BASTERIA, 53: 39-46, 1989

Theodoxus in South-eastern Anatolia, Turkey (Gastropoda Prosobranchia, Neritidae)

Hartwig SCHÜTT

Haydnstrasse 50, D-4000 Düsseldorf-Benrath, West Germany

& Ridvan ŞEŞEN

Dicle Üniversitesi, Fen-Edebiyat Fakültesi, Biyoloji Bölümü, Diyarbakir, Turkey

Two clearly differentiated species of *Theodoxus* are known to occur in SE. Anatolia, which belong to different subgenera. The related species of this region are described morphologically as well as geographically.

Key words: Gastropoda, Prosobranchia, Neritidae, *Theodoxus, Neritaea*, taxonomy, Turkey, Anatolia, Syria.

This article is intended to clarify the position of the *Theodoxus* species living in Southeast Anatolia, Turkey.

The snails of the genus *Theodoxus* are freshwater inhabitants with semi-ovate shells. The species of this genus are widespread in Europe, recent and fossil, and they live exclusively in moving waters on stony substrates, where they graze on the algae. Some species are to a certain extent tolerant to higher salt contents.

In Central Europe four species are known to occur, well differentiated by their shells and colour patterns. But in southern Europe and the Near East there is a lack of clarity regarding recognition and definition of the species, because the differences are often not clearly marked. The form of the shells and the patterns are sometimes good, but frequently only useless, characters for recognition of the species. Neumann (1959: 349) has demonstrated, that the pattern of the shells can be influenced by the ion-content in the water they live in. Also, the shape and size of the shells depend on the environment and its average temperatures. That has led in the past to obscurities in identification of many examples from outside Central Europe.

A good distinctive mark is the morphology of the pegs (for muscular attachment) on the inside of the operculum. This was already recognized by J. Roth (1855: 56), who established the taxon *Neritaea*, which is today used as subgenus with the following diagnosis: "Operculi appendices duae, approximatae, fere aequales inter se, rimula obliqua separatae, ita ut crista interrupta efficiatur, fulta in carinulam palati." He designated *Neritina jordani* Sowerby, 1832, as the type-species.

This terminology is shown in fig. 1. One has to distinguish between the subgenus *Theodoxus* s. s. without peg and the subgenus *Neritaea* with peg. Another subgenus with peg, *Calvertia* Bourguignat, 1880, only for fossils of the Tertiary period, is no longer valid (Papp, 1953: 95). Based on this, Martens (1875-1879) arranged all species known to him, in the course of which he recognized as valid with peg from the Near East (1877: 82-91): *nilotica* Reeve, 1856; *euphratica* Mousson, 1874; *jordani* Sowerby, 1832; *anatolica* Récluz, 1841; *macri* Sowerby, 1849; *mesopotamica* Mousson, 1874; *cinc-*

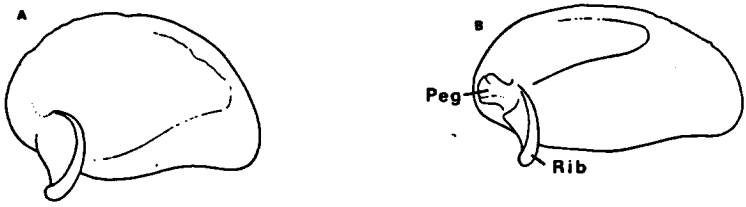


Fig. 1. Opercula of (A) *Theodoxus* (*T.*) *fluviatilis* (L.) and (B) *T.* (*Neritaea*) *jordani* (Sow.) (after Brown, 1980: 28).

tella Martens, 1874; and as valid without peg from the Near East (1879: 222, 225, 238): *doriae* Issel, 1865; *heldreichi* Martens, 1879; *syriaca* Bourguignat, 1853. This systematic classification has hardly been changed. Only recently Schütt (1984: 283) revised the Greek *Theodoxus* species with somewhat different results. The populations in the western parts of Turkey known to her were revised by G. Roth (1987: 73), who tried to illustrate graphically the distribution of both subgenera. In this, as in her earlier work (1984: 217), she came to the conclusion that in SE. Anatolia only one species is really common, namely *Theodoxus (Neritaea) jordani* (Sowerby, 1832); nevertheless she appears to know from the literature, that in this area there is also a species of *Theodoxus* s.s.

SPECIES OF THEODOXUS S.S.

Firstly we discuss the species without peg, which can be expected to occur in SE. Anatolia, and we start from the situation known in the literature in order of priority:

1. *Theodoxus (Theodoxus) syriacus* (Bourguignat, 1852)

1852 *Neritina syriaca* Bourguignat, Test. Nov.: 26 (Syria, circa Berytum).
1853 *Neritina syriaca*, — Bourguignat, Catal. rais. Saulcy: 71.
1874 *Neritina syriaca*, — Martens, Nov. conch.: 33, pl. 5 fig. 41 (Bei Marasch = Merasch im Flussgebiet des Dschihan = Djihan, am Südhang des Taurus, im Grenzgebiet zwischen Kleinasien und Syrien) [no comment on the operculum].
1879 *Neritina syriaca*, — Martens in Martini-Chemnitz, Syst. Conch.-Cab. (2) 10: 238, pl. 23 figs. 9, 10 (bei Beirut; bei Marasch oder Merasch im Flussgebiet des Dschihan am Südabhang des Taurus) [no peg].
1886 *Neritina (Theodoxus) syriaca*, — Westerlund, Fauna Pal. Reg. 6: 152 (Syrien).
1899 *Neritina syriaca*, — Kobelt, Iconogr. (2) 8: 12, pl. 214 fig. 1348 (Beirut, Merasch) [no peg].
1939 *Neritina (Theodoxia) fluviatilis* var. *orientalis* Pallary, Mém. Inst. Egypte 39: 105, pl. 4 figs. 67-69 (sources du Bâhlik = Ain ʿArouss) [no comment on a peg, but the classification with *Theodoxia* shows, that none exists].
1983 *Theodoxus (Neritaea) jordani*, — Schütt; = *syriaca*, Arch. Moll. 113: 26 (Beirut).

Martens (1874: 33) had no original materials from Bourguignat, but he connected the name and the diagnosis to animals from Maraş = Kahramanmaraş. So it remains

uncertain whether we may continue using the name *syriacus*, until it has been demonstrated that the syntypes from Beirut do not belong to *T. jordani*. We noticed, that this small but somewhat long, dark species without peg on the operculum lives at many localities in SE. Anatolia, normally in springs and fast running brooks. We found them at the following places: Göksu, Silifke (see Şeşen, 1988: 12, map 3) together with *Theodoxus (Neritaea) anatolicus*; small spring below Kuyumcu near Çennet Çehennem 25 km E. Silifke; Dedekavak dinlenme yeri, Erdemli, 30 km SW. Mersin (see Şeşen, 1988: 9, map 3); Hacarmantaş su gözü, Bucak, Kozan (see Şeşen, 1988: 13, map 2); spring in village Elmabahçe, Savur, Mardin, 25 km N. Mardin; Karapar spring at Ciğli village near Diyarbakir, belonging to Çarikli çay, a right tributary to Dicle river (Tigris); small spring in village Tüllük 25 km N. Diyarbakir; the following localities see Paydak (1976: 253-259): Kepoğlu çeşmesi, Silvan, Diyarbakir; Buhur köyü kaynak, Derik, Mardin; Radyo vericinisinin 1 km GD'da kaynak, Diyarbakir; Aynizeliha kaynaği, Diyarbakir; Tilara köyü kaynak, Diyarbakir; Fabrikanin 3 km GD'da kaynak, Diyarbakir; Örnek köyü kaynak, Diyarbakir; A. Bağveren köyü kaynak, Diyarbakir; Nasiri köyü kaynak, Diyarbakir; Hanik çeşme, Savur, Mardin; Devegeçidi suyu, Diyarbakir; Fabrika deresi, Diyarbakir; Kepoğlu deresi, Silvan, Diyarbakir; Kahvetepe deresi, Diyarbakir; Suruç suyu, Gribye köyü, Nusaybin, Mardin; Suruç suyu Gündüzsadik köyü, Nusaybin, Mardin; Suruç — Aligör arasi dere, Urfa; Ain Arousss (see Pallary, 1939).

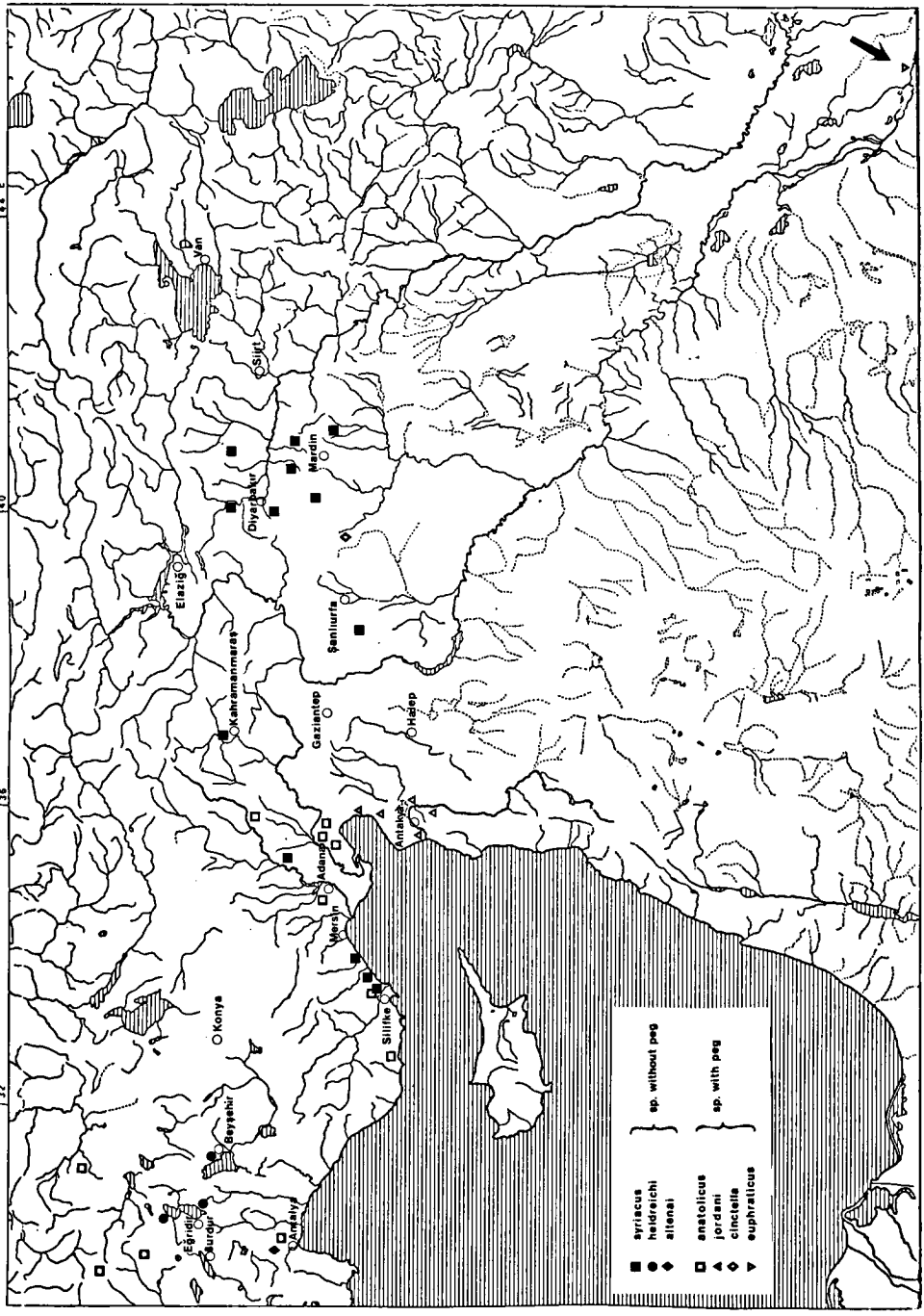
2. *Theodoxus (Theodoxus) doriae* Issel, 1866

1866 *Theodoxus Doriae* Issel, Mem. Accad. Sci. Torino (2) 23: 407, pl. 1 figs. 14-16 (Acque termali di Kerman, Persia meridionale) [without mention of peg].
1879 *Neritina Doriae*, — Martens in Martini-Chemnitz, Syst. Conch.-Cab. (2) 10: 222, pl. 21 figs. 22-23 (Kerman) [implies absence of peg].
1886 *Neritina (Theodoxus) doriae*, — Westerlund, Fauna Pal. Reg. 6: 151 (südliches Persien).
1899 *Neritina doriae*, — Kobelt, Iconogr. (2) 8: 7, pl. 212 fig. 1335 (Kerman) [without mention of peg.].
1934 *Theodoxus (Theodoxus) doriae*, — Schlesch, Arch. Moll. 66: 46 (Agda).
1937 *Theodoxus doriae*, — Biggs, J. Conch. London 20: 349 (Robat, 30 km W. Kerman, Aqda, Erjenun, Nain).

Probably this small species is not so widespread between Central Persia (Iran) and Anatolia; the intermediate area is so far unexplored. The localities of this species are indicated on the map in G. Roth (1987: fig. 4).

3. *Theodoxus (Theodoxus) heldreichi* (Martens, 1879)

1879 *Neritina Heldreichi* (Schwerzenb.) Martens in Martini-Chemnitz, Syst. Conch.-Cab. (2) 10: 225, pl 22 figs. 9-10 (Klein-Asien) [no peg].
1886 *Neritina (Theodoxus) heldreichi*, — Westerlund, Fauna Pal. Reg. 6: 151 (Klein-Asien).
1899 *Neritina heldreichi*, — Kobelt, Iconogr. (2) 8: 9, pl. 213 fig. 1337 (Klein-Asien) [no peg].
1965 *Theodoxus (Theodoxus) heldreichi*, — Schütt, Zool. Meded. Leiden 41: 46, 49, pl. 1 fig. 2 (Beyşehir gölü, Eğridir gölü).
1980 *Theodoxus (T.) heldreichi*, — Bilgin, Diyarbakir. Univ. Tip Fak. Derg., 8 (2) Suppl.: 38 (Beyşehir gölü).
1986 *Theodoxus heldreichi*, — Stojaspal, Mitt. dtsch. malakozool. Ges. 38: 17 (Beyşehir gölü bei Yezildağ und Eğridir gölü bei Eğridir).
1989 *Theodoxus (T.) heldreichi*, — Schütt, Arch. Moll. 119: in press (Çumra bei Konya, Quartär).


syriacus
heldreichi
sitenai
sp. without peg
anatolicus
jordani
cinctella
euphraticus
sp. with peg
Van
Siirt
Mardin
Diyarbakir
Elazig
Kahramanmaras
Şanliurfa
Gaziantep
Hatay
Adana
Mersin
Silifke
Konya
Eğridir
Burdur
Denizli
Afyon
32
36
40
44

This relatively large species with a pattern of stripes on the shell lives in Beyşehir gölü, in Eğridir gölü and Hoyran gölü and can also be found in Quaternary sediments in the Konya basin. It is not known from localities east of the Konya basin.

4. *Theodoxus (Theodoxus) altenai* Schütt, 1965

1965 *Theodoxus (Theodoxus) altenai* Schütt, Zool. Meded. Leiden 41: 46, pl. 1 fig. 4 (See bei Döşemealti, Vilayet Antalya) [without peg].
1980 *Theodoxus (T.) altenai*, — Bilgin, Diyarbakir Univ. Tip Fak. Derg. 8 (2) Suppl.: 38 (Döşemealti, Kirkgöz).
1987 *Theodoxus altenai*, — G. Roth, Tüb. Atl. Vord. Or., Beih. (A) 28: 75 (Kirkgöz gölü).

T. altenai is well characterized by its size, thin shell and checkered pattern, but so far it has been found only in the very limited spring area of Antalya.

SPECIES OF NERITAEA

Secondly we mention the species with peg which can be expected to occur in SE. Anatolia, and we also start from the situation known in the literature in order of priority:

5. *Theodoxus (Neritaea) anatolicus* (Récluz, 1841)

1841 *Nerita anatolica* Récluz, Rev. zool. Soc. Cuv. 1841: 342 (Smyrne).
1877 *Neritina anatolica*, — Martens in Martini-Chemnitz, Syst. Conch.-Cab. (2) 10: 86, pl. 3 figs. 4-5 (nec pl. 13 figs. 17-19, 25-29) (Kleinasien, Syrien und Palästina).
1899 *Neritina anatolica*, — Kobelt, Iconogr. (2) 8: 3, pl. 211 figs. 1321-1323 (Kleinasien, Palästina, Syrien) [with peg].
1980 *Theodoxus (Neritaea) anatolicus*, — Bilgin, Diyarbakir Tip Fak. Dergisi 8 (2) Suppl.: 37, 38 (different localities in West-Anatolia).

This species can be recognized easily by its conchological characters, viz., the well-rounded shape and the normally dark colour with a pattern of light spots. In spite of that, it was often confused in the past with similar forms of other species. Thus Martens (1874: 67) assumed an abnormally wide distribution (translated): "from the western coast of Anatolia with its neighbouring islands to Aleppo and environs and Kurdistan, the mountain countries in the area of middle Euphrates and the upper Tigris from Orfa to Mossul". On the other hand, G. Roth (1987: fig. 6) restricts the distribution too drastically, when she believes that it occurs only in the southern parts of the western coast of Anatolia. The southern limits of *T. anatolicus* coincide with the northern limits of *T. jordani*, i.e. north of Hatay. We believe to have a good criterion

Fig. 2. Distribution of the various species of *Theodoxus* in South-eastern Anatolia. The arrow in the right hand bottom corner points towards the extralimital distribution of *Theodoxus euphraticus* (Mouss.) in S. Iraq.

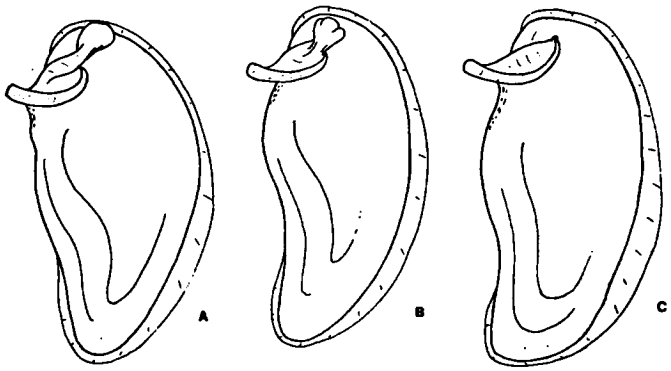


Fig. 3. Opercula of (A) *Theodoxus* (*Neritaea*) *anatolicus* (Récl.), (B) *T.* (*N.*) *jordani* (Sow.), and (C) *T.* (*T.*) *syriacus* (Bgt.).

for determination in the morphology of the inside of the operculum. In *T. anatolicus* rib and peg are connected by an elevated ridge, which does not exist in *T. jordani*, or at least not in such a marked manner that the lamella narrows. We show the difference in fig. 3. We have observed, that the boundary between the two species lies east of Ceyhan nehri, at Adana north of Nur dağlari. We have marked on the map (fig. 2) the localities where we have collected animals and examined the opercula. We do not know the northern limit of *T. anatolicus*. The shells we examined are from: Dağilcak ormaniçi dinlenme tesisindeki su kaynağı, Kozan; Ceyhan içme suyu kaynağı, Tatarli, Ceyhan; Kaynargöz gazinosu tesisleri, Tatarli, Ceyhan; Çatal kaynagı, Havranye köyü, Ceyhan; Misis sulama kanalı, Ceyhan; Göksu, Silifke; Soğuksu, Anamur; brook between Kara dağ and Çatma dağ, 13 km SW. Anatalya; Bucaği-Dinar-Civril arası, Isiklı (see Bilgin, 1980: 38); Eskişehir, Çifteler (see Bilgin, 1980: 38); Şuhut, Sandıklı.

6. *Theodoxus (Neritaea) euphraticus* (Mousson, 1874)

1874 *Neritina euphratica* Mousson, J. Conchyl. Paris 22: 49 (Samava, la Basse-Mésopotamie) [no comment about operculum, but compared with *N. jordani*. Samava = As-Samawah, is a little town at the lower Furat about 250 km NW. Basrah in Iraq].

1874 *Neritina euphratica*, — Martens in Martini-Chemnitz, Syst. Conch.-Cab. (2) 10: 83, pl. 15 figs. 10-11 [rib and peg mentioned: flat and strongly diverging].

1886 *Neritina (Neritaea) euphratica*, — Westerlund, Fauna Pal. Reg. 6: 146 (unterer Euphrat = lower Euphrat area).

1899 *Neritina euphratica*, — Kobelt, Iconogr. (2) 8: 2, pl. 211 fig 1318 (Samara[!]).

1939 *Neritina (Theodoxia) euphratica*, — Pallary, Mém. Inst. Égypte 39: 106 (different localities near Basra).

Until now this nice shell is only known from localities in S. Iraq and there is no reason to assume a connection with populations in Anatolia. Nevertheless a relationship with *T. mesopotamica* cannot be excluded.

7. *Theodoxus (Neritaea) cinctellus* (Martens, 1874)

1874 *Neritina cinctella* Martens, Novitates conchyl. 5: 34, pl. 5 fig. 43 (Ras-el ain in Mesopotamien, an den Quellen des Chabur-Flusses) [Apophyse gut ausgebildet; Wulst auf dem letzten Umgang = peg well developed; last whorl carinate].

1874 *Neritina meridionalis* var. *mesopotamica* Mousson, J. Conchyl. Paris 22: 35 (Diabekr; la Haute-Mésopotamie) (sur deux points différents, près de Diabekr) [without any information about the operculum].

1874 *Neritina anatolica* var. *mesopotamica*, Martens, Novitates conchyl. 5: 33 (Quellen des Chabur-Flusses bei Ras-el-ain im obern Mesopotamien) [Zapfen entwickelt = peg well developed].

1877 *Neritina cinctella*, Martens in Martini-Chemnitz, Syst. Conch.-Cab. (2) 10: 91, pl. 13 figs. 22-24 (Quelle des Chaburflusses bei Ras-el-Ain).

1877 *Neritina mesopotamica*, Martens in Martini-Chemnitz, Syst. Conch.-Cab. (2) 10: 90, pl. 13 figs. 20, 21 (only mentions of the two above cited localities).

1886 *Neritina (Neritaea) cinctella*, Westerlund, Fauna Pal. Reg. 6: 147 (Oberes Mesopotamien = upper Mesopotamia).

1886 *Neritina (Neritaea) mesopotamica*, Westerlund, Fauna Pal. Reg. 6: 147 (oberes Mesopotamien).

1899 *Neritina cinctella*, Kobelt, Iconogr. (2) 8: 4, pl. 211 fig. 1326 (Quelle Ras-el-ain des Chaboras) [with peg].

1899 *Neritina mesopotamica*, Kobelt, Iconogr. (2) 8: 4, pl. 211 fig. 1325 (Quelle Ras-el-ain des Chaboras [with peg].

1939 *Neritina (Neritaea) Gombaulti* Pallary, Mém. Inst. Égypte 39: 107, pl. 4 figs. 53-56 (Ras el ʿAin, sources du Khabour, frontière Nord de la Syrie) [no comment about a peg, but classification with *Neritaea* must be understood to imply presence].

We are convinced that there is a close relationship between all *Theodoxus* from Ras-el-Ain. We have collected them in the springs of the Habur river on the Turkish side of the frontier with Syria, where the Turkish village Ceylanpinar is on the one side and the Syrian village Ras-el-Ain on the other. We have found shells of *T. cinctellus* with all intermediates from the flat *mesopotamicus* type to the strongly keeled *cinctella* type. Unfortunately we could not find living animals of *T. cinctella*, so that it cannot be excluded, that *T. cinctella* is an extinct form from Quaternary sediments. But we cannot support the opinion, that *T. mesopotamicus* and *T. cinctella* are two different species; rather we see them as two forms of one and the same species. Such phenomena are also known for other species of *Theodoxus*, e.g., *T. danubialis* forma *carinata* Schmidt, 1847 (Schütt, 1988: 25) and *T. jordani* var. *turris* Mousson, 1861 (Kobelt, 1899: 3, pl. 211 fig. 1320). We cannot decide whether *T. cinctellus* is related to *T. euphraticus* or to *T. jordani*. For that purpose we need more material from intermediate localities, which is not available at this time.

If the population of Ceylanpinar represents a separate species, the name *mesopotamicus* cannot be used for it, because *Neritima anatolica* var. *mesopotamica* Martens, 1874, is a younger primary homonym of *N. meridionalis* var. *mesopotamica* Mousson, 1874.

Finally we translate the opinion expressed by Kobelt (1904: 121) concerning the zoogeographical situation in this region: "We have to distinguish two groups, which belong to different subgenera. The one, *Neritaea*, Martens, has to be considered an immigrant from the tropics, probably from inner Africa; the immigration must have been very early, for we find their representatives not only in the Nile area, but also in Jordan, Euphrates and in South Anatolia as far as the rivers in West Anatolia; they do not cross the Bosporus. The other group, *Theodoxus* Montfort, inhabits Europe

since the Lias ... and is distributed over the whole continent, except the high North and the high mountains''.

REFERENCES

BIGGS, H. E., 1937. Mollusca of the Iranian Plateau. — J. Conch. London 20: 342-350.

BILGIN, F., 1980. Batı Anadolu'nun bazi önemli tatlı sularından toplanan Mollusca türlerinin sistematiği ve dağılışı. — Systematics and distributions of Mollusca species collected from some fresh waters of West Anatolia. — Diyarbakır Tıp Fakültesi Dergisi 8 (2) Suppl.: 1-64.

BOURGUIGNAT, J.-R., 1852. Testacea novissima quae Cl. de Saulcy in itinere per Orientem annis 1850 et 1851 collegit: 1-31. Paris.

BROWN, D. S., 1980. Freshwater snails of Africa and their medical importance: 1-487. London.

DAGAN, D., 1971. Taxonomic discrimination between certain species of the genus Theodoxus (Gastropoda, Neritidae). — Isr. J. Zool. 20: 223-229.

GERMAIN, L., 1936. Mollusques terrestres et fluviatiles d'Asie-Mineure: 1-492. Paris.

KOBELT, W., 1899. Iconographie der Land- & Süsswasser-Mollusken mit vorzüglicher Berücksichtigung der europäischen noch nicht abgebildeten Arten (NF) 8: 1-111. Wiesbaden.

——, 1904. Iconographie der Land- & Süsswassermollusken mit vorzüglicher Berücksichtigung der europäischen noch nicht abgebildeten Arten (NF) 11: 1-342.

MARTENS, E. VON, 1874. Ueber Vorderasiatische Conchylien. Nach den Sammlungen des Prof. Hausknecht. — Novitates conchologicae. Abbildung und Beschreibung neuer Conchylien, Suppl. 5: 1-125.

——, 1875-1879. Die Gattung Neritina. In: Martini & Chemnitz, Systematisches Conchylien-Cabinet II, 10: 1-64, 1875; 65-144, 1877; 145-208, 1878; 209-303, 1879. Nuremberg.

MOUSSON, A., 1874. Coquilles terrestres et fluviatiles recueillis par M. le Dr. Alex. Schläfli en Orient. — J. Conchyl. Paris 22: 5-60.

NEUMANN, D., 1959. Morphologische und experimentelle Untersuchungen über die Variabilität der Farbmuster auf der Schale von Theodoxus fluviatilis L. — Z. Morph. Ökol. Tiere 48: 349-411.

PALLARY, P., 1939. Deuxième addition à la faune malacologique de la Syrie. — Mém. Inst. Egypte 39: 1-141.

PAPP, A., 1953. Die Molluskenfauna des Pannon im Wiener Becken. — Mitt. Geol. Ges. Wien 44: 85-222.

PAYDAK, F., 1975. Diyarbakır, Urfa, Mardin illeri tetlısu gastropoda'larının sıstematik incelenmesi. — Diyarbakır Tip Fakültesi Dergisi 5: 243-263.

RÉCLUZ, C. A., 1841-1842. Description de quelques espèces de Nérites vivantes. — Rev. zool. Soc. Cuv. 1842: 73-79, 174-184.

ROTH, G., 1984. Intraspezifische Variabilität von Gehäuse, Operculum und Radula bei Theodoxus (Neritaea) jordani in den Levanteländern (Gastropoda: Neritidae). — Mitt. dtsch. malakozool. Ges. 37: 217-222.

——, 1987. Data on the distribution and faunal history of the genus Theodoxus in the Middle East (Gastropoda: Neritidae). — Tübinger Atlas des Vorderen Orients, Beihefte, A, 28: 73-79.

ROTH, J. R., 1856. Spicilegium molluscorum orientalium annis 1852 et 1853 collectorum. — Malakozool. Bl. 2: 17-58, Taf. 1-2.

SCHÜTT, H., 1965. Zur Systematik und Ökologie türkischer Süsswasserprosobranchier. — Zool. Mededel. Leiden, 41: 43-72.

——, 1986. The dissemination of Theodoxus species in Greece including the islands (Moll. Prosobranch.). — Biologia Gallo-hellenica 12: 283-290.

——, 1988. Über die gekielte Variante von Theodoxus danubialis (C. Pfeiffer). — Mitt. dtsch. malakozool. Ges. 42: 25-27.

——, 1989. Fossile Mollusken dreier anatolischer Ovas. — Arch. Moll. 119: in press.

ŞEŞEN, R., 1988. Mersin ve Iskenderun körfezi sahil şeridindeki tatlısularda yaşayan Mollusca türlerinin tespiti. — Dicle Üniv., Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi: 1-54.