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Taxonomical characters for distinguishing *Cerithium lividulum* Risso, 1826, and *C. renovatum* Monterosato, 1884 (Gastropoda, Caenogastropoda, Cerithiidae)

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ABSTRACT

Protoconch and colour pattern of the living animal are here shown to be good characters for distinguishing smaller Mediterranean *Cerithium* species, *Cerithium lividulum* Risso, 1826, and *C. renovatum* Monterosato, 1884. In particular, the protoconch is a very helpful tool for recognizing atypical morphs. The shape of the shell and early teleoconch sculpture and microsculpture are not sufficient: the former character is too variable within each species and sculpture is similar in the two species.

Observation of spawn deposited and cultured in an aquarium shows that both species have a non-planktotrophic larval development. However, *C. lividulum* shows variation in morphology and organization of egg mass. Specimens from NW. Sicily deposited eleven cylindrical egg masses, each egg containing one embryo, and one sac-like egg mass, each egg frequently containing 4 to 6 embryos. We think that the latter egg mass should be considered a rarity (anomaly?) rather than a representative taxonomical variation of *C. lividulum.*

As far as concerns the Eastern Mediterranean populations, we show that the small, almost pupoid, knobbed morph from the Aegean Sea should be considered *C. renovatum,* while the larger crenulated morph, known as *C. syriacum* Pallary, 1938, also living in SE. Sicily, is suggested to be conspecific with *C. lividulum.* A shell from the Pallary collection, in the Muséum National d'Histoire Naturelle (Paris), is here designated as lectotype of *C. syriacum.* Also, some morphs from the Eastern Atlantic are to be considered as belonging to *C. lividulum.*

Use of the protoconch was successfully applied to fossil morphs. We identified *C. lividulum* (with ribbed or knobbed morphs) from Lower Pleistocene and *C. renovatum* from late Middle Pleistocene deposits.

Key words: Gastropoda, Caenogastropoda, Cerithiidae, *Cerithium*, protoconch, Pleistocene, Mediterranean, East Atlantic.

INTRODUCTION

In the Mediterranan Sea the genus *Cerithium* Bruguière, 1789, is a common component in near-shore environments where it is particularly well represented in phanerogam or algal beds, in open sea and in lagoon waters. In the Mediterranean Sea, as well as in the Atlantic and Indo-Pacific provinces (Houbrick, 1974, 1992), *Cerithium* is represented by highly polymorphic taxa and in different cases it is unclear whether differences in shell shape correspond to distinct taxonomical entities or are the result of a great plasticity. As a consequence, two extreme views on the systematics of the Mediterranean genus

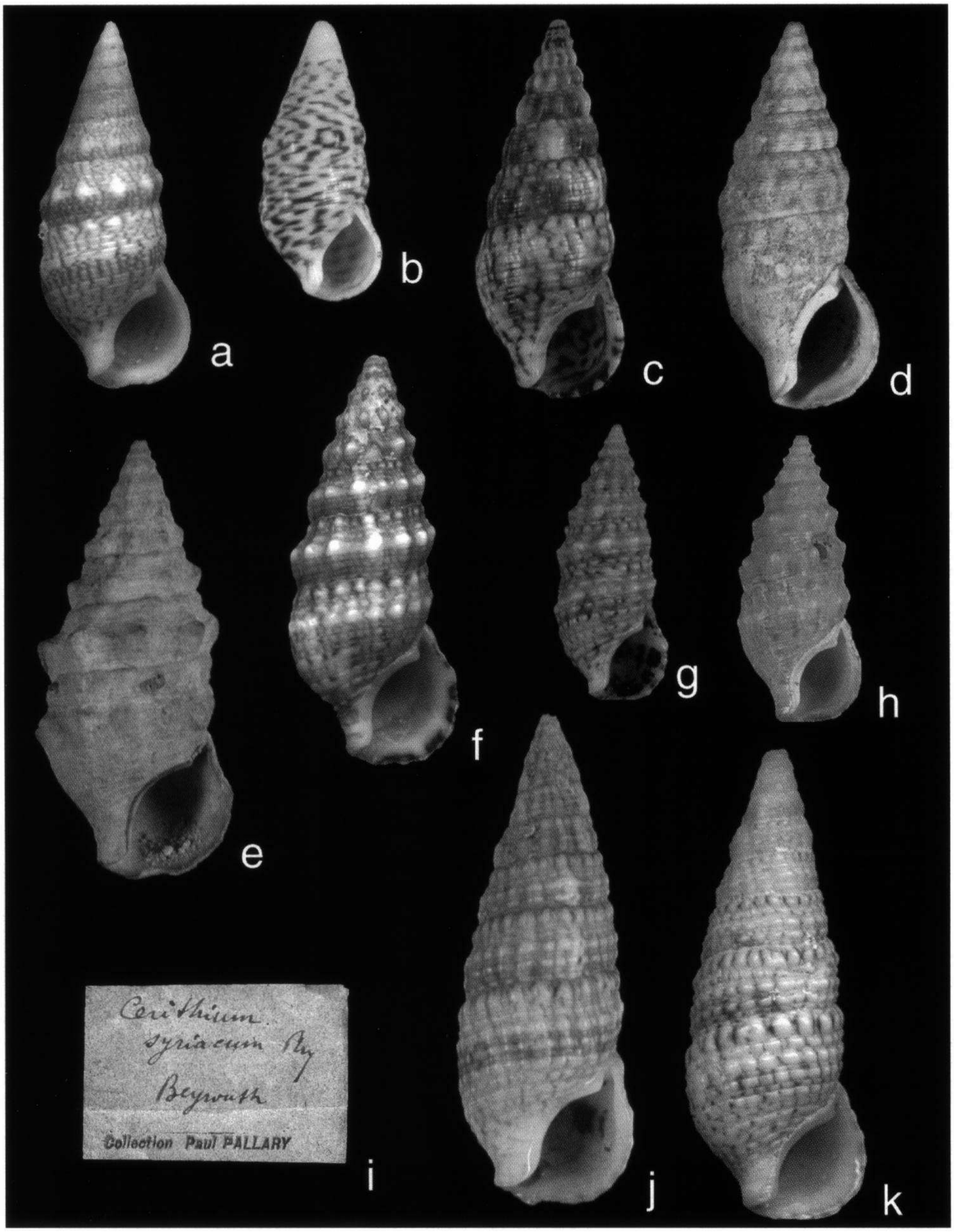

Fig. **1**. Recent and fossil morphotypes of *Cerithium lividulum* Risso, 1826, and *C. renovatum* Monterosato, 1884. All to same scale. **a**, *C. lividulum*, Isle of Lobos, Canary Islands, DGUP Coll. Duraccio, h = 17.5 mm; **b**, Fuerteventura, Selvagens Islands, MNHN Coll. Seganzac, h = 13 mm; **c**, from Mondello (NW. Sicily), DGUP Coll. Garilli, h = 18.5 mm, specimen maintained in aquarium for spawning; **d**, Lower Pleistocene of Dattilo (NW. Sicily), DGUP Coll. Garilli, h = 18.6 mm; **e**, Lower Pleistocene of Case Buffa (SE. Sicily),

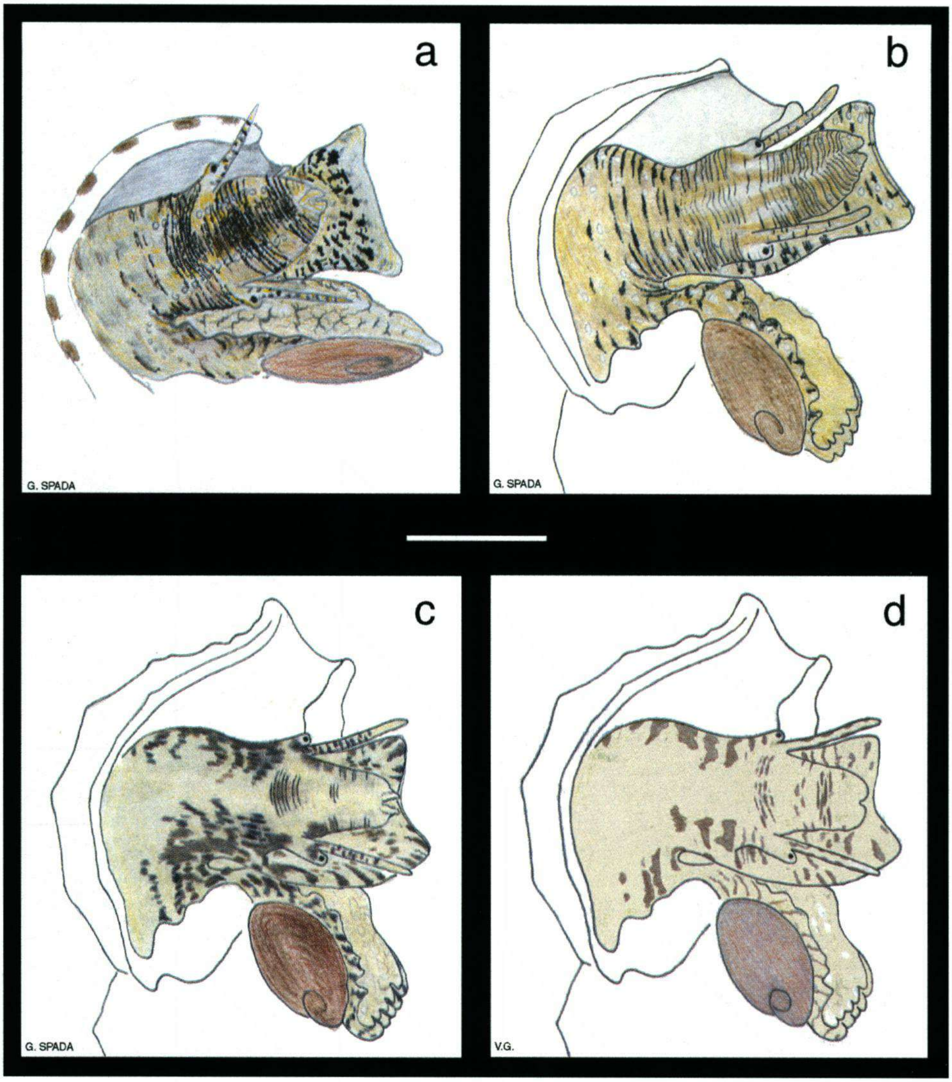

Fig. **2.** Colour of living animal of *Cerithium lividulum* Risso, 1826, and *C. renovatum* Monterosato, 1884. **a-b**, *C. lividulum* from Djerba, S. Tunisia (**a**) and Brucoli, SE. Sicily (**b**); **c-d**, *C. renovatum* from Brucoli (**c**) and Capo Gallo, NW. Sicily (**d**). Scale bar approximately 2 mm.

DGUP Coll. Garilli, h = 21.5 mm; **f**, *C. renovatum*, Capo Gallo (NW. Sicily), DGUP Coll. Garilli, h = 22 mm, specimen kept in aquarium for spawning; **g**, Glychoriza, Isle of Samos, Aegean Sea, MNHN Coll. Boisselier no. 1666, h = 13.1 mm (specimen studied for allozyme electrophoresis); **h**, late Middle Pleistocene of Tommaso Natale (NW. Sicily), DGUP Coll. Ruggieri, h = 14 mm; **i-j**, Lectotype, here designated, of *C. syriacum* Pallary, 1938 (fig. **j**), Beirut (Lebanon), MNHN Coll. P. Pallary, h = 24 mm, and original label by P. Pallary (fig. **i**); **k**, *C. lividulum*, Vendicari (SE. Sicily), morph strongly resembling *C. syriacum* Pallary, 1938, h = 22.6 mm.

Cerithium can be deduced from the literature:

-1, occurrence of only two species, *Cerithium vulgatum* Bruguière, 1792, within the larger morphs, and *C. rupestre* Risso, 1826, within the smaller ones (Bucquoy, Dautzenberg & Dollfus, 1884);

-2, existence of about 50 endemic species (Nordsieck, 1974).

A reasonable and generally well supported view is that of Boisselier-Dubayle & Gofas (1999) who recognized four species using allozyme electrophoresis: *Cerithium vulgatum* (having a polygirate protoconch) and *Cerithium* "lagoon" (closely related to *C. vulgatum* but having a paucispiral protoconch) in the group of the larger morphs and *C. lividulum* Risso, 1826, and *C. "rupestre"* (correctly named *C. renovatum* Monterosato, 1884, by Gofas, Garilli & Boisselier-Dubayle, 2004) within the group of the smaller morphs generally confused under the name *Cerithium rupestre*.

With regard to the group of the smaller species, recently Gofas et al. (2004) provided some taxonomical information mainly based on two key characters: egg masses and teleoconch morphology. Here we report that the use of these two characters is affected by limitations. The first character, which we show here to be variable in *C. lividulum*, can be used only in living populations and is therefore unavailable to paleontologists. The second character is strongly limited in value by the high intraspecific variation in shell shape shown by these species, with particular regard for *C. lividulum*. In effect, as illustrated by Gofas et al. (2004), it is not clear whether some small morphotypes from Eastern Mediterranean and Eastern Atlantic are conspecific with the well established smaller Mediterranean *Cerithium* species.

The main purpose of this article is to provide stable taxonomical characters for distinguishing *C. lividulum* and *C. renovatum* and their fossil and Recent atypical morphotypes.

MATERIALS AND METHODS

Studied material, also collected by the authors, is housed in the Muséum National d'Histoire Naturelle of Paris (MNHN) and in the Dipartimento di Geologia e Geodesia, University of Palermo (DGUP). Apart from specimens hand-collected from the fore-shore zone (mainly *C. lividulum*), living populations were sampled by diving at depths of about 1 to 5 m. In order to detect eventual paleontological occurrence of the discussed species and to evaluate use of morphological taxonomical keys in the past, we also analysed many Pliocene-Pleistocene mollusc assemblages mainly from Italy, Tunisia and Greece. Paleontological material was obtained from bulk samples which were washed in a battery of sieves (mesh 2, 1 and 0.5 mm). Particular attention has been given to early teleoconch sculpture and microsculpture and to the protoconch (hereafter also named larval shell) in order to detect taxonomical relevance. Determination of living samples of *C. lividulum* and *C. renovatum* protoconch morphological features was based either on allozyme electrophoresis (Garilli & Boisselier-Dubayle, 2000), or on some larval and early post-larval specimens obtained by spawn. Egg masses were deposited by specimens collected from populations (*C. lividulum* from Mondello and *C. renovatum* from Capo Gallo, NW. Sicily) morphologically perfectly in agreement with their respective lectotypes designated by Arnaud (1978) and by Gofas et al. (2004). Each species was kept separately in aquariums with seawater filtered in a 63 μm mesh sieve. To avoid contamination, after deposition each egg mass was detached from substrate and moved to an isolated container. For the remaining fossil and Recent material, protoconch features were observed in juvenile shells linked to their respective adult morphs by restoring more or less complete ontogenetic series. Comparison between protoconchs observed in juvenile shells and those obtained from egg masses have been based on Scanning Electronic Microscope analyses.

Protoconch whorls have been counted according to Verduin (1977). Observation of egg masses proved to be useful to recognize the type of larval development whose determination follows the classification in planktotrophic and non-planktotrophic of Mileikovsky (1971) and Jablonski & Lutz (1980, 1983). Attention was also given to the colour pattern of live animals of the above-mentioned populations and on specimens collected at Brucoli (SE. Sicily, by G. Spada) and Djerba (S. Tunisia).

TAXONOMY

Cerithium lividulum Risso, 1826

Shell. — Often misidentified as *C. rupestre* sensu Bucquoy et al. (1884), *C. lividulum* has a very polymorphic shell (see Giannuzzi-Savelli, Pusateri, Palmeri & Ebreo, 1996, figs 49-56; Gofas et al., 2004, figs 1A-C, 4, 7 G-H for shell variation). As shown by the lectotype designated by Arnaud (1978) and depicted by Gofas et al. (2004, fig. 4A-B), the typical *C. lividulum* (fig. 1c) has a conical, more or less pupoid shell with moderately convex whorls bearing folds, flat spiral cords and usually varices on the early teleoconch whorls. Very early teleoconch whorls have one major spiral cord, usually forming a keel; one, rarely two secondary, flat, rudimentary to prominent spiral cords in the abapical portion of the whorls may also be present (fig. 3b). The next whorls bear axial folds. Teleoconch microsculpture consists of narrowly spaced microtubercules forming very fine spiral cords (fig. 3a-c). The colour pattern usually consists of brown, reddish-brown spots on a greenish-whitish background.

Egg mass and larval development. — Six specimens, collected at Mondello (NW. Sicily), were kept in an aquarium where they deposited twelve egg masses from June to August 2000. Eleven samples, one of which was pictured in Gofas et al. (2004), show a slightly reniform to cylindrical, short (about 1 cm to 1.5 cm in length) gelatinous mass (fig. 4c) in which each egg contains a single embryo. Each egg mass was estimated to contain about 170-250 eggs depending on its length. A single spawn (fig. 4a-b) shows different morphology. It consists of a rough, short (about 8 mm in length) gelatinous mass, with a very irregular outline, in which each egg capsule contains 1 (very rarely) to 4-6 embryos. This egg mass was estimated to contain about 35 egg capsules. In contrast to all other samples, in this isolated case a consistent percentage of empty eggs were observed and many embryos did not hatch. This probably is a case of abnormal development rather than a representative taxonomic variation.

In all egg masses an encapsulated veliger stage was detected and hatching occurred 7 to 9 days after deposition. Metamorphosis was reached 1 to 2 days before or in 2 to 3 days after hatching and crawling miniature snails went directly to the walls of the tank.

Larval shell. — Post hatching juveniles from all egg masses were analysed in order to observe the larval shell (fig. 5). This consists of 1.2-1.6 convex whorls sculptured by microscopic dots forming discontinuous, spiral lines. In the early half whorl dots are arranged in bands. Protoconch diameter ranges between 340 μm and 380 μm; height is between about 320 μm and 360 μm. The same sculptural pattern was illustrated by Bandel (1975, from Banyuls-sur-Mer, Mediterranean France), by Dantart, Frechilla & Ballesteros (1990, from Formentera, Balearic Islands), by Gofas (1987, from Benzù, Strait of Gibraltar), all s.n. *C. rupestre*, and by Moreno-Lampreave (1998, from Almeria, Mediterranean Spain and Calvi, Corsica) s.n. *C. lividulum*. The well-marked protoconch/teleoconch boundary is almost straight or very slightly sinuous.

Colour of the live animal. — Specimens from Mondello (NW. Sicily) showed a colour pattern similar to that observed in populations of Djerba (S. Tunisia, fig. 2a) and Brucoli

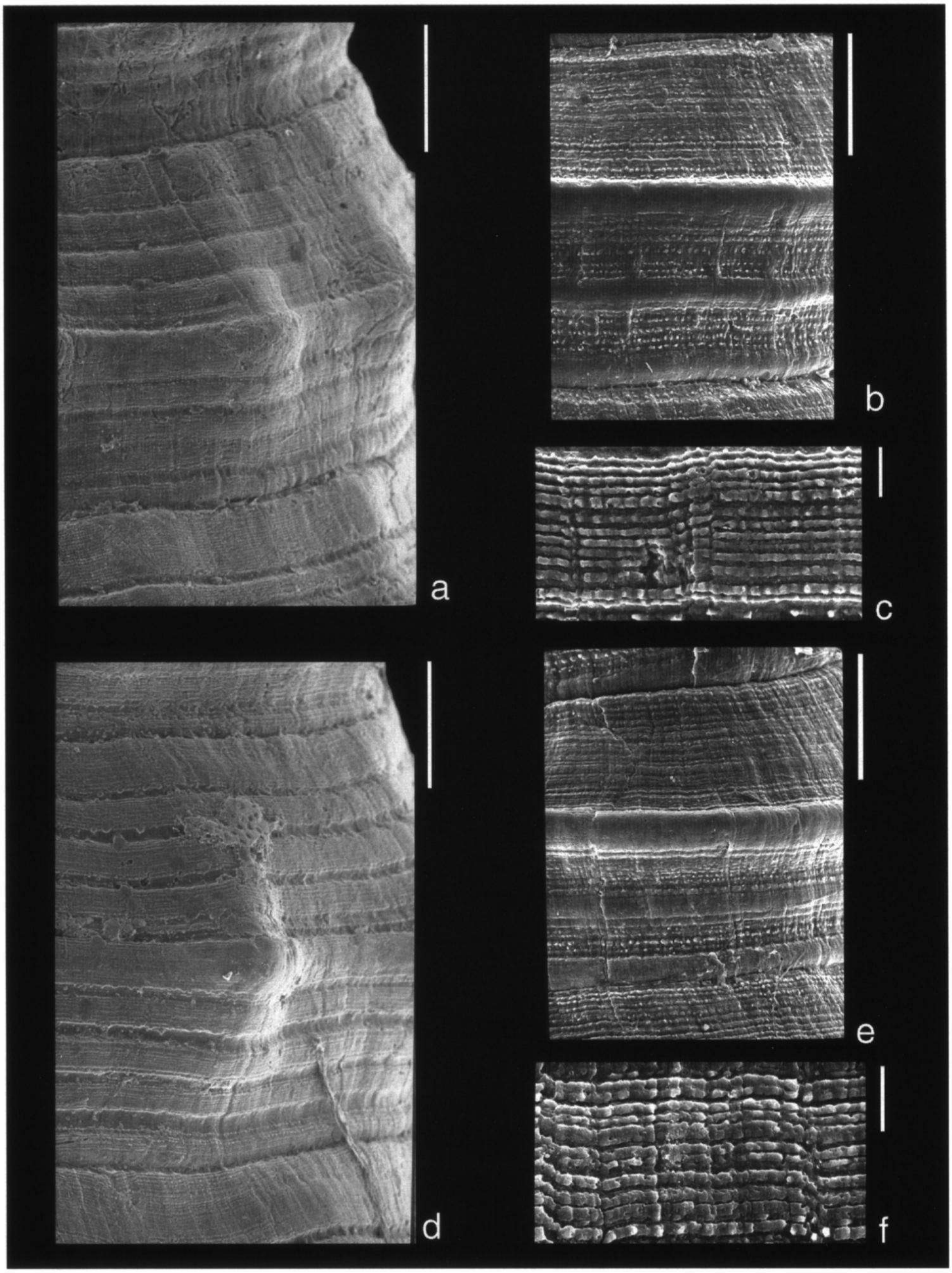

Fig. 3. Early teleoconch sculpture and microsculpture of *Cerithium lividulum* Risso, 1826, and *C. renovatum* Monterosato, 1884. **a-c**, *C. lividulum* from Mondello (NW. Sicily); **a**, 5th teleoconch whorl; **b**, 2nd teleoconch whorl; **c**, microsculpture of spiral cord, 5th teleococnh whorl; **d-f**, *C. renovatum* from Capo Gallo (NW. Sicily); **d**, 5th teleoconch whorl; **e**, 2nd teleoconch whorl; **f**, microsculpture of spiral cord, 5th teleoconch whorl. Scale bars 200 µm in a and d, 100 µm in b and e, 20 µm in c and f.

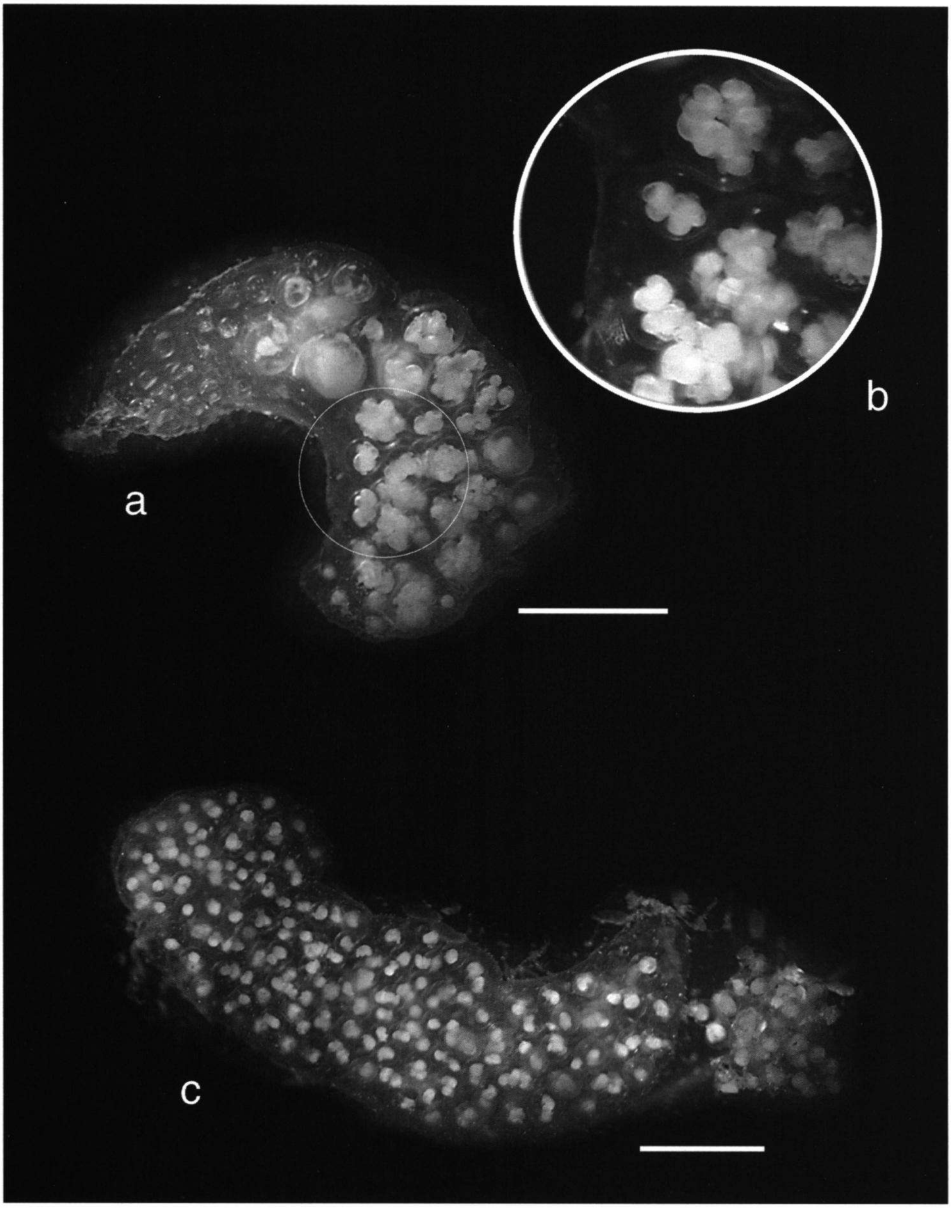

Fig. **4**. Variation in egg masses deposited in aquarium by specimens of *C. lividulum* Risso, 1826, collected at Mondello (NW. Sicily). **a** and **b**, general view (**a**) and enlarged portion (**b**) of the isolated egg mass showing 1 to 4-6 embryos in each capsule; **c**, one of the eleven egg masses, showing one embryo in each capsule. Scale bars 2 mm.

(SE. Sicily, fig. 2b): narrow, dark brown bands, mainly on the head, and larger spots mainly on the foot on a yellow background.

The case of *Cerithium syriacum* Pallary, 1938

Originally described as *Cerithium mediterraneum syriaca* by Pallary (1919) and subsequently elevated to species level by Pallary (1938), this taxon is based on populations from the coast of Lebanon. According to Gofas et al. (2004) the synonymy of *C. syriacum* and *C. lividulum* is to be verified. Fourteen possible syntypes from Lebanon (Beirut, 9; El Batrun, 1; and Tripoli, 4) are housed in the MNHN with label (fig. 1i) allowing to trace them to Pallary's material. The figured shell (fig. 1j) from Beirut well agrees with Pallary's picture (1938, pl. 1 fig. 22) and is here designated as lectotype in order to establish what really Pallary intended to describe. The shell of *C. syriacum* is characterized by a crenulate, almost roughly reticulate sculpture consisting of narrow and abundant axial ribs, often very obsolete, crossed by flat spiral cords out of which two, in the middle and in abapical portion of mature whorls, are stronger and bear white spots on the ribs (fig. 1j); varices may be present in juvenile and subadult whorls or even in the last whorls. This sculptural pattern slightly resembles that observed in *C. strumaticum* Locard, 1896, which is synonym of *C. lividulum* (Gofas et al., 2004; see also this article for a syntype of *C. strumaticum*, fig. 4I-J). This morph mainly differs from *C. syriacum* in having a markedly pupoid shell with stronger and less numerous axial ribs. We found shell characters as shown by *C. syriacum* (compare fig. 1j to fig. 1k) in populations living in the fore-shore pools along the coast between the Tonnara of Vendicari and Marzamemi (SE. Sicily). The taxonomical status of individuals of the Vendicari population was confirmed by allozyme electrophoresis (Garilli & Boisselier-Dubayle, 2000). Young specimens from the same population have a larval shell perfectly identical to the one obtained from the *C. lividulum* population collected in Mondello (compare fig. 5d with fig. 5f). Also the colour pattern of the live animal of the Vendicari and Mondello populations are comparable. We also observed that the typical *C. syriacum* shell shape is shared by several samples housed in different collections from eastern Mediterranean localities: Cap Carmel, Israel, MNHN Coll. Vignal, labelled as *C. lividulum* (1); Aya Thekla, Cyprus, DGUP Coll. G. Spada; Cyprus, MNHN Coll. Vignal, labelled as *C. lividulum* var. *ruderata* Monterosato (7) and MNHN Coll. Gaudry, labelled in the same way (41); Rhodes, Greece, MNHN Coll. Vignal, labelled as *C. lividulum* var. (6); Isle of Kalymnos, Greece, MNHN Coll. Locard, labelled as *C. mediterraneum* (3) and MNHN Coll. Vignal, with label indicating determination by Monterosato as *Lithocerithium archipelagicum* Monterosato (4); Isle of Delos, MNHN Coll. Vignal, with two labels (*C. rupestre* and *C. lividulum*) (6); Glycorhiza beach, Pythagorion, Isle of Samos, MNHN Coll. Gofas, (1); Isle of Spetses, North coast, Greece, MNHN Coll. Gofas (7).

Cerithium lividulum in the Eastern Atlantic

Another question posed by Gofas et al. (2004) is whether the small ceriths from the Canary Islands may be considered conspecific with *C. lividulum* or whether they are the result of subspecific separation. The names *Thericium strumaticum canariense, T. medrickyi, Stomothericium stomum* (all introduced by Nordsiek, 1974: 10-11, figs 71a, 72a, 90) are available for the Canary populations. Except for *T. strumaticum canariense,* we did not study Atlantic populations which morphologically well agree with Nordsieck's nominal taxa. In reality the very small morph from the Selvagens Islands (about 160 km north of the Canary Islands, MNHN Coll. Seganzac; about 260) and Tenerife, Canary Islands (MNHN Coll. Vignal; 5) strongly resembles what is described by Nordsieck & Garcia-

Talavera (1979: 89) as *T. strumaticum* f. *canariense*. This taxon shows a not markedly sculptured shell with axial, brown zigzag flammules on a whitish background (a colour pattern we never saw in Mediterranean populations, fig. 1b). Material from the Selvagens, represented by complete ontogenetic series, shows the same protoconch characters (fig. 5h) as observed in typical *C. lividulum*. Also the knobbed, unusually coloured specimens (reddish-pale brown, very narrow axial spots on a white background) from the small Isle of Lobos (DGUP Coll. Duraccio, NW coast of Fuerteventura, Canary, fig. 1a) have a larval shell (fig. 5e) perfectly corresponding to that of *C. lividulum*. Several lots from the Canary Islands with shells similar to the Mediterranean morphs are housed in the MNHN: Arrecife, Lanzarote Coll. Bouchet (4); La Isleta, Lanzarote, Coll. Bouchet (54); Orzola, Lanzarote, Coll. Bouchet (6); Lanzarote Coll. Staadt (2); Las Gallettas, Tenerife, Coll. Bouchet & Gofas (14); Pal-Mar, Tenerife, Coll. Bouchet & Gofas (2); Punta Hidalgo, Tenerife, Coll. Bouchet & Gofas (6).

Cerithium renovatum Monterosato, 1884

Shell. — This taxon is frequently misidentified as *C. rupestre* Risso, 1826; typically it has a turreted, conical teleoconch with very slightly convex whorls bearing a series of white spiralling knobs, obsolete or lacking on the body whorl, on a yellowish brown background (fig. 1f). The sculpture of the very early teleoconch whorls (fig. 3e) shows the same pattern as described for *C. lividulum*. Early subadult whorls are sculptured by obsolete axial folds bearing prominent tubercles in the middle. Teleoconch microsculpture (fig. 3d-f) is indistinguishable from that shown by *C. lividulum*.

Egg mass and larval development. — All spawn (of which one was described and pictured by Gofas et al., 2004, fig. 2D) was deposited by specimens collected at Capo Gallo (NW. Sicily); deposition occurred from June to July 2000. Egg masses consist of a very narrow gelatinous tube in which eggs are arranged in a single strand. One mass was estimated to contain about one hundred eggs. An encapsulated veliger stage was detected and hatching occurred 8-11 days after deposition; juveniles emerged in the crawling stage. Metamorphosis was reached 2-3 days before or in 2-6 days after hatching.

Larval shell. — In order to observe the larval shell (of which no picture is available in the literature), some pre- and post-hatching specimens were obtained from egg masses. The protoconch (fig. 6a-f) consists of 0.7 to 1.6 angled whorls sculptured with spirally, somewhat irregular microtubercles and pustulae, which become less marked close to the protoconch/teleoconch boundary. Two series of strong, spirally pustulae form a double cord, resulting in a characteristic keeled profile of the whorls. Protoconch/teleoconch demarcation is slightly sinuous. Diameter ranges between about 330 μm (in specimens having an encapsulated metamorphosis, fig. 6b) and 410 μm. Height is quite variable, being between about 200 μm (in specimens quickly reaching metamorphosis) and 480 μm.

Colour of live animal. — Specimens from Capo Gallo (NW. Sicily) show a colour pattern consisting of reddish-brown spots (larger at the periphery and on the foot and narrow on the head) and whitish spots on a yellowish-cream background (fig. 2d). A very similar pattern was observed by G. Spada (fig. 2c) in a population collected at Brucoli (SE. Sicily) of which the shell perfectly agrees with that observed in a population (from Capo Gallo) analysed by allozyme electrophoresis.

C. renovatum in the Eastern Mediterranean

Gofas et al. (2004) doubtfully considered smaller, knobbed morphs from the Aegean (Greece) to be conspecific with *C. renovatum*. We analysed a population from that area

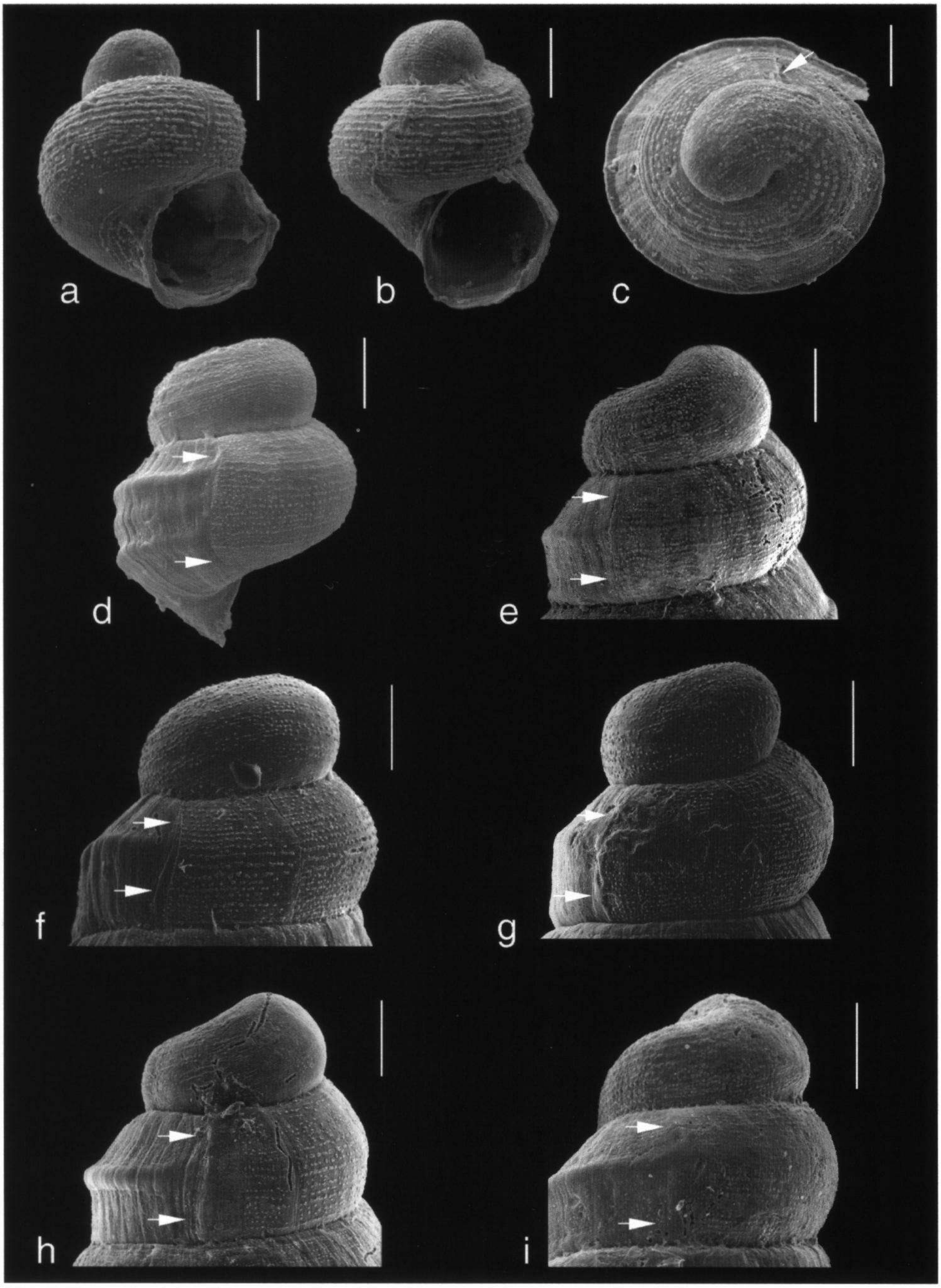

Fig. 5. Recent and fossil protoconchs of *Cerithium lividulum* Risso, 1826. **a**, ventral view of post hatching specimen developed from egg mass pictured in fig. 4a-b, deposited in aquarium by specimens collected at Mondello (NW. Sicily); **b-d**, ventral (**b**), apical (**c**) and lateral view (**d**) of post hatching specimens obtained from egg mass pictured in fig. 4c deposited in aquarium by specimens of the same population from Mondello. **e**, Isle of Lobos, Canary Islands; **f**, Vendicari (SE. Sicily), specimen from a population with shells morphologically well agreeing with those of *C. syriacum* Pallary, 1938; **g**, Lower Pleistocene of Case Buffa (SE. Sicily); **h**, Fuerteventura, Selvagens Islands; **i**, Lower Pleistocene of Dattilo (NW. Sicily). Scale bars 100 µm. Arrows indicate protoconch/teleoconch demarcation.

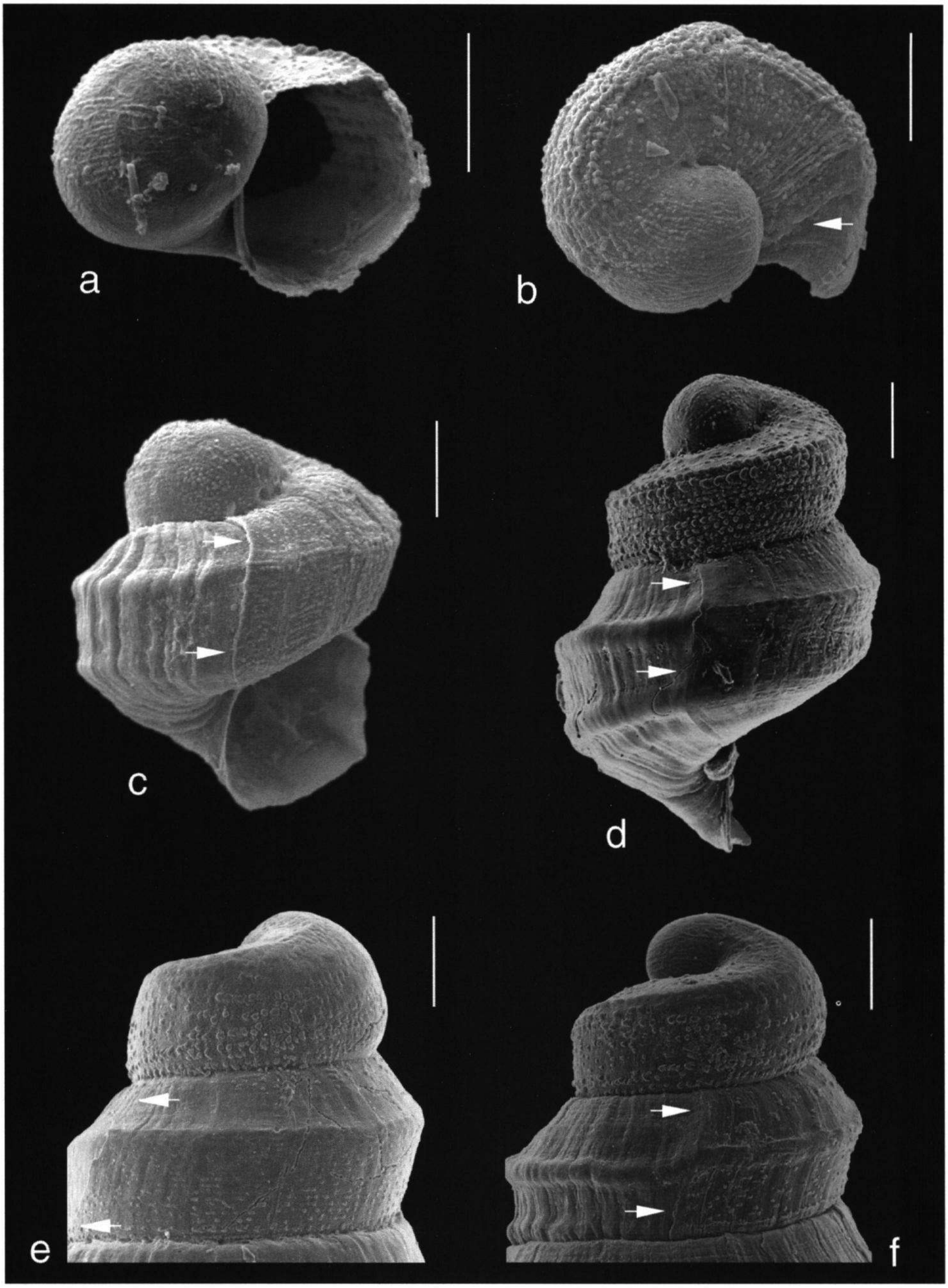

Fig. 6. Recent and fossil protoconchs of *Cerithium renovatum* Monterosato, 1884. **a-d**, pre (**a** and **b**, ventral and apical view respectively) and post (**c** and **d**, lateral view) hatching specimens developed from egg masses, deposited in aquarium by specimens collected at Capo Gallo (NW. Sicily); **e**, from Isle of Samos (Aegean, Greece); **f**, from the late Middle Pleistocene of Tommaso Natale (Palermo). Scale bars 100 μm. Arrows indicate protoconch/teleoconch demarcation.

(Glychoriza Bay, Isle of Samos) characterized by a very small, slightly pupoid shell with faint, whitish knobs and a greenish background (fig. 1g). Juvenile specimens showed the characteristic keeled protoconch (fig. 6e) of *C. renovatum*. The taxonomical status of individuals from this population was also confirmed by allozyme electrophoresis (Garilli & Boiselier-Dubayle, 2000). Further research could be helpful in verifying whether the very small morph, described by Pallary (1938: 33, figs 7-8) as *C. phaeniciarum* from Tartous (Syria), represents the easternmost Mediterranean occurrence of *C. renovatum*. A possible syntype of this Pallary taxon, effectively resembling *C. renovatum*, was figured by Gofas et al. (2004, fig. 7E-F).

PALEONTOLOGY

Malatesta (1960: 95-96 and text-fig. 6), who considered *C. rupestre* a synonym of *C. lividulum*, proposed a phylogenetic lineage for the smaller Mediterranean *Cerithium* as follows:

1) Pliocene, *Thericium doliolum* (Brocchi, 1814), a species slightly resembling not markedly knobbed morphs of *Cerithium lividulum*.

2) Pleistocene, *T. lividulum antiquatum* (also indicated by Malatesta as *C. lividulum*), a ribbed morph lacking knobs, corresponding to the typical *C. lividulum*.

3) Recent, *T. lividulum lividulum* (also indicated by Malatesta as *C. rupestre*), with a turreted, gently knobbed shell corresponding to what we call *Cerithium renovatum*.

Our data on Pleistocene morphotypes contrast with what is pointed out above under 2 and 3. We found both ribbed (fig. 1d) and knobbed to spiny (fig. 1e) morphotypes, having the typical protoconch of *C. lividulum* (fig. 5g, i), from Case Buffa (Vittoria, SE. Sicily, Lower Pleistocene according to Conti, Di Geronimo, Esu & Grasso, 1979) and from Dattilo (Trapani, NW. Sicily, Lower Pleistocene, Emilian Substage according to Garilli, 1998). With regard to the question sub 3, suggesting that *C. renovatum* (*T. l. lividulum* of Malatesta, 1974) is a Recent taxon, we found this species, with the typical keeled protoconch, and resembling the Aegean small morph (compare fig. 1h with fig. 1g), in the Pleistocene deposits of Bovetto (Reggio Calabria, South Italy) and Tommaso Natale (Palermo, NW. Sicily). In particular, the former deposit, the about 120 m terrace with *Strombus bubonius* Lamarck, 1822, dated 125 ky B.P., is to be referred to the Upper Pleistocene isotopic stage 5e (Dumas, Gueremy, Hearty, Lhenaff & Raffy, 1988); the latter, dated 250 ± 30 ky B.P. by Hearty, Miller, Stearns & Szabo (1986), is to be referred to the late Middle Pleistocene.

CONCLUDING REMARKS

C. lividulum and *C. renovatum* are very polymorphic taxa; shell shape and size are widely variable, and also early teleoconch sculpture and microsculpture are indistinguishable in the two species.

The colour pattern of the animal and, especially, the protoconch are shown to be useful and stable taxonomical tools for separating the investigated species and for recognizing atypical morphotypes. As regards the colour of the animal, *C. lividulum* shows narrow, dark brown bands, mainly on the head, and larger spots mainly on the foot, while *C. renovatum* has reddish to brown spots (larger at the periphery and on the foot and narrow on the head) and whitish spots in a yellowish to cream background. With regard to larval shells, both species have a paucispiral protoconch bearing spirally arranged microtubercles (stronger in *C. renovatum* which often shows large pustulae), but in *C. lividulum* the whorls are rounded and markedly convex while the protoconch of *C. renovatum* shows a stronger sculpture and an angled profile of the whorls resulting in a well marked keel. In both species a relevant variation in number of protoconch whorls, diameter and height, particularly marked in *C. renovatum* (0.7 to 1.6 whorls), was detected. This is most probably due to the variable time (mainly for *C. renovatum*) needed by both species until metamorphosis.

In particular, the morphological features of the larval shells represent dependable taxonomic key characters, whose application can be successfully extended to biogeographical and paleontological cases regarding the investigated species. Our taxonomical data set, based on protoconch features, confirms the presence of *C. lividulum* and *C. renovatum* as separate taxa in the Eastern Mediterranean. The small, almost pupoid, morph from the Aegean Sea and the crenulated morph (known as *C. syriacum* Pallary, 1938), typical of Lebanon, Cyprus, the Aegean Sea and SE. Sicily, are suggested to be conspecific with *C. renovatum* and *C. lividulum* respectively. The latter species is present around the Canary Islands, where it is represented by polymorphic types showing the same protoconch morphological patterns but quite different colour patterns of the shell as compared to the morphs known from the Mediterranean Sea. Our morphological data-set is insufficient for detecting eventual subspecific separation among Mediterranean and Atlantic populations, above all when considering the wide intraspecific range of variation shown by *C. lividulum*. Genetical analyses should be very helpful in order to correctly answer this question.

Using the protoconch as a taxonomic character for fossils, we detected ribbed and knobbed *C. lividulum* morphs from the Lower Pleistocene while *C. renovatum* seems to be a more recent species being recorded from the late Middle Pleistocene.

Our observations on egg masses indicate that spawn of *C. lividulum* is quite variable in shape as well as in number of embryos per egg. Specimens collected in NW. Sicily, kept in an aquarium, usually laid more or less cylindrical egg masses in which each egg contains one embryo. Only once a sac-like egg mass, each egg frequently containing 4 to 6 embryos, was deposited. This rare egg mass, in which fecundity and hatching was relatively low, could be interpreted as an anomaly.

For *C. renovatum* no relevant morphological variability was observed in the cultured spawn, all having the same pattern as illustrated by Gofas et al. (2004).

For both species a non-planktotrophic larval development with no free swimming stage and a pre- or post-hatching metamorphosis were observed.

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