

A REDESCRIPTION OF *THEODOXUS SCHULTZII* (GRIMM, 1877), AN ENDEMIC NERITID GASTROPOD OF THE CASPIAN SEA

MICHAEL L. ZETTLER

Baltic Sea Research Institute, Seestr. 15, D-18119 Rostock, Germany

Abstract *Theodoxus schultzii* (Grimm, 1877), one of the rarest gastropod species of the Caspian Sea, is redescribed from recently sampled material. Morphological features are described, with photographs of the shell, operculum and radula. The shell of this species is characterised by its mostly citreous colour and elongation of the apertural edges. In its typical form, it is very similar to other species of the genus. The features of the radula and operculum are very similar to those of *T. pallasi* Lindholm, 1924 from the Caspian Sea and *T. astrachanicus* Starobogatov, 1994 from the Volga delta.

Key words *Theodoxus schultzii*, Caspian Sea, redescription, morphology, operculum, radula, brackish water

INTRODUCTION

The Caspian Sea (Fig. 1) is one of the largest inland water bodies in the world and hosts a fauna that includes many endemic taxa (e.g. Falomeeva 2001). During studies on the identity and distribution of *Theodoxus* species from across the whole geographical range of the genus, the author obtained material of *Theodoxus astrachanicus* Starobogatov, 1994, *T. pallasi* Lindholm, 1924 [syn. *T. lituratus* (Eichwald, 1838)] and *T. schultzii* (Grimm, 1877) from the Caspian region. The first species is strictly limited to the Volga delta, the second is widely distributed in the Caspian Sea¹, whereas *T. schultzii* is restricted to the deeper waters in the middle and south of the Caspian Sea (Kolesnikov, 1947; Logvinenko & Starobogatov, 1968; Starobogatov *et al.*, 1994; Karpinsky, 2002). *Theodoxus schultzii* is endemic to the Caspian Sea (Falomeeva, 2001; Karpinsky, 2002) and found mainly on hard substrates such as shell aggregations or sand mixed with silt and shells in water depths between 20 and 100 m (Karabeili & Logvinenko, 1978). Probably due to its habitat (it lives in deeper waters and not at the shore line)

¹ *T. pallasi* shows a wider distribution in the Ponto-Caspian area (i.e. the Aral Sea and its tributaries) (Logvinenko & Starobogatov, 1968). It has to be proved if this species occurs (alive or fossil) in the Black Sea area (e.g. Asov Sea) as well. In the literature it is found occasionally (e.g. Shadin, 1950, Logvinenko & Starobogatov, 1968, Starobogatov, 1970, Baba, 2002) but my analysis of several populations surrounding the Black Sea revealed only other species.

Contact author : michael.zettler@io-warnemuende.de

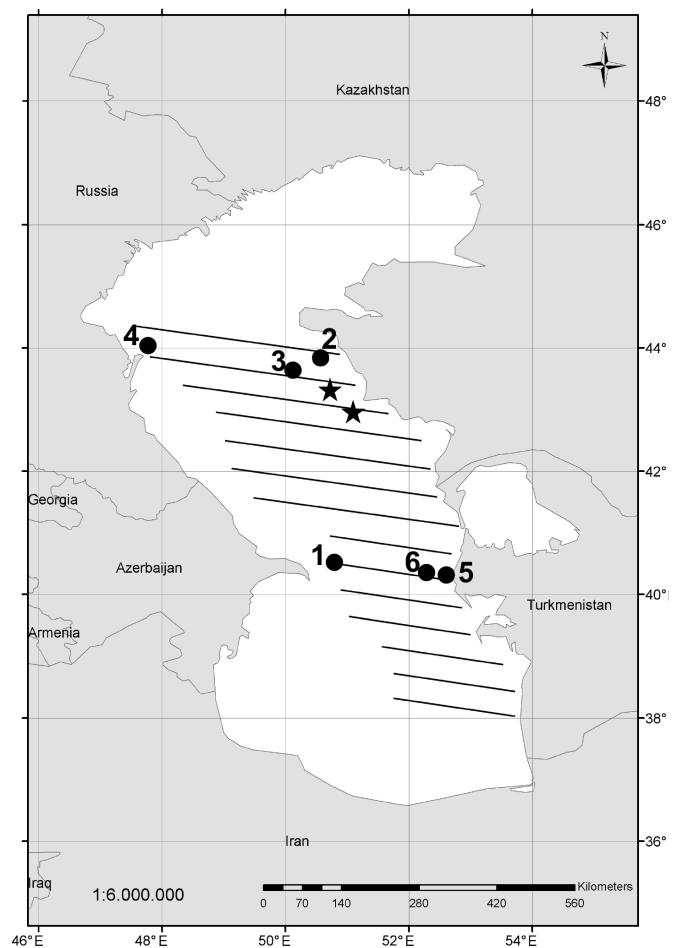


Fig. 1 The distribution of *Theodoxus schultzii* within the Caspian Sea after Karabeili & Logvinenko (1978) and Karpinsky (2002). The revised localities are indicated by dots with numbers and refer to the text. The stars mark the two stations of the original description of Grimm (1877).

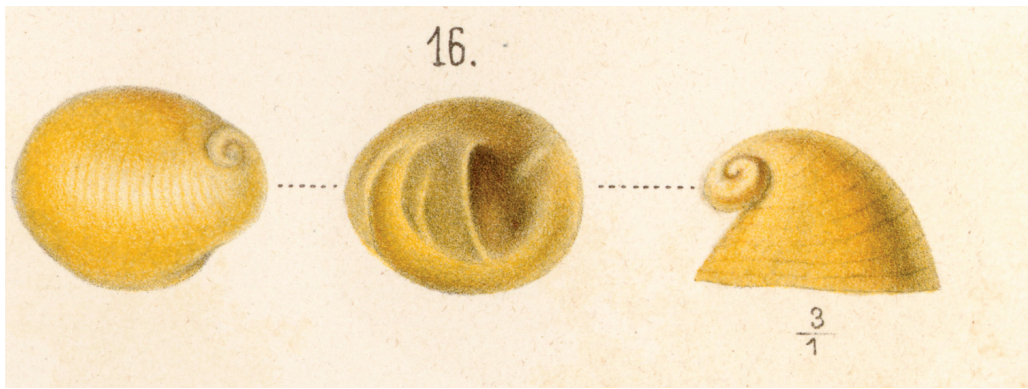


Fig. 2 Illustrations from the first description of *Theodoxus schultzii* by Grimm (1877)

it has rarely been found during recent decades. Due to this rarity, taxonomic data are restricted to a few early studies. The original description of this species by Grimm (1877), based on 38 live specimens and some shell material, was written in Russian and contained information on shell size and radula structure. The redescription of Dybowski (1888) and three other older studies (Martens, 1879; Westerlund, 1886; Thiele, 1931) were made by examining one specimen sampled by Grimm and stored in the Museum of Natural History in Berlin or by citation of Grimm's (1877) work. None of these previous studies described the form of the operculum or anatomical features. Only the little known study of Andrussov (1912) on the neritid gastropods of Neogene deposits of the Ponto-Caspian area deals with morphological features of the operculum. Additionally, the figures of the shell and radula in these early studies do not show details clearly (Fig. 2). The present paper redescribes *T. schultzii* using modern methods.

MATERIAL AND METHODS

Through the kindness of Mikhail Karpinsky (Moscow), who has extensively studied the benthos of the Caspian Sea (Karpinsky, 2002), I received recently sampled material of *Theodoxus schultzii* (Table 1). Anatoly Tarasov (Astrakhan) provided me with material from the Russian part of the Caspian Sea and with specimens of *T. astrachanicus* for comparison. Additionally, Zoltán Fehér from the Hungarian Natural History Museum (HNHM) provided one sample of *T. schultzii*.

Recently sampled specimens by Karpinsky and Tarasov were collected by grabbing (van Veen

grab). For the material of the HNHM no information was available. Table 1 gives the collection localities of the samples used in this study. Shell length and shell height were measured using a stereo microscope (Stemi SV 11, CARL ZEISS, Germany). The relationship between shell length and shell height were independently regressed. For comparison with other *Theodoxus* species we examined the radula and operculum from several specimens found at each site. The pictures of the shells were made by a digital camera (NIKON Coolpix 995) and those of the radula and operculum using a scanning electron microscope (Cam Scan 44WEX).

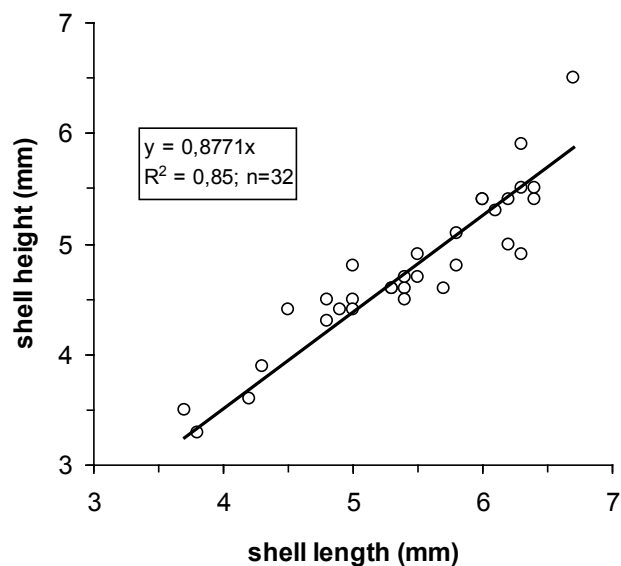


Fig. 3 The correlation between shell length and shell height of *Theodoxus schultzii* from different locations in the Caspian Sea.

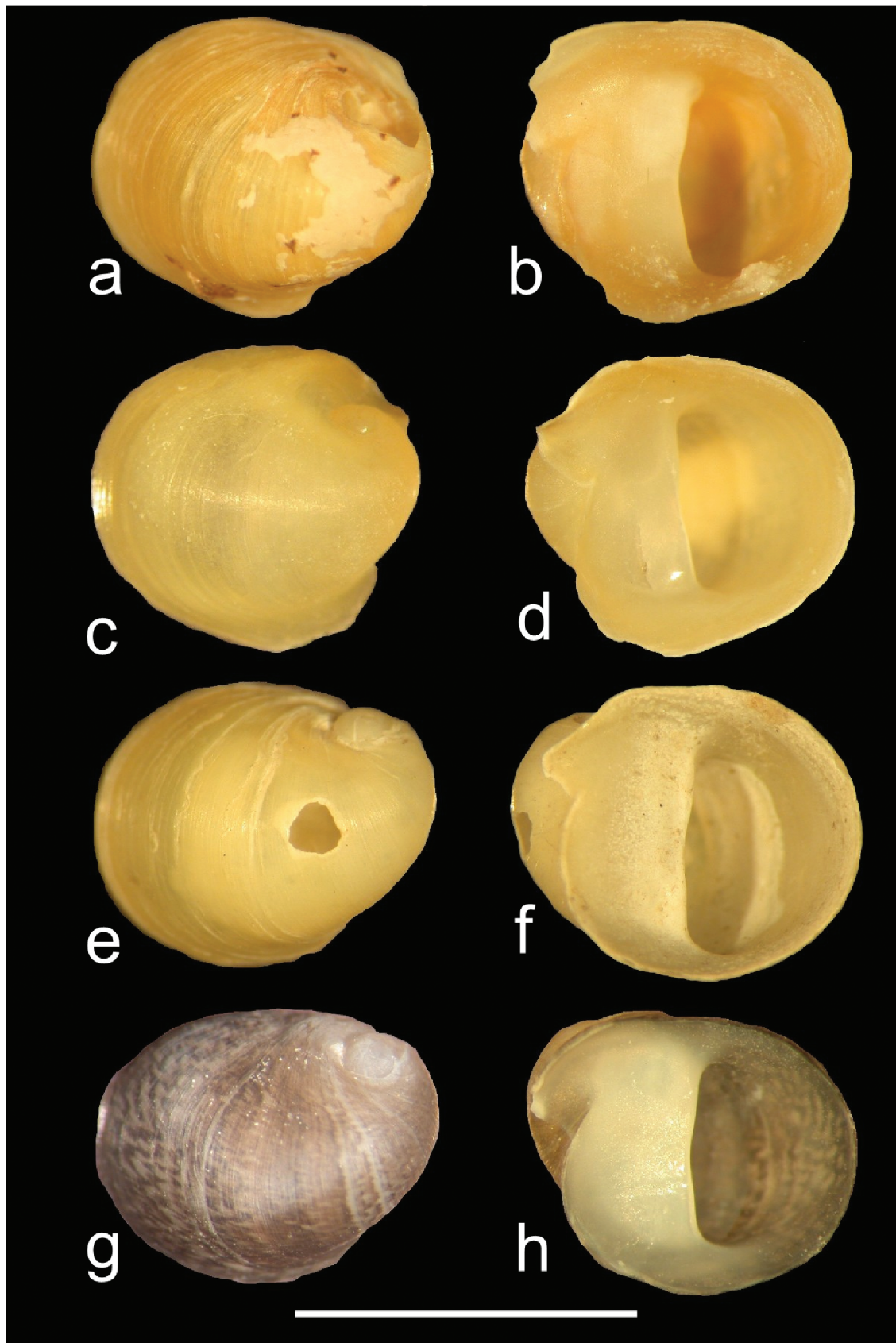


Fig. 4 *Theodoxus schultzii* from the Caspian Sea: **a-b** locality 1, Azerbaijan; **c-d** locality 2, Kazakhstan; **e-f** locality 4, Russia; **g-h** locality 6, Turkmenistan (see figure 1 and table 1 for locations). The scale bar indicates 5 mm.

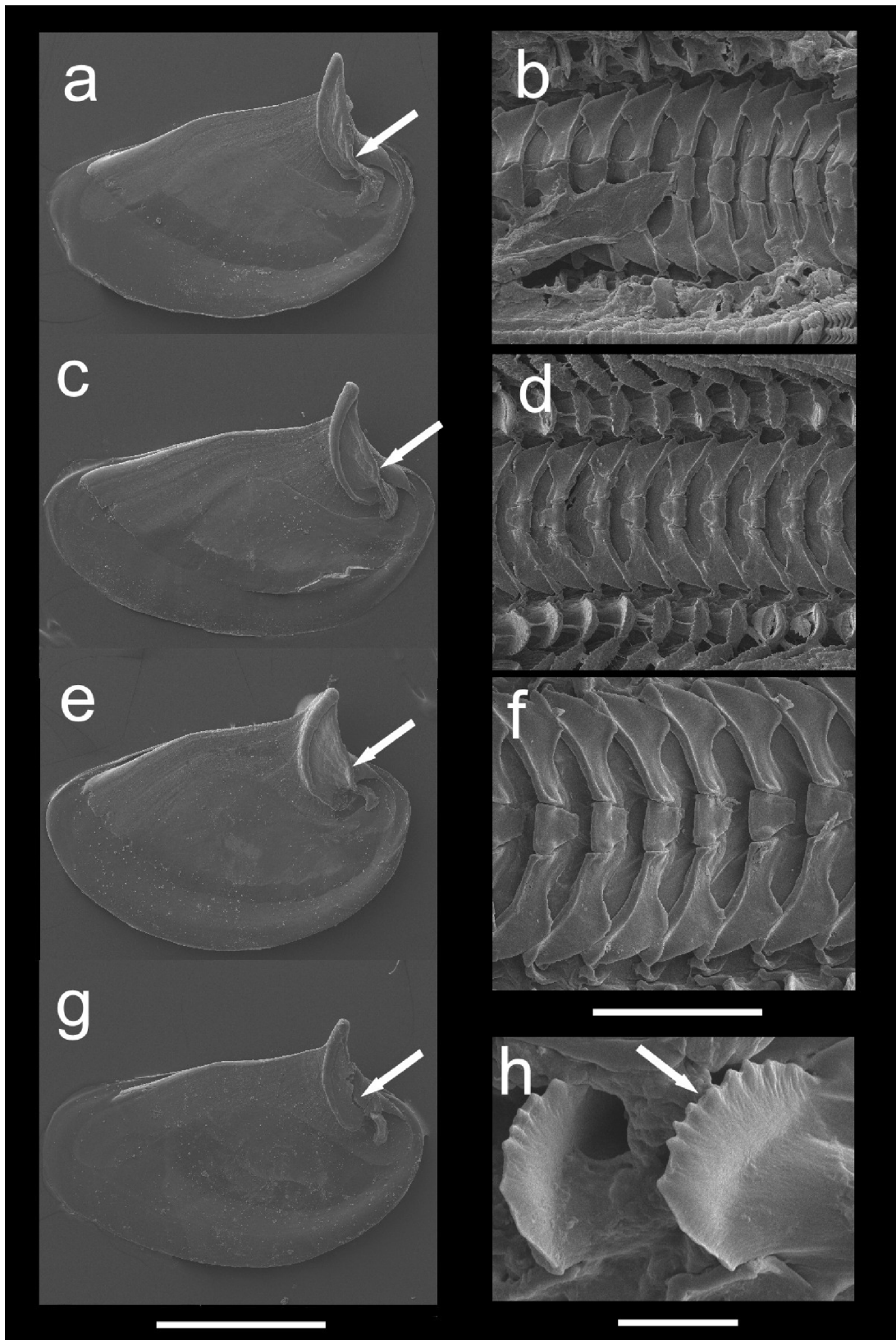


Fig. 5 Operculum and radula of *Theodoxus schultzei* from the Caspian Sea: **a-b** locality 1, Azerbaijan; **c-d** locality 2, Kazakhstan; **e-f, h** locality 3, Kazakhstan; **g** locality 6, Turkmenistan (see figure 1 and table 1 for locations). The scale bars indicate 1 mm (left), 100 μm (upper right) and 20 μm (lower right). The arrows on the left hand side mark the characteristic fold at the apophyse of the operculum. On the right hand side the arrow marks the typical rough tines of the fourth lateral teeth of the radula.

Table 1 Examined material of *T. schultzii* from the Caspian Sea. The numbers refer to the text and figures. [coll.=collection of Hungarian Natural History Museum (HNHM) or of the author]

no	country	year	decimal	decimal	Depth (m)	Salinity (psu)	legit	coll.
			North	East				
1	Azerbaijan	1986	40.550	50.917	48	11-12.5	Karpinsky	author
2	Kazakhstan	1986	43.933	50.583	45	11-12.5	Karpinsky	author
3	Kazakhstan	1987	43.787	50.135	72	11-12.5	Karpinsky	author
4	Russia	1994	44.013	47.751	?	?	Tarasov	author
5	Turkmenistan	1969	40.180	52.750	?	?	?	HNHM
6	Turkmenistan	1986	40.267	52.167	50	11-12.5	Karpinsky	author

REDESCRIPTION

NERITIDAE Lamarck, 1809
Theodoxus Montfort, 1810

Type species *Theodoxus lutetianus* Montfort, 1810 (= *Nerita fluviatilis* Linnaeus, 1758; ICZN Op. 335, 1955)

Theodoxus (Theodoxus) schultzii (Grimm, 1877)

Original description *Neritina Schultzii* Grimm, 1877: Kaspiskoje morje i ego fauna. Trudy Aralo-Kaspiskoj Ekspedizii. II (2). M. Stasjulevitsch, St. Petersburg: 77-78, pl. 7 (Fig. 1)² and pl. 8 (Fig. 16).

Type locality Caspian Sea.

Type material Location not known but, considering the affiliation of O.A. Grimm, probably situated in the Museum of Natural History of St. Petersburg.

Description In the present paper, a total of 32 specimens of *T. schultzii* were measured in shell length and height (Fig. 3). The correlation between these two parameters was linear with $R^2=0.85$ and with a significance level less than $p = 0.001$. The maximum shell length was 6.7 mm with a maximum width of 6.5 mm. The shell shape is squarish to circular (Fig. 4). Regarding periostracum colouration, *T. schultzii* is a relatively stable species. In most cases the colour is

citreous (Fig. 4a-f). Only a few exceptions were found (Fig. 4g-h), with more whitish-purple ground colour with some dark zigzag lines or orange-yellow with some black dotted lines. In the latter version this species is similar to *T. pallasii*. The most characteristic feature of the shell is the conspicuous elongation of the upper and lower mouth edge (Fig. 4). Both rise themselves from the whorl level and form one or two ribs on the broadened columellar area so that it appears like a scalarid shell. *T. schultzii* is the only species within this genus with such a shell shape. Like all other *Theodoxus* species, the operculum is equipped with a ridge (or rib) on the inner side (=apophysis), supporting the attachment of the columellar muscle. Microscopic inspection of the opercula revealed one characteristic feature, a fold at the apophysis of the operculum (Fig. 5). There is no knob (or peg) on the opercular hinge like within the subgenus *Neritaea* Roth, 1855.

Regarding the radular pattern, a high degree of similarity to *T. fluviatilis* is obvious (Fig. 5). The only prominent difference is the typical rough tines of the fourth lateral teeth (Fig. 5h).

Distribution Endemic to the Caspian Sea. Only a very few "recent" investigations deliver new and primary information on distribution or ecology of this species. The studies of Karabeili & Logvinenko (1978) and Karpinsky (2002) show the distribution of *T. schultzii* within the Caspian Sea by means of their own sampling. The correlation with water depth, specific sediment

² Note to Grimm's description: There is a mistake within the text on page 78. The reference should be to Tab. 7, fig. 1 (not 5).

substrates and the association with *Dreissena* beds were expressed therein.

Derivation of name Named in honour of G.F. Schultze, captain of the schooner "Persiania"

DISCUSSION

GENERIC PLACEMENT

T. schultzii was once considered to be representative of a third subgenus, *Ninnia* Brusina (in Westerlund 1902, p133), but Starobogatov (1970) came to the conclusion that it belongs within the subgenus *Theodoxus* s. str. In contrast to some older views, *T. schultzii* belongs to the subgenus *Theodoxus* s. str. and not to its own subgenus (see above).

COMPARISONS

The shell measurements of Grimm (1877) were very similar to my results. However, the specimens of Andrussow (1912) were much larger³. With 10 and 8 mm in length, respectively, the two forms he described showed larger dimensions. Individuals with citreous colour are identified as var. *flava* whereas the variety with some dark zigzag dots are described as var. *punctulata*. Some radular features are very similar to *T. fluviatilis* (Zettler *et al.*, 2004). Due to the exceptional form of the shell, the differentiation of *T. schultzii* is very straightforward. Otherwise, *T. schultzii* shares both the fold at the apophysis and the rough tines of the fourth lateral teeth with *T. pallasii* from the Caspian Sea and *T. astrachanicus* from the Volga delta. Within this "group", these features are very similar whereas to all other species of this genus, mostly minor differences are apparent. It remains to be proved if these three species differ anatomically or genetically. Though these results may be seen as tentative, they should provide substance for further investigation of this species complex.

ACKNOWLEDGEMENTS

The help of various scientists in providing material is cordially acknowledged. They were: Dr. M. Karpinsky (Moscow), Dr. A. Tarasov (Astrakhan) and Dr. Z. Fehér (Budapest). The

author express his thanks to Dr. Paul Bunje (Berkeley) for check the English language.

REFERENCES

- ANDRUSSOW N 1912 Ueber einige Neritiden aus neogenen Ablagerungen des pontocaspischen Gebietes. *Zapiski Imperatorskago St.-Petersburgskago Mineralogiceskago Obscestva* **49**: 1-17+pl.I-II
- BABA K 2002 An area-analytical zoogeographical classification of the gastropod family Neritidae. *Nachrichtenblatt der Ersten Vorarlberger Malakologischen Gesellschaft* **10**: 8-14.
- DYBOWSKI W 1888 Die Gastropoden-Fauna des Kaspischen Meeres. Nach der Sammlung des Akademikers Dr. K.E. v. Baer. *Malakozoologische Blätter N.F.* **10**: 1-79.
- FALOMEVA A 2001 Benthos species. In: B Chaikin (ed) *Caspian Environment Programme. Caspian Flora and Fauna Species Checklist*. http://enrin.grida.no/caspian/additional_info/species_checklist.pdf.
- GRIMM OA 1877 Kaspiskoje morje i ego fauna. *Trudy Aralo-Kaspiskoj Ekspedizii*. II(2). M. Stasjulevitsch, St. Petersburg, pp. 1-105.
- KARABELI OZ & LOGVINENKO BM 1978 Raspredelenija brjuchonogich molljuskov roda *Theodoxus* cemejstva Neritidae v srednem I juschnom Kaspii. *Naucnye Doklady Vyssej Skoly, Biologiceskije Nauk*, pp. 42-46.
- KARPINSKY MG 2002 Ekologija bentosa srednego I juschnogo Kaspija. VNIRO Publishing, Moscow, 283pp.
- KOLESNIKOV VP 1947 Tabliza dlja opredelenija kaspijskich gastropod. *Bjulleten Moskovskogo Obscestva Ispytatelej Prirody, Otr. Geologii* **22**: 105-112.
- LOGVINENKO BM & STAROBOGATOV YI 1968 Typ molljuski – Mollusca. In: Birstein YA, Vinogradov LG, Kondakov NN, Kun MS, Astrahova TV & Romanova NN (eds) *Atlas bespozvochnych Kaspijskogo Morja*. Izdatelstvo „Pischevaja Promyschlenost“, Moskva, pp. 308-385.
- MARTENS E VON 1879 Die Gattung *Neritina*. In: Kobelt, W. & Weinkauff, H.C. (eds) *Systematisches Conchylien-Cabinet von Martini und Chemnitz*. Bauer & Raspe, Nürnberg, 303pp.
- SHADIN VI 1952 Molljuski presnych i solonovatykh vod SSSR. Opredeliteli po faune SSSR. Akademia Nauk SSSR, Moskva, 376pp.
- STAROBOGATOV YI 1970 Fauna molluskov i zoogeograficeskoje pajonirovanie kontinentalnych vodoemov semnogo schara. Akademija Nauk SSSR Zoolgiceskij Institut, Leningrad, 372pp.
- STAROBOGATOV YI, FILCHAKOV VA, ANTONOVA LA, PIROGOV VV 1994 New data on molluscs and malacostracans of the Volga delta. *Vestnik Zoologii* **28**: 8-12.
- THIELE J 1931 Handbuch der systematischen Weichtierkunde. Gustav Fischer, Stuttgart: 1022pp.
- WESTERLUND CA 1886 VI. Fam. Ampullaridae, Paludinidae, Hydrobiidae, Melanidae, Valvatidae & Neritidae.

³ Andrussow (1912) studied both fossil and recent material. The origins of these large specimens were not clearly specified.

Fauna der in der Paläarktischen Region lebenden Binnenconchylien. Hakan Ohlsson, Lund, 156pp.
WESTERLUND CA 1902 Methodus dispositionis Conchyliorum extramarinorum in Regione palae-arctica viventium, familias, genera, subgenera et stirpes sistens. *Actis Academiae scientiarum et artium*

Slavorum meridionalium **151**: 81-139
ZETTLER ML, FRANKOWSKI J, BOCHERT R & RÖHNER M 2004 Morphological and ecological features of *Theodoxus fluviatilis* (Linnaeus, 1758) from Baltic brackish water and German freshwater populations. *Journal of Conchology* **38**(3): 303-316.

