHMW 1847/0058/1152, locality 13, Pinarlar Yaylasi, Akpinar, height 14.7 mm [p. 260].
- 8. Clathurella pouweri nov. sp., paratype 2, NHMW 1847/0058/1153, locality 13, Pinarlar Yaylasi, Akpinar, height 14.4 mm [p. 260].
- 9. Clathurella sp., NHMW 1847/0058/1158, locality 13, Pinarlar Yaylasi, Akpinar, height 12.0 mm [p. 262].
- Pleurotomoides aff. strombillus (Dujardin, 1837), NHMW 1847/0058/1159, localities 7 & 8, Akboğazi, Lale River, height 19.2 mm [p. 262].



Clathurellidae

- 1. Pleurotomoides isabelae nov. sp., holotype, NHMW 1847/0058/1507, locality 17, Seyithasan, height 8.2 mm [p. 262].
- 2. Pleurotomoides sp., NHMW 1847/0058/1518, locality 17, Seyithasan, height 6.1 mm [p. 263].

Mangeliidae

- 3. *Agathotoma angusta* (Bellardi, 1847), NHMW 1847/0058/1160, localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 6.8 mm [p. 263].
- 4. Bela halavatsi (Boettger, 1902), NHMW 1847/0058/1161, locality 17, Seyithasan, height 4.3 mm [p. 265].
- 5. Bela hispidula (Bellardi, 1847), NHMW 1847/0058/1162, locality 17, Seyithasan, height 12.2 mm [p. 265].
- 6. Bela hispidula (Bellardi, 1847), NHMW 1847/0058/1163, localities 7 & 8, Akboğazi, Lale River, height 13.1 mm [p. 265].
- 7. Bela jeffreysi (Bellardi, 1877), NHMW 1847/0058/1164, locality 17, Seyithasan, height 9.1 mm [p. 266].
- 8. Bela scalariformis (Brugnone, 1862), NHMW 1847/0058/1226, locality 17, Seyithasan, height 5.6 mm [p. 267].
- 9. Bela scalariformis (Brugnone, 1862), NHMW 1847/0058/1227, locality 17, Seyithasan, height 4.5 mm [p. 267].
- 10. Bela trinacria Mariottini & Smriglio, 2009, NHMW 1847/0058/1517, locality 17, Seyithasan, height 5.4 mm [p. 268].



Mangeliidae

- 1. Bela seyithasanensis nov. sp., holotype, NHMW 1847/0058/1168, locality 17, Seyithasan, height 8.9 mm [p. 268].
- 2. *Bela seyithasanensis* nov. sp., **paratype 1**, RGM 794 564 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 10.9 mm [p. 268].
- 3. Mangelia gertrudae (Boettger, 1906), NHMW 1847/0058/1169, locality 17, Seyithasan, height 7.3 mm [p. 269].
- 4. Mangelia subcostata Boettger, 1906, NHMW 1847/0058/1170, locality 17, Seyithasan, height 5.5 mm [p. 270].
- 5. Mangelia sp., RGM 794 532, locality 17, Seyithasan, height 4.9 mm [p. 270].

Raphitomidae

- 6. Favriella dorae (Boettger, 1906), NHMW 1847/0058/1509, locality 13, Pinarlar Yaylası, Akpınar, height 3.8 mm [p. 271].
- 7. Raphitoma herminae (Boettger, 1902), JvdV, locality 17, Seyithasan, height 4.4 mm [p. 271].
- 8. Raphitoma leufroyi (Michaud, 1828), NHMW 1847/0058/1171, locality 17, Seyithasan, height 7.0 mm [p. 271].
- 9. *Raphitoma spinosissima* nov. sp., **holotype**, NHMW 1847/0058/1172, locality 13, Pinarlar Yaylasi, Akpinar, height 11.8 mm [p. 272].
- 10. Raphitoma subpurpurea (Boettger, 1902), NHMW 1847/0058/1175, locality 17, Seyithasan, height 4.7 mm [p. 273].
- 11. Raphitoma vandervoorti nov. sp., holotype, NHMW 1847/0058/1173, locality 17, Seyithasan, height 6.9 mm [p. 273].



Raphitomidae

- 1. Raphitoma vandervoorti nov. sp., paratype 1, NHMW 1847/0058/1174, locality 17, Seyithasan, height 4.9 mm [p. 273].
- 2. Raphitoma sp., RGM 776 936 (ex JvdV collection), locality 17, Seyithasan, height 5.9 mm [p. 274].
- 3. Andonia transsylvanica (Hoernes & Auinger, 1890), RGM 794 059 (ex JvdV collection), locality 6, hill slopes in forest westnorthwest of Lale, subadult, height 5.3 mm [p. 274].

Cochlespiridae

 Cochlespira protomediterranea nov. sp., holotype, NHMW 1847/0058/1177, locality 13, Pinarlar Yaylasi, Akpinar, height 15.6 mm [p. 276].

Drilliidae

- 5. 'Crassopleura' sigmoidea (Bronn, 1831), NHMW 1847/0058/1508, locality 13, Pinarlar Yaylasi, Akpinar, height 7.4 mm [p. 276].
- 6. Fusiturris plicatula (Grateloup, 1832), NHMW 1847/0058/1179, locality 13, Pinarlar Yaylası, Akpinar, height 36.7 mm [p. 277].
- 7. *Spirotropis karamanensis* R. Janssen, 1993, NHMW 1847/0058/1181, locality 13, Pinarlar Yaylasi, Akpinar, height 11.3 mm [p. 278].
- 8. Stenodrillia sp., NHMW 1847/0058/1184, locality 13, Pinarlar Yaylasi, Akpinar, height 37.6 mm [p. 278].
- 9. *Stenodrillia* cf. *obeliscus* (Desmoulins, 1842), NHMW 1847/0058/1187, locality 13, Pinarlar Yaylasi, Akpinar, height 23.8 mm [p. 279].
- 10. Turriclavus harpulus (Brocchi, 1814), NHMW 1847/0058/1189, locality 13, Pinarlar Yaylasi, Akpinar, height 17.8 mm [p. 279].

Pseudomelatomidae

- 11. Crassispira pustulata (Brocchi, 1814), NHMW 1847/0058/1190, locality 17, Seyithasan, height 22.3 mm [p. 280].
- 12. Miraclathurella bittneri (Boettger, 1902), NHMW 1847/0058/1193, locality 13, Pinarlar Yaylası, Akpinar, height 10.9 mm [p. 281].
- 13. Miraclathurella granaria (Dujardin, 1837), NHMW 1847/0058/1194, locality 17, Seyithasan, height 9.0 mm [p. 282].



Clavatulidae

- 1. Clavatula ernesti (Toula, 1901), NHMW 1847/0058/1197, locality 17, Seyithasan, height 70.4 mm [p. 283].
- 2. Clavatula ernesti (Toula, 1901), NHMW 1847/0058/1199, locality 13, Pinarlar Yaylası, Akpınar, height 72.1 mm [p. 283].
- Clavatula ernesti (Toula, 1901), RGM 17 044, holotype of Pleurotoma (Clavatula) ernesti Toula, 1901, village of Konia, Larenda, Cilicien, height 56.7 mm (photo RGM) [p. 283].
- 4. Clavatula gracilis Erünal-Erentöz, 1958, NHMW 1847/0058/1204, locality 17, Seyithasan, height 65.7 mm [p. 284].
- Clavatula francisci (Toula, 1901), holotype, RGM 17 045, village of Konia, Larenda, Cilicien, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene, height 54.8 mm (photo RGM) [p. 284].
- 6. Clavatula francisci (Toula, 1901), NHMW 1847/0058/1206, locality 17, Seyithasan, height 63.5 mm [p. 284].
- 7. *Clavatula theodori* (Toula, 1901), **holotype**, RGM 17 049, village of Konia, Larenda, Cilicien, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene, height 39.7 mm (photo RGM) [p. 285].
- 8. Clavatula theodori (Toula, 1901), NHMW 1847/0058/1209, locality 13, Pinarlar Yaylasi, Akpinar, height 39.5 mm [p. 285].
- 9. Clavatula theodori (Toula, 1901), NHMW 1847/0058/1211, locality 17, Seyithasan, height 41.5 mm [p. 285].





Clavatulidae

- 1. Clavatula gradata (Defrance, 1826), NHMW 1847/0058/1213, locality 17, Seyithasan, height 30.2 mm [p. 285].
- 2. Clavatula olgae (Hoernes & Auinger, 1891), NHMW 1847/0058/1215, locality 17, Seyithasan, height 41.5 mm [p. 286].
- 3. Clavatula olgae (Hoernes & Auinger, 1891), NHMW 1847/0058/1216, locality 17, Seyithasan, height 41.1 mm [p. 286].
- 4. Clavatula olgae (Hoernes & Auinger, 1891), NHMW 1847/0058/1217, locality 17, Seyithasan, height 37.4 mm [p. 286].
- Clavatula olgae (Hoernes & Auinger, 1891), NHMW 1847/0058/1220, locality 13, Pinarlar Yaylasi, Akpinar, height 36.4 mm [p. 286].
- Clavatula olgae (Hoernes & Auinger, 1891), NHMW 1847/0058/1221, locality 13, Pinarlar Yaylasi, Akpinar, height 45.2 mm [p. 286].
- 7. *Clavatula sotterii* (Michelotti, 1847), RGM 794 567, locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 15.7 mm [p. 287].
- Clavatula sotterii (Michelotti, 1847), RGM 776 907 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 17.9 mm [p. 287].
- 9. Clavatula sotterii (Michelotti, 1847), NHMW 1847/0058/1503, localities 7 & 8, Akboğazi, Lale River, height 16.9 mm [p. 287].
- 10. Clavatula sotterii (Michelotti, 1847), NHMW 1847/0058/1504, localities 7 & 8, Akboğazi, Lale River, height 13.0 mm [p. 287].
- 11. *Clavatula sotterii* (Michelotti, 1847), RGM 776 906 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 11.3 mm (subadult) [p. 287].
- Clavatula sotterii (Michelotti, 1847), RGM 776 905 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, height 21.6 mm [p. 287].
- Clavatula sp., RGM 794 057 (ex JvdV collection), localities 1 & 2, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, height 31.6 mm [p. 288].
- 14. Clavatula sp., NHMW 1847/0058/1223, locality 17, Seyithasan, height 31.1 mm [p. 288].



Clavatulidae

- 1. Clavatula labiolirata nov. sp., holotype, NHMW 1847/0058/1224, locality 17, Seyithasan, height 31.4 mm [p. 288].
- 2. Clavatula labiolirata nov. sp., paratype 1, NHMW 1847/0058/1225, locality 17, Seyithasan, height 26.8 mm [p. 288].
- 3. Clavatula seyithasanensis nov. sp., holotype, NHMW 1847/0058/1234, locality 17, Seyithasan, height 46.7 mm [p. 289].
- 4. Clavatula seyithasanensis nov. sp., paratype 1, NHMW 1847/0058/1235, locality 17, Seyithasan, height 56.6 mm [p. 289].
- 5. Clavatula seyithasanensis nov. sp., paratype 2, NHMW 1847/0058/1236, locality 17, Seyithasan, height 39.2 mm [p. 289].
- 6. *Perrona robustocarinifera* nov. sp., **holotype**, NHMW 1847/0058/1237, locality 17, Seyithasan, height 42.3 mm [p. 289].
- 7. *Perrona robustocarinifera* nov. sp., **paratype 1**, RGM 794 090 (ex JvdV collection), locality 17, Seyithasan, height 41.5 mm [p. 289].
- 8. Perrona descendens (Hilber, 1879), NHMW 1847/0058/1239, locality 17, Seyithasan, height 28.5 mm [p. 290].
- 9. Perrona descendens (Hilber, 1879), NHMW 1847/0058/1240, locality 17, Seyithasan, height 36.5 mm [p. 290].
- 10. Perrona inedita (Bellardi, 1877), NHMW 1847/0058/1242, locality 13, Pinarlar Yaylasi, Akpinar, height 66.0 mm [p. 291].
- 11. Perrona inedita (Bellardi, 1877), NHMW 1847/0058/1243, locality 13, Pinarlar Yaylasi, Akpinar, height 50.6 mm [p. 291].



Clavatulidae

- 1. Perrona taurinensis (Bellardi, 1877), NHMW 1847/0058/1245, locality 13, Pinarlar Yaylasi, Akpinar, height 52.3 mm [p. 291].
- 2. Perrona taurinensis (Bellardi, 1877), NHMW 1847/0058/1246, locality 13, Pinarlar Yaylasi, Akpinar, height 53.1 mm [p. 291].
- 3. Clavatula ernesti (Toula, 1901), NHMW 1847/0058/1197, locality 17, Seyithasan, height 70.4 mm [p. 283].
- 4. Clavatula gracilis Erünal-Erentöz, 1958, NHMW 1847/0058/1204, locality 17, Seyithasan, height 65.7 mm [p. 284].
- 5. Clavatula francisci (Toula, 1901), NHMW 1847/0058/1206, locality 17, Seyithasan, height 63.5 mm [p. 284].
- 6. Clavatula theodori (Toula, 1901), NHMW 1847/0058/1209, locality 13, Pinarlar Yaylasi, Akpinar, height 39.5 mm [p. 285].
- 7. Clavatula gradata (Defrance, 1826), NHMW 1847/0058/1213, locality 17, Seyithasan, height 30.2 mm [p. 285].
- 8. Clavatula olgae (Hoernes & Auinger, 1891), NHMW 1847/0058/1215, locality 17, Seyithasan, height 41.5 mm [p. 286].
- 9. *Clavatula* sp., RGM 794 057 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, height 31.6 mm [p. 288].
- 10. Clavatula labiolirata nov. sp., holotype, NHMW 1847/0058/1224, locality 17, Seyithasan, height 31.4 mm [p. 288].
- 11. Clavatula seyithasanensis nov. sp., holotype, NHMW 1847/0058/1234, locality 17, Seyithasan, height 46.7 mm [p. 289].
- 12. Perrona robustocarinifera nov. sp., holotype, NHMW 1847/0058/1237, locality 17, Seyithasan, height 42.3 mm [p. 289].
- 13. Perrona descendens (Hilber, 1879), NHMW 1847/0058/1239, locality 17, Seyithasan, height 28.5 mm [p. 290].
- 14. Perrona inedita (Bellardi, 1877), NHMW 1847/0058/1242, locality 13, Pinarlar Yaylasi, Akpinar, height 66.0 mm [p. 291].
- 15. Perrona taurinensis (Bellardi, 1877), NHMW 1847/0058/1245, locality 13, Pinarlar Yaylasi, Akpinar, height 52.3 mm [p. 291].
- 16. Comitas korytnicensis Bałuk, 2003, NHMW 1847/0058/1248, locality 13, Pinarlar Yaylasi, Akpinar, height 31.8 mm [p. 292].
- 17. Comitas korytnicensis Bałuk, 2003, NHMW 1847/0058/1249, locality 13, Pinarlar Yaylasi, Akpinar, height 29.4 mm [p. 292].



Horaiclavidae

- 1. Haedropleura avenacea Boettger, 1906, NHMW 1847/0058/1251, locality 13, Pinarlar Yaylasi, Akpinar, height 6.2 mm [p. 292].
- 2. Haedropleura avenacea Boettger, 1906, NHMW 1847/0058/1252, locality 13, Pinarlar Yaylasi, Akpinar, height 7.0 mm [p. 292].

Turridae

- 3. Gemmula badensis (R. Hoernes, 1875), NHMW 1847/0058/1511, locality 13, Pinarlar Yaylasi, Akpinar, height 32.9 mm [p. 293].
- Gemmula coronata (Münster in Goldfuss), NHMW 1847/0058/1257, locality 13, Pinarlar Yaylası, Akpinar, height 19.9 mm (incomplete) [p. 294].
- Unedogemmula galvanii (Bellardi, 1877), NHMW 1847/0058/1510, locality 13, Pinarlar Yaylası, Akpinar, height 24.5 mm [p. 294].
- Unedogemmula giebeli (Bellardi, 1877), RGM 794 561 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 34.1 mm [p. 295].

Terebridae

- 7. Subula buiturica Moisescu, 1955, RGM 794 080 (ex JvdV collection), locality 17, Seyithasan, height 50.4 mm [p. 295].
- 8. Subula plicaria (de Basterot, 1825), NHMW 1847/0058/1260, locality 17, Seyithasan, height 55.3 mm [p. 296].
- 9. Subula plicaria (de Basterot, 1825), NHMW 1847/0058/1261, locality 17, Seyithasan, height 55.2 mm [p. 296].
- 10. Terebra acuminata Borson, 1820, RGM 776 860 (ex JvdV collection), locality 17, Seyithasan, height 50.0 mm [p. 297].
- 11. Terebra acuminata Borson, 1820, NHMW 1847/0058/1263, locality 17, Seyithasan, height 75.3 mm [p. 297].
- 12. Terebra acuminata Borson, 1820, NHMW 1847/0058/1264, locality 17, Seyithasan, height 73.3 mm [p. 297].
- 13. Terebra acuminata Borson, 1820, NHMW 1847/0058/1265, locality 17, Seyithasan, height 43.5 mm [p. 297].
- 14. *Terebra* cf. *cacellensis* Pereira da Costa, 1866, RGM 794 065 (ex JvdV collection), locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, maximum diameter 19.7 mm [p. 299].



Architectonicidae

- 1. *Nipteraxis monilifera* (Bronn, 1831), NHMW 1847/0058/1269, locality 13, Pınarlar Yaylası, Akpınar, maximum diameter 13.8 mm [p. 300].
- 2. *Pseudotorinia obtusa* (Bronn, 1831), RGM 776 861 (ex JvdV collection), locality 6, hill slopes in forest west-northwest of Lale, maximum diameter 14.2 mm [p. 300].
- Psilaxis simplex (Bronn, 1831), NHMW 1847/0058/1272, locality 13, Pinarlar Yaylasi, Akpinar, maximum diameter 17.8 mm [p. 301].

Mathildidae

4. *Mathilda granosa* (Borson, 1821), RGM 794 058 (ex JvdV collection), locality 6, hill slopes in forest west-northwest of Lale, height 3.0 mm [p. 303].

Pyramidellidae

- 5. Pyramidella plicosa Bronn, 1838, NHMW 1847/0058/1383, locality 13, Pinarlar Yaylasi, Akpinar, height 9.5 mm [p. 304].
- 6. Longchaeus unisulcatus (Dujardin, 1837), NHMW 1847/0058/1276, locality 17, Seyithasan, height 13.8 mm [p. 306].
- 7. Nisosyrnola concava (Boettger, 1907), NHMW 1847/0058/1278, locality 17, Seyithasan, height 4.2 mm [p. 307].
- 8. Nisosyrnola concava (Boettger, 1907), NHMW 1847/0058/1470, locality 17, Seyithasan, height 6.7 mm [p. 307].
- 9. Chrysallida longula Boettger, 1907, NHMW 1847/0058/1443, locality 17, Seyithasan, height 3.0 mm [p. 313].
- 10. Turbonilla lanceae (Libassi, 1859), NHMW 1847/0058/1279, locality 13, Pinarlar Yaylasi, Akpinar, height 9.5 mm [p. 316].
- 11. Turbonilla miocrassulata (Sacco, 1895), NHMW 1847/0058/1384, localities 7 & 8, Akboğazi, Lale River, height 8.0 mm [p. 317].

Amathinidae

12. Clathrella clathrata (Philippi, 1844), NHMW 1847/0058/1280, locality 17, Seyithasan, height 5.2 mm [p. 319].

Acteonidae

- 13. '*Acteon' semistriatus* (Férussac, 1822), NHMW 1847/0058/1268, localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, subadult, height 7.6 mm [p. 323].
- 14. 'Acteon' subpunctulatus Boettger, 1902, RGM 776 928 (ex JvdV collection), locality 17, Seyithasan, height 2.3 mm [p. 324].

Ringiculidae

- 15. *Ringicula exilis* (Eichwald, 1829), NHMW 1847/0058/1556, locality 6, hill slopes in forest west-northwest of Lale, height 10.3 mm [p. 325].
- 16. Ringicula minor (Grateloup, 1838), NHMW 1847/0058/1557, locality 17, Seyithasan, height 5.5 mm [p. 326].

Haminoeidae

- 17. *Haminoea* cf. *hydatis miocaenica* Berger, 1953, RGM 776 933 (ex JvdV collection), locality 17, Seyithasan, height 4.8 mm [p. 327].
- 18. Cylichna clathrata (Defrance, 1825), NHMW 1847/0058/1471, locality 17, Seyithasan, height 9.1 mm [p. 331].
- 19. Cylichna subcylindrica (d'Orbigny, 1852), RGM 776 927 (ex JvdV collection), locality 17, Seyithasan, height 4.5 mm [p. 332].



Cylichnidae

- 1. Roxania utriculus (Brocchi, 1814), NHMW 1847/0058/1559, locality 17, Seyithasan, height 3.0 mm [p. 332].
- 2. Roxania utriculus (Brocchi, 1814), NHMW 1847/0058/1473, locality 13, Pinarlar Yaylasi, Akpinar, height 5.8 mm [p. 332].
- 3. Acteocina lajonkaireana (de Basterot, 1825), NHMW 1847/0058/1558, locality 17, Seyithasan, height 3.0 mm [p. 333].
- 4. Acteocina lajonkaireana (de Basterot, 1825), RGM 776 924 (ex JvdV collection), locality 17, Seyithasan, height 2.5 mm [p. 333].
- 5. Scaphander dertonensis (Sacco, 1896), NHMW 1847/0058/1474, locality 17, Seyithasan, height 53.1 mm [p. 335].
- 6. Scaphander dertonensis (Sacco, 1896), NHMW 1847/0058/1657, locality 17, Seyithasan, height 30.1 mm [p. 335].
- 8. Acteocina voeslauensis (Berger, 1953), RGM 776 931 (ex JvdV collection), locality 17, Seyithasan, height 3.5 mm [p. 334].

Retusidae

- 7. Retusa decussata Sacco, 1896, RGM 776 930 (ex JvdV collection), locality 17, Seyithasan, height 2.8 mm [p. 336].
- 9. Atys latesulcata (Boettger, 1902), RGM 776 925 (ex JvdV collection), locality 17, Seyithasan, height 3.5 mm [p. 328].
- 10. Pyrunculus elongatus (Eichwald, 1830), RGM 776 934 (ex JvdV collection), locality 17, Seyithasan, height 3.5 mm [p. 338].
- 11. Pyrunculus elongatus (Eichwald, 1830), RGM 776 935 (ex JvdV collection), locality 17, Seyithasan, height 4.7 mm [p. 338].
- 12. *Retusa* cf. *subangystoma* (d'Orbigny, 1852), NHMW 1847/0058/1476, locality 13, Pınarlar Yaylası, Akpınar, height 9.1 mm [p. 336].
- 13. Retusa umbilicata (Montagu, 1803), RGM 776 929 (ex JvdV collection), locality 17, Seyithasan, height 3.3 mm [p. 336].

Juliidae

- 14. Julia girondica Cossmann & Peyrot, 1914, NHMW 1847/0058/1478, locality 17, Seyithasan, maximum diameter 5.6 mm [p. 340].
- 15. Julia girondica Cossmann & Peyrot, 1914, NHMW 1847/0058/1479, locality 17, Seyithasan, maximum diameter 5.5 mm [p. 340].
- 16. Julia nov. sp., NHMW 1847/0058/1481, locality 17, Seyithasan, maximum diameter 9.3 mm [p. 341].

Buccinidae

- 17. *Metula submitraeformis* (d'Orbigny, 1852), RGM 776 864 (ex JvdV collection), locality 13, Pinarlar Yaylası, Akpinar, height 38.6 mm (photo JvdV) [p. 167].
- 18. Monostiolum ? nov. sp., NHMW 1847/0058/1655, locality 17, Seyithasan, height 15.5 mm [p. 169].


Acmaeidae

1. Tectura sp., RGM 794 598 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 23].

Scissurellidae

2. Scissurella transplvanica Reuss, 1860, RGM 794 597 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 23].

Colloniidae

- 3. Homalopoma laleensis nov. sp., holotype, RGM 784 071, locality 6, hill slopes in forest west-northwest of Lale, SEM [p. 33].
- 4. Homalopoma laleensis nov. sp., paratype 1, RGM 784 072, locality 6, hill slopes in forest west-northwest of Lale, SEM [p. 33].
- 5. Akritogyra cf. conspicua (Monterosato, 1880), RGM 794 596 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 33].

Phasianellidae

6. Tricolia eichwaldi (Hörnes, 1855), RGM 794 582 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 34].

Neritidae

7. Agapilia picta (Férussac, 1823), RGM 776 846 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 36].

Phenacolepadidae

8. Phenacolepas ancyliformis (Grateloup, 1828), RGM 783 574, locality 17, Seyithasan, SEM [p. 38].

Cerithiidae

9. Thericium ataturki nov. sp., paratype 6, RGM 784 076, locality 17, Seyithasan, SEM [p. 40].

Batillariidae

 Tiaracerithium eceae nov. sp., paratype 1, RGM 784 077. locality 11, brackish assemblage, southwest bank of Gödet Creek near Tilkikaya, SEM [p. 47].

Scaliolidae

11-14. Sandbergeria perpusilla (Grateloup, 1827), RGM 784 053, locality 17, Seyithasan, SEM [p. 48].



Dialidae

1. Gibborissoia angulosa nov. sp., paratype 6, RGM 784 078, locality 17, Seyithasan, SEM [p. 49].

Potamididae

- 2. Bittium reticulatum (da Costa, 1778), RGM 784 039, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 55].
- 3. Bittium reticulatum (da Costa, 1778), RGM 783 579, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 55].
- 4. Bittium sp., RGM 783 577, locality 17, Seyithasan, Karaman Basin, SEM [p. 56].
- 5. Bittium sp., RGM 783 578, locality 17, Seyithasan, Karaman Basin, SEM [p. 56].

Potamididae

6. Cerithidium? schwartzi (Hörnes, 1856), RGM 783 576, locality 17, Seyithasan, SEM [p. 56].

Turritellidae

- 7. Ptychidia vindobonensis (Handmann, 1882), RGM 784 015, locality 13, Pinarlar Yaylası, Akpinar, SEM [p. 58].
- 8. Oligodia bicarinata (Eichwald, 1830), RGM 784 017, locality 17, Seyithasan, SEM [p. 61].
- 9. Mesalia cochleata (Brocchi, 1814), RGM 784 047, locality 17, Seyithasan, SEM [p. 64].

Truncatellidae

10. Truncatella subcylindrica (Linné, 1767), RGM 776 853 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 67].





Murchisonellidae

1. *Rissopsetia* sp., NHMW 1847/0058/1560, localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel; 1c: detail of microsculpture, SEM [p. 322].

Rissoidae

- 2. Obtusella taurominima (Sacco, 1895), RGM 784 093, locality 17, Seyithasan, SEM [p. 68].
- 3. Obtusella taurominima (Sacco, 1895), RGM 776 855 (ex JvdV collection), locality 13, Seyithasan, SEM [p. 68].
- 4. Rissoa clotho Hörnes, 1856, RGM 794 591 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 68].
- 5. Pusillina philippi (Aradas & Maggiore, 1844), RGM 776 910, locality 17, Seyithasan, SEM [p. 69].
- 6. Pusillina philippi (Aradas & Maggiore, 1844), RGM 794 594 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 69].
- 7. Pusillina cf. inconspicua (Alder, 1844), RGM 783 554, locality 17, Seyithasan, SEM [p. 69].



Rissoidae

- 1. Pusillina cf. inconspicua (Alder, 1844), RGM 783 554, locality 17, Seyithasan, SEM [p. 69].
- 2. Pusillina cf. inconspicua (Alder, 1844), RGM 783 555, locality 17, Seyithasan, SEM [p. 69].
- 3. Pusillina sp, RGM 794 518, locality 17, Seyithasan, SEM [p. 69].
- 4. Alvania critica Boettger, 1907, RGM 794 588 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 2.5 mm [p. 70].
- 5. Alvania lachesis (de Basterot, 1825), RGM 784 041, locality 17, Seyithasan, SEM [p. 70].
- 6. Alvania miocenica Sacco, 1895, RGM 794 589 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 71].



Rissoidae

- 1. Alvania miocenica Sacco, 1895, RGM 794 589 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 71].
- 2. Alvania miocenica Sacco, 1895, RGM 794 587 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 71].
- 3. Alvania productilis Boettger, 1907, RGM 794 586 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 73].
- Alvania cf. punctura (Montagu, 1803), 1895, RGM 794 590 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 73].
- 5. Manzonia crassa (Kanmacher, 1798), RGM 784 002, locality 17, Seyithasan, SEM [p. 74].
- 6. Rissoina vindobonensis Sacco, 1895, RGM 776 854 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 75].
- 7. *Rissoina* (*Zebinella*) *obsoleta* Hörnes, 1856, RGM 794 592 (ex JvdV collection), locality 17, Seyithasan; 7b detail of microsculpture, SEM [p. 76].
- 8. Rissoina (Zebinella) cf. decussata (Montagu, 1803), RGM 794 593 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 77].

Iravadiidae

9. Pseudonoba striata (Hornes, 1856), RGM 784 038, locality 17, Seyithasan, SEM [p. 78].





Iravadiidae

- 1. Erentoezia akpinarensis nov. sp., holotype, RGM 784 096, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 79].
- 2. Erentoezia akpinarensis nov. sp., paratype 1, RGM 784 097 locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 79].
- 3. Rhombostoma? daani nov. sp., holotype, RGM 784 075, locality 17, Seyithasan, SEM [p. 80].

Caecidae

- 4. Caecum clarkii Carpenter, 1858, RGM 784 001, locality 17, Seyithasan, SEM [p. 80].
- 5. *Caecum subannulatum* de Folin, 1870, RGM 776 937 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, SEM [p. 81].
- 6. *Caecum subannulatum* de Folin, 1870, RGM 776 938 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, SEM [p. 81].
- 7. *Parastrophia mediterranea* (O.G. Costa, 1861), RGM 794 600 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 81].
- Parastrophia mediterranea (O.G. Costa, 1861), RGM 794 583 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 81].

Elachisinidae

- 9. *Elachisina hoernesi* (Boettger, 1902), RGM 784 074, localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, SEM [p. 82].
- 10. Elachisina rolani nov. sp., holotype, RGM 783 556, locality 17, Seyithasan, SEM [p. 83].
- 11. Elachisina rolani nov. sp., paratype 1, RGM 783 557, locality 17, Seyithasan, SEM [p. 83].
- 12. Elachisina gofasi nov. sp., holotype, RGM 783 558, locality 17, Seyithasan, SEM [p. 83].
- 13. Elachisina gofasi nov. sp., paratype 1, RGM 783 559, locality 17, Seyithasan, SEM [p. 83].
- 14. Elachisina gofasi nov. sp., paratype 2, RGM 783 560, locality 17, Seyithasan, SEM [p. 83].

Iravadiidae

15. Hyala vitrea (Montagu, 1803), RGM 784 083, locality 17, Seyithasan, SEM [p. 78].



Tornidae

- 1. Discopsis reductus (Rolán & Rubio, 1990), RGM 794 599 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 84].
- 2. Tornus karamanensis nov. sp., paratype 3, RGM 784 018, locality 17, Seyithasan, SEM [p. 84].
- 3. Tornus karamanensis nov. sp., paratype 4, RGM 776 941, locality 17, Seyithasan, SEM [p. 84].

Vitrinellidae

- 4. Circulus planorbillus (Dujardin, 1837), RGM 794 581 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 85].
- 5. Circulus striatus (Philippi, 1836), RGM 794 584 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 86].
- 6. Circulus supranitidus (Wood, 1842), NHMW 1847/0058/1096, localities 7 & 8, Akboğazi, Lale River, SEM [p. 87].
- 7. Idioraphe defrancei (de Basterot, 1825), RGM 784 016, locality 17, Seyithasan, SEM [p. 87].
- 8. Megatyloma auingeri (Boettger, 1902), NHMW 1847/0058/1554, locality 17, Seyithasan, SEM [p. 88].





Vitrinellidae

- 1. Solariorbis punctatocarinatus nov. sp., holotype, NHMW 1847/0058/1345, locality 17, Seyithasan, SEM [p. 88].
- Solariorbis woodi (Hörnes, 1856), RGM 784 013, locality 17, Seyithasan; 2c: arrow marks protoconch/teleoconch boundary, SEM [p. 89].

Strombidae

3. Persististrombus inflexus (Eichwald, 1830), RGM 784 022, locality 17, Seyithasan, SEM [p. 89].

Aporrhaidae

- 4. Aporrhais dactylifera (Boettger, 1902), RGM 794 512, locality 13, Pinarlar Yaylası, Akpınar, SEM [p. 92].
- 5. Aporrhais pespelecani (Linnaeus, 1758), RGM 784 023, locality 17, Seyithasan, SEM [p. 93].

Calyptraeidae

6. Calyptraea chinensis (Linnaeus, 1758), RGM 794 595 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 95].

Vanikoridae

7. Cymenorytis brandenburgi (Boettger 1907), RGM 794 585 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 97].





Vanikoridae

- 1. *Cymenorytis brandenburgi* (Boettger 1907), RGM 794 585 (ex JvdV collection), locality 17, Seyithasan; detail of microsculpture, SEM [p. 97].
- 2. Cymenorytis brandenburgi (Boettger 1907), RGM 784 068, locality 17, Seyithasan, SEM [p. 97].

Xenophoridae

3. *Xenophora italica* (Grateloup, 1845), RGM 784 014, locality 13, Pinarlar Yaylası, Akpınar; arrow marks protoconch/teleoconch boundary, SEM [p. 99].

Naticidae

- Cochlis curta (Erünal-Erentöz, 1958), RGM 794 513, locality 13, Pinarlar Yaylası, Akpınar; arrows mark two possible positions for protoconch/teleoconch boundary, SEM [p. 100].
- 5. *Euspira guillemini* (Payraudeau, 1826), RGM 794 514, locality 17, Seyithasan; arrow marks protoconch/teleoconch boundary, SEM [p. 103].
- 6. *Euspira helicina helicina* (Brocchi, 1814), RGM 776 858 (ex JvdV collection), localities 7 & 8, Akboğazi, Lale River; 6a: arrow marks protoconch/teleoconch boundary, 6b detail of microsculpture, SEM [p. 103].
- 7. *Euspira helicina helicina* (Brocchi, 1814), RGM 776 859 (ex JvdV collection), localities 7 & 8, Akboğazi, Lale River, SEM [p. 103].
- 8. *Neverita olla* (de Serres, 1829), RGM 794 515, locality 17, Seyithasan; arrow marks protoconch/teleoconch boundary, SEM [p. 107].

Ranellidae

9. Sassia turrita (Eichwald, 1830), RGM 784 021, locality 13, Pinarlar Yaylası, Akpınar, SEM [p. 130].

Ficidae

10. Ficus condita (Brongniart, 1823), NHMW 1847/0058/1373, locality 17, Seyithasan, digital photograph [p. 132].

Triphoridae

11. Triphora (s.lat.) sp., RGM 794 516, locality 17, Seyithasan, SEM [p. 134].





Cerithiopsidae

- 1. Cerithiopsis (s. lat.) cf. barleei Jeffreys, 1867, RGM 784 086, locality 17, Seyithasan, SEM [p. 136].
- 2. Cerithiopsis (s. lat.) cf. barleei Jeffreys, 1867, RGM 784 087, locality 17, Seyithasan, SEM [p. 136].
- 3. Cerithiopsis (s. lat.) jeffreysi Watson, 1885, RGM 784 084, locality 17, Seyithasan, SEM [p. 136].
- 4. Cerithiopsis (s. lat.) subulata (Wood, 1848), RGM 784 085, locality 17, Seyithasan, SEM [p. 137].
- 5. Cerithiopsis (s. lat.) subulata (Wood, 1848), RGM 776 856 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 137].
- 6. Cerithiopsis (s. lat.) cf. tubercularis (Montagu, 1803), NHMW 1847/0058/1561, locality 17, Seyithasan, SEM [p. 137].
- 7. Seila turritissima Sacco, 1895, RGM 776 857 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 137].

Aclididae

8. Aclis ascaris (Turton, 1819), RGM 784 063, locality 13, Pinarlar Yaylası, Akpinar, SEM [p. 142].

Eulimidae

- 9. Eulima cf. jaskiewiczi Bałuk, 1995, RGM 794 568, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 142].
- 10. Vitreolina sp., NHMW 1847/0058/1382, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 143].
- 11. Melanella sp., RGM 776 939 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 143].



Muricidae

- 1. Dermomurex (Trialatella) kilikiensis nov. sp., paratype 3, RGM 794 569, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 149].
- 2. Ocinebrina perparva nov. sp., paratype 3, NHMW 1847/0058/0903, locality 17, Seyithasan, SEM [p. 152].
- 3. Ocinebrina polonica (Bałuk, 1995), RGM 784 004, localities 7 & 8, Akboğazi, Lale River, SEM [p. 153].
- 4. Typhinellus labiatus (Cristofori & Jan, 1832), RGM 784 003, localities 7 & 8, Akboğazi, Lale River, SEM [p. 162].

Buccinidae

- 5. Euthria curvirostris (Grateloup, 1833), RGM 794 572, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 165].
- 6. Euthriofusus anatolicus (Toula, 1902), NHMW 1847/0058/1562, locality 13, Pinarlar Yaylası, Akpınar, digital photograph [p. 166].
- 7. *Pisania striata* (Gmelin, 1791), NHMW 1847/0058/0888, locality 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, digital photograph [p. 168].
- 8. Anna exsculpta (Dujardin, 1837), RGM 784 005, locality 17, Seyithasan, SEM [p. 168].

Nassariidae

- 9. Nassarius spectabilis (Nyst, 1845), RGM 794 576, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 172].
- 10. Nassarius elatus gayeae (Erünal-Erentöz, 1958), RGM 784 035, locality 13, Pinarlar Yaylası, Akpinar, SEM [p. 174].
- 11. Nassarius elatus gayeae (Erünal-Erentöz, 1958), RGM 794 577, locality 13, Pinarlar Yaylası, Akpinar, SEM [p. 174].



Nassariidae

- 1. Nassarius elatus gayeae (Erünal-Erentöz, 1958), RGM 794 577, locality 13, Pınarlar Yaylası, Akpınar, SEM [p. 174].
- 2. Nassarius barbarossai nov. sp., paratype 1, NHMW 1847/0058/1376, localities 7 & 8, Akboğazi, Lale River, SEM [p. 174].
- 3. Nassarius erunalae nov. sp., holotype, NHMW 1847/0058/1453, localities 7 & 8, Akboğazi, Lale River, SEM [p. 175].
- 4. Nassarius erentoezae nov. sp., paratype 1, NHMW 1847/0058/1451, localities 7 & 8, Akboğazi, Lale River, SEM [p. 176].
- 5. Nassarius coloratus (Eichwald, 1830), RGM 784 033, locality 17, Seyithasan, SEM [p. 177].
- 6. Nassarius edlaueri (Beer-Bistrický, 1958), RGM 794 578, locality 17, Seyithasan, SEM [p. 178].
- 7. Nassarius doliolum (Eichwald, 1830), RGM 776 847 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 180].
- 8. Nassarius asperulus (Brocchi, 1814), RGM 794 579, locality 17, Seyithasan, SEM [p. 181].



Plate 65

Nassariidae

- 1. Nassarius serraticosta (Hörnes, 1852), RGM 794 580, locality 17, Seyithasan, SEM [p. 181].
- 2. Nassarius pseudoserrulus nov. sp., paratype 2, NHMW 1847/0058/1374, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 182].
- 3. Nassarius granularis (Borson, 1820), NHMW 1847/0058/0905, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 183].
- 4. Nassarius intersulcatus (Hilber, 1879), RGM 784 034, locality 17, Seyithasan, SEM [p. 183].
- 5. Nassarius pascaleae nov. sp., paratype 5, NHMW 1847/0058/1267, 13, Pinarlar Yaylasi, Akpinar, digital photograph [p. 183].
- 6. Nassarius larandicus nov. sp., paratype 6, RGM 794 525, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 184].
- 7. *Naytiopsis hypertropha* (Boettger, 1906), RGM 776 848 (ex JvdV collection), localities 7 & 8, Akboğazi, Lale River, SEM [p. 186].

Columbellidae

8. Costoanachis terebralis (Grateloup, 1834), RGM 784 032, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 188].



Columbellidae

- 1. Costoanachis terebralis (Grateloup, 1834), RGM 784 032, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 188].
- 2. *Mitrella borsoni* (Bellardi, 1848), RGM 794 526, localities 7 & 8, Akboğazi, Lale River; arrow marks protoconch/teleoconch boundary, SEM [p. 189].
- Mittella fallax (Hoernes & Auinger, 1880), RGM 784 036, locality 13, Pinarlar Yaylasi, Akpinar; 3a: arrow marks protoconch/ teleoconch boundary, SEM [p. 189].
- 4. *Mitrella* aff. *inedita* (Bellardi *in* Sacco, 1890), RGM 794 527, locality 13, Pinarlar Yaylasi, Akpinar; arrow marks protoconch/ teleoconch boundary, SEM [p. 190].
- Mitrella kostejana (Boettger, 1906), RGM 794 528, locality 17, Seyithasan; arrow marks protoconch/teleoconch boundary, SEM [p. 190].
- Mitrella teres (Bellardi, 1890), RGM 784 037, locality 17, Seyithasan; 6a: arrow marks protoconch/teleoconch boundary, SEM [p. 192].

Fasciolariidae

- 7. *Tarantinaea hoernesii* (Seguenza, 1875), NHMW 1847/0058/0921, locality 13, Pinarlar Yaylasi, Akpinar, digital photograph [p. 198].
- 8. *Aptyxis* aff. *palatinus* (Strausz, 1954), NHMW 1847/0058/1466, localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, digital photograph [p. 200].
- 9. Streptochetus ornatus (d'Orbigny, 1852), RGM 784 007, locality 17, Seyithasan, SEM [p. 201].

Volutidae

- 10. Lyria taurinia (Michelotti, 1847), RGM 794 529, locality 17, Seyithasan, SEM [p. 202].
- 11. Athleta ficulina (Lamarck, 1811), RGM 784 029, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 203].





Volutidae

- 1. Athleta ficulina (Lamarck, 1811), RGM 784 029, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 203].
- 2. Athleta rarispina (Lamarck, 1811), RGM 784 030, locality 17, Seyithasan, SEM [p. 205].

Olividae

- 3. *Strephona dufresnei* (de Basterot, 1825), RGM 784 027, localities 7 & 8, Akboğazi, Lale River; arrow marks protoconch/teleoconch boundary, SEM [p. 221].
- 4. Amalda glandiformis (Lamarck, 1810), RGM 784 061, locality 6, hill slopes in forest west-northwest of Lale, SEM [p. 222].

Cystiscidae

- 5. Gibberula conoidea (Sacco, 1890, ex Bellardi ms), RGM 784 042, locality 17, Seyithasan, SEM [p. 208].
- 6. Gibberula sp., RGM 784 070, locality 6, hill slopes in forest west-northwest of Lale, SEM [p. 209].

Mitridae

- 7. Ziba goniophora (Bellardi, 1850), RGM 784 059, locality 17, Seyithasan, SEM [p. 213].
- 8. Pusia baluki nov. sp., paratype 9, RGM 784 044, locality 17, Seyithasan, SEM [p. 214].
- 9. Pusia pyramidella (Brocchi, 1814), RGM 784 043, locality 13, Pinarlar Yaylası, Akpınar, SEM [p. 215].



Plate 68

Conomitridae

- 1. Conomitra karamanensis nov. sp., paratype 3, RGM 784 054, localities 7 & 8, Akboğazi, Lale River, SEM [p. 219].
- 2. Conomitra karamanensis nov. sp., paratype 4, RGM 784 055, localities 7 & 8, Akboğazi, Lale River, SEM [p. 219].

Costellariidae

3. Thala obsoleta (Brocchi, 1814), RGM 784 008, locality 17, Seyithasan, SEM [p. 218].

Cancellariidae

- 4. Aneurystoma afenestrata (Sacco, 1894), NHMW 1847/0058/0410, locality 17, Seyithasan, digital photograph [p. 224].
- 5. *Contortia bellardii* (Michelotti, 1847), NHMW 1847/0058/0413, locality 13, Pınarlar Yaylası, Akpınar, digital photograph [p. 226].
- 6. Contortia callosa (Hörnes, 1854), NHMW 1847/0058/0414, locality 13, Pinarlar Yaylasi, Akpinar, digital photograph [p. 226].
- 7. Contortia contorta (de Basterot, 1825), RGM 784 020, localities 7 & 8, Akboğazi, Lale River;7c detail of microsculpture, SEM [p. 226].
- 8. Sveltia dertovaricosa Sacco, 1890, RGM 784 031, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 228].
- 9. Calcarata calcarata (Brocchi, 1814), RGM 784 019, locality 13, Pinarlar Yaylası, Akpinar; 9b apical view (slightly distorted), SEM [p. 229].
- 10. Tritonoharpa alanbeui nov. sp., paratype 3, NHMW 1847/0058/1342, locality 17, Seyithasan, SEM [p. 234].



Borsoniidae

- 1. Asthenotoma nov. sp., NHMW 1847/0058/1515, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 255].
- 2. Genota rudolfi (Toula, 1901), RGM 784 026, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 258].
- 3. Genota pseudoelisae nov. sp., paratype 6, RGM 784 025, localities 7 & 8, Akboğazi, Lale River, SEM [p. 258].
- 4. Microdrillia teretiaeformis A.W. Janssen, 1972, RGM 784 073, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 259].

Clathurellidae

- Clathurella casilorica Boettger, 1906, NHMW 1847/0058/1148, locality 17, Seyithasan; 5c detail of microsculpture, SEM [p. 260].
- 6. Pleurotomoides aff. strombillus (Dujardin, 1837), RGM 783 241, localities 7 & 8, Akboğazi, Lale River, SEM [p. 262].
- 7. Pleurotomoides isabelae nov. sp., holotype, NHMW 1847/0058/1507,, locality 17, Seyithasan, digital photograph [p. 262].





Clathurellidae

1. Pleurotomoides sp., NHMW 1847/0058/1518, locality 17, Seyithasan; 1d: detail of microsculpture, SEM [p. 263].

Mangeliidae

- 2. Agathotoma perforata (Brusina, 1877), NHMW 1847/0058/1343, locality 17, Seyithasan, SEM [p. 264].
- 3. Bela halavatsi (Boettger, 1902), RGM 784 079, locality 17, Seyithasan; 3e detail of microsculpture, SEM [p. 265].
- 4. Bela jeffreysi (Bellardi, 1877), RGM 784 082, locality 17, Seyithasan; 4c detail of microsculpture, SEM [p. 266].
- 5. Bela scalariformis (Brugnone, 1862), RGM 784 081, locality 17, Seyithasan; 5b detail of microsculpture, SEM [p. 267].
- 6. Bela trinacria Mariottini & Smriglio, 2009, RGM 784 080, locality 17, Seyithasan, SEM [p. 268].




400 *µ*m

1b

2.0 mm

2b

2.0 mm

์1c_

2a

Mangeliidae

- 1. Bela trinacria Mariottini & Smriglio, 2009, RGM 784 080, locality 17, Seyithasan; 1c: detail of microsculpture, SEM [p. 268].
- 2. *Bela seyithasanensis* nov. sp., **paratype 2**, RGM 794 531 (ex JvdV collection), locality 6, hill slopes in forest west-northwest of Lale, SEM [p. 268].
- 3. Mangelia subcostata Boettger, 1906, RGM 794 530, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 270].
- 4. Mangelia sp., RGM 794 532, locality 17, Seyithasan, SEM [p. 270].

Raphitomidae

- 5. Favriella dorae (Boettger, 1906), NHMW 1847/0058/1509, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 271].
- 6. Raphitoma herminae (Boettger, 1902), RGM 794 533, localities 7 & 8, Akboğazi, Lale River, height 4.4 mm [p. 271].
- 7. Andonia trassylvanica (Hoernes & Auinger, 1890), RGM 776 863 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 274].



Raphitomidae

- 1. Andonia transsylvanica (Hoernes & Auinger, 1890), RGM 784 060, locality 6, hill slopes in forest west-northwest of Lale, SEM [p. 274].
- 2. Teretia anceps (Eichwald, 1830), RGM 784 049, locality 13, Pinarlar Yaylasi, Akpinar; 2d detail of microsculpture, SEM [p. 275].

Drilliidae

- 3. Spirotropis karamanensis R. Janssen, 1993, RGM 784 050, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 278].
- 4. Stenodrillia sp., RGM 794 534, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 278].

Pseudomelatomidae

5. Crassispira pustulata (Brocchi, 1814), RGM 784 024, locality 17, Seyithasan, SEM [p. 280].

Clavatulidae

- 6. Clavatula ernesti (Toula, 1901), RGM 794 535, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 283].
- 7. Clavatula gracilis Erünal-Erentöz, 1958, RGM 794 536, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 284].
- 8. Clavatula francisci (Toula, 1901), RGM 776 909, locality 17, Seyithasan, SEM [p. 284].
- 9. Clavatula francisci (Toula, 1901), RGM 776 908, locality 17, Seyithasan, SEM [p. 284].





Clavatulidae

- 1. Clavatula theodori (Toula, 1901), RGM 794 537, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 285].
- 2. Perrona inedita (Bellardi, 1877), RGM 794 538, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 291].
- 3. Comitas korytnicensis Bałuk, 2003, RGM 794 539, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 292].

Horaiclavidae

4. Haedropleura avenacea Boettger, 1906, RGM 784 010, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 292].

Turridae

5. Unedogemmula giebeli (Bellardi, 1877), RGM 776 922 locality 13, Pınarlar Yaylası, Akpınar, SEM [p. 295].

Omalogyridae

- 6. Ammonicerina rota (Forbes & Hanley, 1853), RGM 784 058, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 303].
- 7. Omalogyra atomus (Philippi, 1841) s. lat., damaged during SEM imaging, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 304].

Pyramidellidae

- 8. Syrnola sp. RGM 784 088, locality 17, Seyithasan, SEM [p. 307].
- 9. Syrnola sp. RGM 783 600, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 307].
- 10. Syrnola sp. RGM 784 089, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 307].
- 11. Nisosyrnola concava (Boettger, 1907), NHMW 1847/0058/1470, locality 17, Seyithasan, SEM [p. 307].
- 12. Megastomia conoidea (Brocchi, 1814), RGM 784 040, locality 17, Seyithasan, SEM [p. 308].
- 13. Odostomia fusulus Monterosato, 1878, RGM 776 912, locality 17, Seyithasan, SEM [p. 309].
- 14. Odostomia elisabethae Boettger, 1907, RGM 776 913, locality 17, Seyithasan, SEM [p. 310].



Pyramidellidae

- 1. Odostomia erjaveciana Brusina, 1869, NHMW 1847/0058/1562, locality 17, Seyithasan, SEM [p. 310].
- 2. Odostomia unidentata (Montagu, 1803), RGM 776 915, locality 17, Seyithasan, SEM [p. 310].
- 3. Odostomia sp., RGM 776 914, locality 17, Seyithasan, SEM [p. 311].
- 4. Pyramistomia deubeli (Boettger, 1902), NHMW 1847/0058/1434, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 311].
- 5. Chrysallida emaciata (Brusina, 1866), holotype, RGM 784 069, locality 17, Seyithasan, SEM [p. 312].
- 6. Chrysallida cf. fenestrata (Jeffreys, 1848), RGM 794 575, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 312].
- 7. Chrysallida longula Boettger, 1907, RGM 783 941, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 313].
- 8. Chrysallida majae nov. sp., holotype, RGM 794 573, locality 17, Seyithasan, SEM [p. 314].
- 9. Chrysallida majae nov. sp., paratype 1, RGM 794 574, locality 17, Seyithasan, SEM [p. 314].
- 10. Chrysallida obtusa (Brown, 1827), RGM 784 012, locality 17, Seyithasan, SEM [p. 314].
- 11. Chrysallida suturalis (Philippi, 1844), RGM 784 092, locality 17, Seyithasan, SEM [p. 315].
- 12. Turbonilla gastaldi auct. (?Semper 1861), RGM 784 090, locality 17, Seyithasan, SEM [p. 315].
- 13. Turbonilla cf. superstructa Boettger, 1907, RGM 784 091, locality 17, Seyithasan, SEM [p. 316].



Pyramidellidae

- 1. Turbonilla pliopupoides (Sacco, 1892), RGM 776 851 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 317].
- 2. Turbonilla sp., RGM 776 918, locality 17, Seyithasan, SEM [p. 317].
- Eulimella scillae (Scacchi, 1835), RGM 776 911 (ex JvdV collection), locality 6, hill slopes in forest west-northwest of Lale, SEM [p. 318].
- 4. Eulimella scillae (Scacchi, 1835), RGM 783 164, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 318].
- 5. Eulimella cerullii (Cossmann, 1915), RGM 776 916, locality 17, Seyithasan, SEM [p. 319].

Amathinidae

- 6. Monotygma elata (von Koenen, 1882), RGM 776 917 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 320].
- 7. *Monotygma elata* (von Koenen, 1882), NHMW 1847/0058/1388, locality 6, hill slopes in forest west-northwest of Lale, SEM [p. 320].

Murchisonellidae

- 8. Anisocycla pointeli (de Folin, 1868), RGM 784 062, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 321].
- 9. Anisocycla nitidissima (Montagu, 1803), RGM 783 163, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 321].
- 10. Henrya wareni nov. sp., holotype, NHMW 1847/0058/1564, locality 17, Seyithasan, SEM [p. 322].

Acteonidae

11. 'Acteon' problematicus nov. sp., holotype, RGM 784 064, locality 17, Seyithasan, SEM [p. 324].

Ringiculidae

- 12. Ringicula exilis (Eichwald, 1829), RGM 784 046, locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 325].
- Ringicula laevigata (Eichwald, 1830), NHMW 1847/0058/1387, locality 6, hill slopes in forest west-northwest of Lale, SEM [p. 326].
- 14. Ringicula minor (Grateloup, 1838), RGM 784 045, localities 7 & 8, Akboğazi, Lale River, SEM [p. 326].



Ringiculidae

1. Ringicula minor (Grateloup, 1838), RGM 784 045, localities 7 & 8, Akboğazi, Lale River, SEM [p. 326].

Philinidae

- Philine catena (Montagu, 1803), RGM 776 862 (ex JvdV collection), locality 17, Seyithasan; 2b: detail of microsculpture, SEM [p. 329].
- 3. Philine aff. intricata Monterosato, 1884, broken during handling, locality 17, Seyithasan, SEM [p. 329].
- Philine scabra (Müller, 1784), RGM 776 850 (ex JvdV collection), locality 17, Seyithasan; 4b: detail of microsculpture, SEM [p. 330].
- 5. Philine seyithasanensis nov. sp., holotype, RGM 776 919, locality 17, Seyithasan; 5c detail of microsculpture, SEM [p. 331].
- 6. Philine seyithasanensis nov. sp., paratype 1, RGM 776 921 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 331].

Haminoeidae

- 7. Micratys fragilissimus nov. sp., holotype, RGM 784 066, locality 17, Seyithasan, SEM [p. 328].
- 8. Micratys fragilissimus nov. sp., paratype 1, RGM 784 067, locality 17, Seyithasan, SEM [p. 328].

Cylichnidae

- 9. Acteocina lajonkaireana (de Basterot, 1825), RGM 784 028, locality 17, Seyithasan, SEM [p. 333].
- 10. Acteocina voeslauensis (Berger, 1953), RGM 776 920 (ex JvdV collection), locality 17, Seyithasan, SEM [p. 334].

Retusidae

- 11. Retusa truncatula (Bruguière, 1792), RGM 784 009, locality 17, Seyithasan, SEM [p. 337].
- 12. Pyrunculus elongatus (Eichwald, 1830), RGM 784 000, locality 17, Seyithasan, SEM [p. 338].



Retusidae

- 1. Retusa umbilicata (Montagu, 1803), RGM 784 006, locality 17, Seyithasan, SEM [p. 336].
- 2. Volvulella acuminata (Bruguière, 1792), RGM 784 011, locality 17, Seyithasan, SEM [p. 339].

Juliidae

- 3. Berthelinia nov. sp., RGM 776 849 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, SEM [p. 341].
- 4. Berthelinia nov. sp., RGM 784 065, locality 17, Seyithasan, SEM [p. 341].

Naticidae

 Natica pachyope var. curta Erünal-Erentöz, 1958, holotype, AÜ LE-K-214/1, probably locality 12-14, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene, specimen illustrated by Erünal-Erentöz, 1958, pl. 5, fig. 8, 8a-b (photo YI) [p. 100].

Conidae

- Varioconus erunalerentoezae nov. sp., holotype, AÜ-LE-K-253, locality unknown, Karaman Basin, Turkey, Tirtar Formation, Serravallian, middle Miocene (photo YI) [p. 248].
- 7. Varioconus karamanensis (Erünal-Erentöz, 1958), AÜ-LE-K-252, locality unknown, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene (photo YI) [p. 249].
- Monteiroconus daciae (Hoernes & Auinger, 1879), AÜ-LE-K-249, locality unknown, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene (photo YI) [p. 242].

Clavatulidae

- 9. *Clavatula* (*Clavatula*) *theodori* (Toula, 1901), AÜ-LE-K-237, locality unknown, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene, possibly specimen illustrated by Erünal-Erentöz, 1958, pl. 14, fig. 10 (photo YI) [p. 285].
- Clavatula (Clavatula) theodori var. calcaratiformis Erünal-Erentöz, 1958, AÜ-LE-K-238, locality unknown, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene, possibly specimen illustrated by Erünal-Erentöz, 1958, pl. 14, fig. 13 (photo YI) [p. 285].



Turritellidae

- 1. Ptychidia vindobonensis (Handmann, 1882), NHMW 1847/0058/1671, locality 13, Pinarlar Yaylasi, Akpinar, height 50.2 mm [p. 58].
- 2. Olygodia bicarinata (Eichwald, 1830), NHMW 1847/0058/1672, locality 17, Seyithasan, height 57.7 mm [p. 61].

Strombidae

3. *Persististrombus inflexus* (Eichwald, 1830), RGM 777 865 (ex JvdV collection), locality 13, Pinarlar Yaylası, Akpinar, height 71.7 mm (juvenile) [p. 89].

Naticidae

- 4. *Cochlis curta* (Erünal-Erentöz, 1958), RGM 777 866 (ex JvdV collection), locality 13, Pinarlar Yaylası, Akpınar, height 25.7 mm (juvenile) [p. 100].
- 5. Cochlis sp. 2, RGM 777 867 (ex JvdV collection), localities 7 & 8, Akboğazi, Lale River, height 22.1 mm [p. 101].
- 6. Cochlis sp. 3, RGM 777 868 (ex JvdV collection), localities 7 & 8, Akboğazi, Lale River, height 23.1 mm [p. 102].
- 7. Polinices redemptus (Michelotti, 1847), RGM 777 869 (ex JvdV collection), locality 17, Seyithasan, height 44.1 mm [p. 105].

Tonnidae

8. Cassis postmamillaris Sacco, 1890, RGM 777 870 (ex JvdV collection), locality 17, Seyithasan, height 50.5 mm [p. 123].

Babyloniidae

9. Babylonia eburnoides (Mathéron, 1842), NHMW 1847/0058/1670, locality 17, Seyithasan, height 29.8 mm [p. 164].

Buccinidae

- 10. *Euthria curvirostris* (Grateloup, 1833), RGM 777 871 (ex JvdV collection), localities 2 & 3, roadcut at turnoff to Lale on Mut road and fields between main Mut road and road to Lale, where the two roads run almost parallel, height 39.5 mm [p. 165].
- 11. *Metula submitraeformis* (d'Orbigny, 1852), RGM 777 864 (ex JvdV collection), locality 13, Pinarlar Yaylası, Akpinar, height 38.6 mm [p. 167].

Columbellidae

 Orthurella convexula Sacco, 1904, RGM 777 872 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 34.1 mm [p. 193].



Fasciolariidae

1. Streptochetus ornatus (d'Orbigny, 1852), RGM 777 873 (ex JvdV collection), locality 17, Seyithasan, height 47.9 mm [p. 201].

Volutidae

- 2. Lyria taurinia (Michelotti, 1847), RGM 777 874 (ex JvdV collection), locality 17, Seyithasan, height 67.3 mm [p. 202].
- 3. *Athleta ficulina* (Lamarck, 1811), RGM 777 875 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 64.3 mm [p. 203].
- 4. Athleta rarispina (Lamarck, 1811), RGM 777 876 (ex JvdV collection), locality 17, Seyithasan, height 35.5 mm [p. 205].

Harpidae

5. Oniscidia cythara (Brocchi, 1814), RGM 777 877 (ex JvdV collection), locality 17, Seyithasan, height 40.5 mm [p. 206].

Olividae

 Amalda glandiformis (Lamarck, 1810), RGM 777 878 (ex JvdV collection), locality 13, Pinarlar Yaylası, Akpinar, height 34.5 mm [p. 222].

Mitridae

- 7. *Cancilla planicostata* (Bellardi, 1877), RGM 777 879 (ex JvdV collection), localities 7 & 8, Akboğazi, Lale River, height 36.7 mm [p. 211].
- Cancilla suballigata (Bellardi, 1877), RGM 777 880 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 27.1 mm [p. 212].

Costellariidae

- 9. Ziba goniophora (Bellardi, 1850), RGM 777 882 (ex JvdV collection), locality 17, Seyithasan, height 15.8 mm [p. 213].
- 10. Pusia baluki nov. sp., paratype 10, RGM 777 881 (ex JvdV collection), locality 17, Seyithasan, height 16.3 mm [p. 214].

Cancellariidae

- 11. *Bivetiella dertonensis* (Bellardi, 1841), RGM 777 883 (ex JvdV collection), locality 12, slopes east-northeast of Akpınar village, height 24.6 mm [p. 224].
- 12. Contortia callosa (Hörnes, 1854), RGM 777 884 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 31.4 mm [p. 226].



Conidae

- 1. Kalloconus berghausi (Michelotti, 1847), RGM 777 885 (ex JvdV collection), locality 17, Seyithasan, height 29.1 mm [p. 236].
- Kalloconus hungaricus (Hoernes & Auinger, 1879), RGM 777 886 (ex JvdV collection), locality 17, Seyithasan, height 47.1 mm [p. 238].
- 3. Lautoconus bitorosus (Fontannes, 1880), RGM 777 887 (ex JvdV collection), locality 17, Seyithasan, height 75.0 mm [p. 239].
- 4. *Monteiroconus antiquus* (Lamarck, 1810), RGM 777 888 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 79.9 mm [p. 241].
- Monteiroconus antiquus (Lamarck, 1810), RGM 776 948 (ex JvdV collection), locality 13, Pinarlar Yaylası, Akpinar, height 59.8 mm [p. 241].
- 6. *Monteiroconus daciae* (Hoernes & Auinger, 1879), RGM 777 889 (ex JvdV collection), locality 17, Seyithasan, height 30.2 mm (juvenile) [p. 242].
- 7. Monteiroconus mercati (Brocchi, 1814), RGM 777 890 (ex JvdV collection), locality 17, Seyithasan, height 84.6 mm [p. 244].
- 8. Monteiroconus mercati (Brocchi, 1814), RGM 777 776 949 (ex JvdV collection), locality 17, Seyithasan, height 87.7 mm [p. 244].
- 9. *Plagioconus puschi* (Michelotti, 1847), RGM 777 891 (ex JvdV collection), locality 13, Pınarlar Yaylası, Akpınar, Karaman Basin, Turkey, Tırtar Formation, Serravallian, middle Miocene; height 81.9 mm [p. 245].



Conidae

- 1. Varioconus pelagicus (Brocchi, 1814), RGM 777 892 (ex JvdV collection), locality 17, Seyithasan, height 38.6 mm [p. 247].
- 2. Varioconus pelagicus (Brocchi, 1814), RGM 777 893 (ex JvdV collection), locality 17, Seyithasan, height 52.6 mm [p. 247].
- 3. Varioconus erunalerentoezae nov. sp., paratype 8, RGM 777 894 (ex JvdV collection), locality 17, Seyithasan, height 34.3 mm [p. 248].
- 4. Varioconus karamanensis (Erünal-Erentöz, 1958), NHMW 1847/0058/1550, locality 17, Seyithasan, height 41.6 mm [p. 249].
- Conilithes dujardini (Deshayes, 1845), RGM 777 895 (ex JvdV collection), localities 7 & 8, Akboğazi, Lale River, height 30.5 mm [p. 252].
- Varioconus taurinensis (Bellardi & Michelotti, 1840), RGM 777 896 (ex JvdV collection), locality 17, Seyithasan, height 25.1 mm [p. 251].
- 7. Varioconus taurinensis (Bellardi & Michelotti, 1840), RGM 777 897 (ex JvdV collection), locality 17, Seyithasan, height 27.3 mm [p. 251].

Borsoniidae

- Genota pseudoelisae nov. sp., paratype 7, RGM 777 898 (ex JvdV collection), localities 7 & 8, Akboğazi, Lale River, height 28.5 mm [p. 258].
- 9. Genota rudolfi (Toula, 1901), RGM 777 899 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 44.6 mm [p. 258].

Drilliidae

10. Crassispira pustulata (Brocchi, 1814), RGM 777 900 (ex JvdV collection), locality 17, Seyithasan, height 22.8 mm [p. 280].

Clavatulidae

- 11. Perrona robustocarinifera nov. sp., paratype 2, NHMW 1847/0058/1673, locality 17, Seyithasan, height 38.2 mm [p. 289].
- 12. *Perrona inedita* (Bellardi, 1877), RGM 777 901 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 58.8 mm [p. 291].
- Perrona taurinensis (Bellardi, 1877), RGM 777 902 (ex JvdV collection), locality 13, Pinarlar Yaylasi, Akpinar, height 61.0 mm [p. 291].

Terebridae

- 14. Subula buiturica Moisescu, 1955, RGM 777 903 (ex JvdV collection), locality 17, Seyithasan, height 53.2 mm [p. 295].
- 15. Subula plicaria (de Basterot, 1825), RGM 777 904 (ex JvdV collection), locality 17, Seyithasan, height 60.5 mm [p. 296].



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