

Testacellidae, a Newly-recorded Family of Semislugs (Gastropoda) for the Bulgarian Fauna

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Abstract: The carnivorous semislug *Testacella (Testacella) haliotideae* Draparnaud, 1801, is recorded for the first time in Bulgaria from the northern Bulgarian Black Sea coast, close to the city of Varna. This species belongs to a genus and family newly reported for the Bulgarian fauna; in addition, this site is a new locality, as well as the easternmost record of this gastropod family and of *T. haliotideae* in Europe. An adult specimen of *T. haliotideae* was investigated anatomically and details of its reproductive system are given.

Key words: semislugs, *Testacella haliotideae*, Testacellidae, Gastropoda, reproductive system, new record, Bulgaria

Introduction

In the course of collecting trips along the Bulgarian Black Sea coast, five specimens of a semislug so far not known as a member of the Bulgarian malacofauna were found. The specimens were identified as *T. haliotideae* Draparnaud, 1801, a carnivorous member of the family Testacellidae Gray, 1840, which includes only one genus, *Testacella* Cuvier, 1800, comprising 7 species (BANK 2011, NARDI, BODON 2011). Four of them (*T. bisulcata* Risso, 1826; *T. bracciai* Nardi & Bodon, 2011; *T. gestroi* Issel, 1873; and *T. riedeli* Giusti, Manganelli & Schembri, 1995) occur more or less locally in France and Italy while the others (*T. haliotideae* Draparnaud, 1801; *T. maugei* Férussac, 1819; and *T. scutulium* Sowerby, 1820) are more widely distributed throughout Europe and the coastal areas of North Africa (ANDERSON 2005, WELTER-SCHULTES 2012). All the Testacellidae species have a subterranean way of life, can burrow to depths of more than one meter and feed on earthworms, snails and other slugs. The members of this genus have a short season of surface activity; thus they are among the most difficult gastropod species to be found (KERNEY, CAMERON 1994, BARKER 1999).

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Material and Methods

Material examined: Five specimens of *T. haliotideae* were collected during the day in rainy and rather cool conditions in Sts. Constantine and Helena Resort on the northern Bulgarian Black Sea coast (Varna District) at the following three localities:

1) Above the Grand (central) beach, near the periphery of a seaside park (Fig. 1a, d). Vegetation: *Ulmus minor* Mill., *Robinia pseudoacacia* L., *Taraxacum officinale* L., *Ornithogalum sibthorpii* Greuter, *Dichanthium ischaemum* (L.) Roberty; P. Mitov leg., 24.III.2013, 43° 13' 54.9" N, 28° 00' 52.4" E, 9 m altitude, air temperature approx. 3°C, 1 adult specimen; 06.XII.2013, 43°13'54.0"N, 28° 00' 52.2"E, 9 m altitude, 10 meters from the previous locality, air temperature approx. 7-8°C, temperature on the soil 7°C, soil temperature 5.9°C, 1 juvenile specimen;

The adult specimen (Fig. 2a) was found at noon (12.09) on the soil surface under a stone (Fig. 1d). The juvenile specimen (Fig. 2b) was found at 16.44, at sunset, under a piece of concrete, on the soil surface also covered with rotten leaves.

2) Close to a mineral (thermal) water pool, on a small hill (Fig. 1b). Vegetation: *Ulmus minor* Mill., *Acer pseudoplatanus* L., *Carpinus betulus* L., *Robinia pseudoacacia* L., *Quercus robur* L., *Hedera helix* L., *Corydalis solida* (L.) Schwartz, *Scandix pecten-veneris* L.; P. Mitov leg., 10.III.2014, 43° 13' 47.3" N, 28° 00' 45.5" E, 14 m altitude, air temperature 4.0°C, temperature on the soil 3.0-4.3°C, soil temperature 5.6°C, 2 juvenile specimens (one of them under a stone on the ground with rotten leaves, the other on the bottom side of the stone). The specimens were found at 13.28, after rain, on a windy and cloudy day.

3) Close to Coral Hotel (Fig. 1c). Vegetation: *Ulmus minor* Mill., *Corydalis solida* (L.) Schwartz, *Lamium purpureum* L., *Galium aparine* L.; P. Mitov leg., 10.III.2014, 43° 13' 45.4" N, 28° 00' 19.2" E, 27 m altitude, air temperature 3.5°C, temperature on the soil 4.3°C, soil temperature 6.1°C, 1 juvenile specimen under a stone on the ground with rotten leaves. The specimen was found at 11.56, after rain, in windy and cloudy weather.

The specimens were fixed and preserved in 70% ethanol and deposited in the collection of the National Museum of Natural History in Sofia, Bulgaria. Photographs of the live animals were taken with a digital camera Nikon D1 by Mr. Mikhail Mikhailov (Sofia). The vestigial shell and reproductive organs were photographed under an Olympus BX41 SZ61 stereo microscope with an Olympus Color View 1 digital camera. Digital images captured at different focal planes were assembled using the application Combine ZM. Species identification was made according to the complex features provided in QUICK (1960), CAMERON *et al.* (1983), KERNEY, CAMERON (1994), and BARKER (1979, 1999). The reproductive system was compared with those given by COLLINGE (1893), QUICK (1960), BARKER (1979, 1999), GIUSTI *et al.* (1995), and DE MATTIA (2006).

Results

Testacellidae Gray, 1840

Testacella (Testacella) haliotidea Draparnaud, 1801

External morphology

The specimens (Fig. 2) are yellowish-brown when alive, with colourless mucus and a small external shell located at the posterior end of the body; the shell periostracum is brown in colour in the adult (Figs. 2, 3), but yellowish in the juveniles. The shell in the adult specimen has dimensions of 7.0 x 4.50 mm, and a height of 1.8 mm. The shells in the juveniles range 2.9-5.8 mm (average 3.97 mm, n=4) in length,

1.95 - 3.75 mm (average 2.54 mm, n=4) in width, and 0.6-1.75 mm (average 1.11 mm, n=4) in height. The lateral body-grooves in the adult specimen are separated by 1.68 mm at their point of origin (Fig. 3a), while in the juveniles this value is between 0.85 and 1.25 mm (average 0.97, n=4). The total length of the living adult animal (extended) is 74 mm; the total length of the preserved adult specimen is 34.9 mm. The total length of the living extended juveniles ranges from 19.04 to 46.07 mm (average 31.1, n=4). The total length of the contracted juveniles (not fixed) is 10.71-20.4 mm (average 13.75, n=4).

Reproductive system

Based on the results of the analysis of the reproductive apparatus (Figs. 4, 5), the specimen has been determined as *T. haliotidea*. The adult specimen is mature, showing developed genitalia: albumen gland, ovispermiduct and bursa copulatrix, penis (internally with numerous bilaterally flattened conical papillae) with a single long flagellum, one small penial diverticulum (caecum), and one retractor muscle originating from the apex of the penial flagellum (Fig. 4, 5). The presence of a long penial flagellum and a short penial caecum (Fig. 4b), which are absent in other *Testacella* spp., clearly discriminates *T. haliotidea* from the other taxa (BARKER 1999, DE MATTIA 2006).

After the comparison of the reproductive system with schemes given in COLLINGE (1893: Pl. I, figs. 1, 4), QUICK (1960: fig. 1), BARKER (1979: fig. 3E, 1999: fig. 89), GIUSTI *et al.* (1995: figs 294-296), and DE MATTIA (2006: fig. 1a), it was observed that the form of bursa copulatrix is oval (Fig. 4a) and closest to those illustrated by BARKER (1979: fig. 3E) and GIUSTI *et al.* (1995: fig. 294). It is intermediate in shape compared to the bursa copulatrix given for *T. haliotidea* by QUICK (1960: fig. 1b) and BARKER (1999: fig. 89). The duct of the bursa copulatrix is relatively short and stout, as given in BARKER (1979, 1999), GIUSTI *et al.* (1995), and DE MATTIA (2006), but it is very different from the figure given in COLLINGE (1893) where it is long and thin. The penis, penial diverticulum and penial flagellum (Fig. 4b) are very close in form to the same elements given by GIUSTI *et al.* (1995: figs 294, 295) and DE MATTIA (2006: fig. 1a).

Discussion

With the new record of the species *T. haliotidea*, the number of the terrestrial gastropod species known from Bulgaria reaches 280 and the number of families increases to 38 (DEDOV 1998, IRIKOV, ERÖSS



Fig. 1. Collecting sites near the northern Black Sea coast of Bulgaria: Sts. Constantine and Helena resort: the habitats and microhabitats (arrows = stones/stone bed), where the semislug *T. haliotide* was collected (photos P. Mitov): a) close to the Grand (central) beach, near the periphery of a seaside park (24.III.2013); b) close to the mineral (thermal) water pool (10.III.2014); c) close to Coral Hotel (10.III.2014); d) the stone bed (soil surface under stone) with the adult *T. haliotide* (arrowed) and (on the left) its potential prey, the earthworms (locality close to the Grand beach).



Fig. 2. Habitus of the semislug *T. haliotidea*, newly recorded for Bulgaria: a) adult (27.III.2013), b) juvenile (20.XII.2013). Scale bars = 10 mm. (photos M. Mikhailov)



Fig. 3. *Testacella haliotidea*, posterior end of the body. a) the externally located shell with the two branched, lateral grooves originating from the anterior edge of the shell (arrow = point of origin of the grooves); close-up view of the same shell: b) dorsal view; c) ventral view; d) lateral right aspect; e) lateral left aspect. All scale bars = 2 mm. (photos P. Mitov)

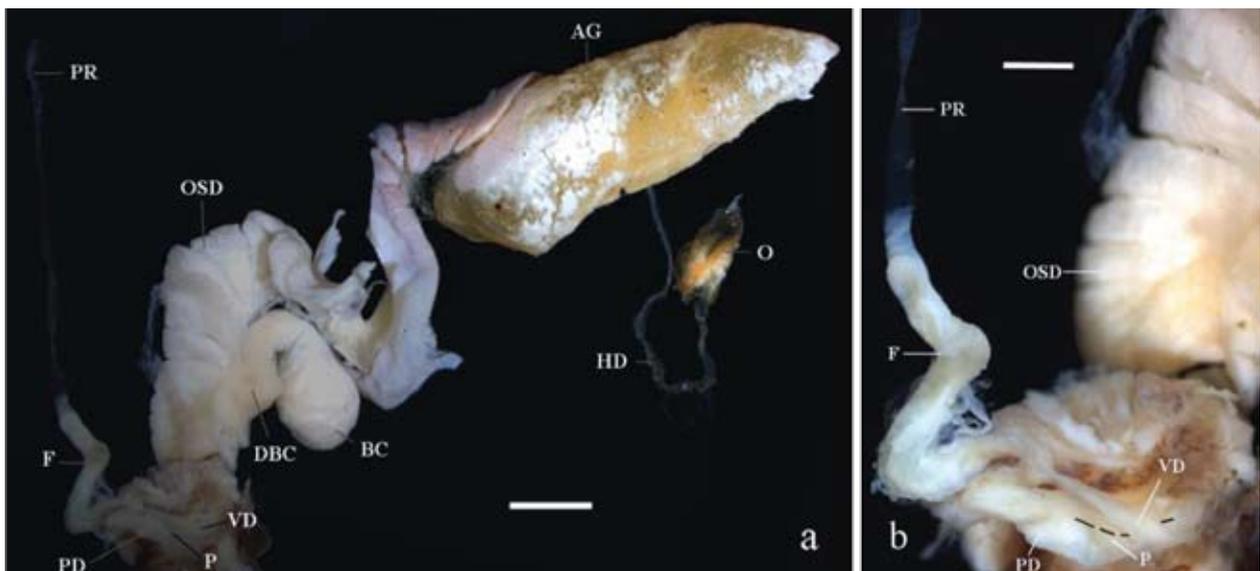


Fig. 4. *Testacella haliotidea*: a) reproductive system, scale bar = 3 mm; b) distal genitalia: male part, scale bar = 1 mm. Key: AG, albumen gland; BC, bursa copulatrix; DBC, duct of the bursa copulatrix; F, flagellum; HD, hermaphrodite duct; O, ovotestis; OSD, ovispermiduct; P, penis; PD, penial diverticulum (caecum); PR, penial-flagellum retractor muscle; VD, vas deferens; dashed line = line cut. (photos P. Mitov)

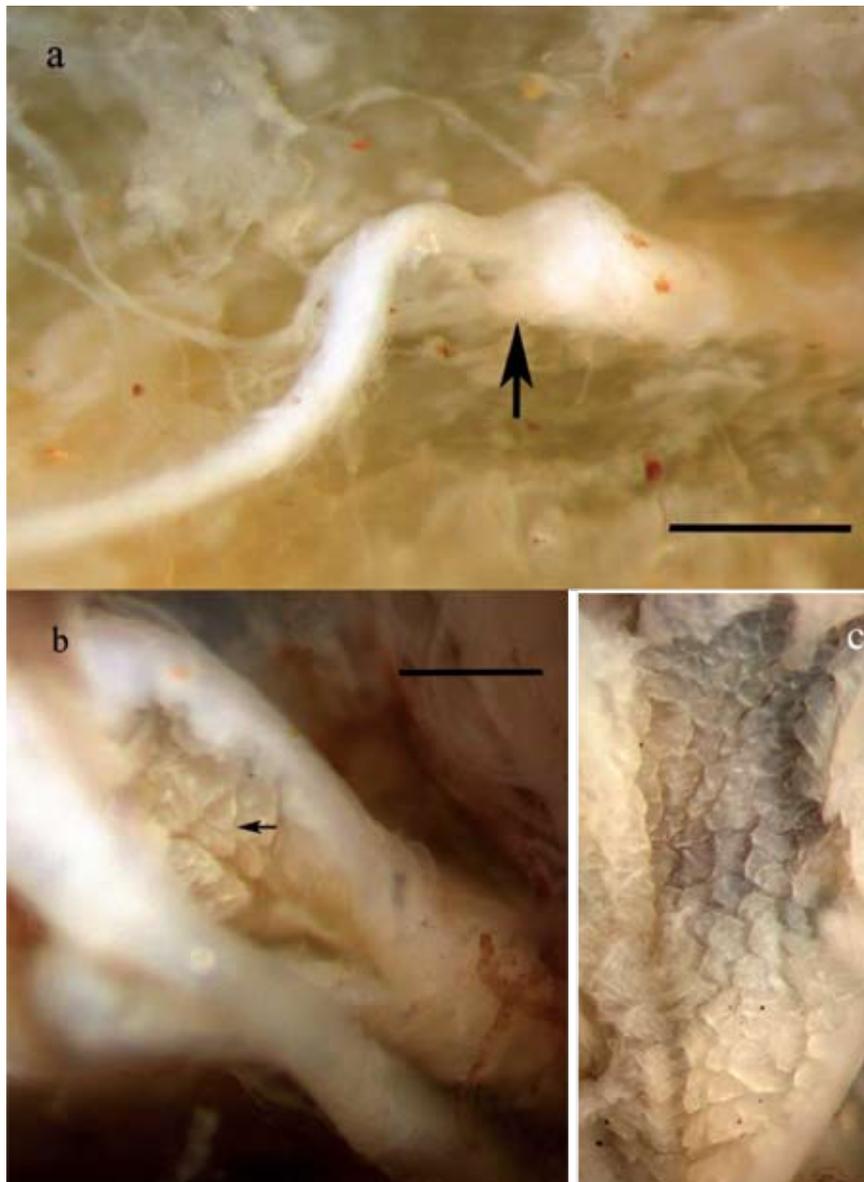


Fig. 5. *Testacella haliotidea*: a) termination of hermaphrodite duct in albumen gland (ventral view) with its bulbous talon (arrowed); b) dissected penis – visible internally are the numerous bilaterally flattened conical papillae (arrowed); c) inner side of the penis: close-up view of the penial papillae. Scale bars = 0.5 mm. (photos P. Mitov)

2008, DEDOV, SUBAI 2012). As the species is new to the Bulgarian gastropod fauna, we have given a description of its morphology as well as details of its reproductive anatomy.

The genus *Testacella* is native to the western Palearctic region (BARKER 1999) and has a Euro-Mediterranean-Macaronesian distribution (DE MATTIA 2006). The native area of *T. haliotidea* includes North Africa (QUICK 1960, BARKER 1999, THOMAS *et al.* 2010) and Europe (Andorra, the Balearic Islands, the Balkan Peninsula, Belgium, Great Britain, Corsica, Denmark, French mainland, Germany, Ireland, Italian mainland, Madeira, The Netherlands, Spanish mainland, and Switzerland), where the spe-

cies is found in disturbed habitats such as gardens, parks, arable fields, vineyards, nurseries, weedy areas, greenhouses, and compost heaps (QUICK 1960, GERBER, HEINS 1991, KERNEY, CAMERON 1994, BANK 2011, ANDERSON 2005, DE MATTIA 2006, KARAMAN 2006, SHEA 2007, DE WINTER, VAN NIEULANDE 2011, WELTER-SCHULTES 2012). The species has been also introduced to North America (Canada and U.S.A.: Pennsylvania, California), Cuba, South Africa, Australia and New Zealand (QUICK, 1960, BARKER 1979, 1999, SHEA 2007, MC DONNELL *et al.* 2009, THOMAS *et al.* 2010). Until now, this species was reported for the Balkan Peninsula only from Croatia, Bosnia and Herzegovina, and Slovenia (BANK 2011,

KARAMAN 2006). In the literature, there are no data on the anatomy of the specimens reported as *T. haliotidea* for this region; thus, its presence is uncertain (see also DE MATTIA 2006, WELTER-SCHULTES 2012). The discovery of *T. haliotidea* in Bulgaria is the easternmost locality of the species in Europe, respectively in the Balkan Peninsula, and expands the species range by more than 1000 km to the east.

The late finding of such a relatively large shelled slug in Bulgaria could be explained by its concealed (subterranean) way of life (see QUICK 1960, BARKER 1979, 1999, KERNEY, CAMERON, 1994, THOMAS *et al.* 2010) and rare appearances above the soil surface, mainly at the night, and after rain (see GERBER, HEINS 1991, BARKER 1999). The phenology of this slug is also peculiar: it is most active in spring and autumn when mating and then occurs either in the soil or under cover on the soil surface (see BARKER 1999, WELTER-SCHULTES 2012). Alternative explanation is the relative poor level of knowledge of terrestrial gastropod fauna of the Bulgarian Black Sea coast.

References

- ANDERSON R. 2005. An annotated list of the non-marine Mollusca of Britain and Ireland. – *Journal of Conchology*, **38** (6607): 1-31.
- BANK R. A. 2011. Fauna Europaea: Mollusca Gastropoda. Fauna Europaea. version 2.4, <http://www.faunaeur.org>.
- BARKER G. M. 1979. The introduced slugs of New Zealand (Gastropoda: Pulmonata). – *New Zealand Journal of Zoology*, **6** (3): 411-437.
- BARKER G. M. 1999. Naturalised Terrestrial Stylommatophora (Mollusca: Gastropoda). Fauna of New Zealand, Number 38. Manaaki Whenua Press, Lincoln, Canterbury, New Zealand, 254 pp.
- BYRNE A., E. A. MOORKENS, R. ANDERSON, I. J. KILLEEN and E. C. REGAN 2009. Ireland Red List No. 2 – Non-Marine Molluscs. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland, 49 pp.
- CAMERON R. A. D., EVERS HAM B. and JACKSON N. 1983. A Field Key to the Slugs of the British Isles. *Field Studies* 5: 807-824.
- COLLINGS, W. E. 1893. III – The Morphology of the Generative System in the Genus *Testacella* – *Annals and Magazine of Natural History*, 12, [sixth series]: 21-25.
- DE MATTIA W. 2006. New records of *Testacella scutulum* Sowerby, 1821 and *Paralaoma servilis* (Shuttleworth, 1852) (Gastropoda: Pulmonata: Testacellidae et Punctidae) from Istria, Kvarner and Dalmatia (Italy, Slovenia and Croatia). – *Malakologische Abhandlungen*, **24**: 121-127.
- DE WINTER A. J., VAN NIEULANDE F. A. D. 2011. *Testacella haliotidea* Draparnaud, 1801 in the Netherlands (Gastropoda Pulmonata, Testacellidae). – *Basteria*, **75** (1-3): 11-22.
- DEDOV I. 1998. Annotated checklist of the Bulgarian terrestrial snails. – *Linzer Biologische Beiträge*, **30** (2): 745-765.
- DEDOV I., SUBAI P. 2012. Five new records of terrestrial gastropods (Mollusca: Gastropoda) for Bulgarian fauna. – *Historia naturalis Bulgarica*, **20**: 103-106.
- Nevertheless, it cannot be excluded also the possible anthropogenic passive transport of the species. *T. haliotidea* is known as a species introduced to several geographic areas (see above) and its discovery near the city of Varna could be the result of an introduction due to the intensive construction activity and the impact of tourism along the seashore. Further field studies should establish the current distribution of this species in Bulgaria and should clarify whether this subterranean carnivorous species is native or alien, thus allowing to evaluate its conservation status. In some countries, it is categorised as vulnerable (see BYRNE *et al.* 2009).
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- GERBER J., HEINS R. 1991. *Testacella haliotidea* Draparnaud 1801 (Stylommatophora: Testacellidae) seit zehn Jahren im südlichen Holstein. – *Schriften zur Malakozoologie*, **4**: 62-64.
- GIUSTI F., MANGANELLI G. and SCHEMBRI P. J. 1995. The non-marine molluscs of the Maltese Islands. – *Monografie di Museo Regionale di Scienze Naturali*, Torino, **15**: 1-607.
- IRIKOV A., ERÖSS Z. 2008. An updated and annotated checklist of Bulgarian terrestrial gastropods (Mollusca: Gastropoda). – *Folia Malacologica*, **16** (4): 199-207.
- KARAMAN B. J. 2006. Former investigations of the fauna of snails (Mollusca, Gastropoda) in Bosnia & Herzegovina. *Natura Montenegrina*, Podgorica 5: 55-66.
- KERNEY M. P., CAMERON R. A. D. 1994. Collins field guide land snails of Britain and Nord-West Europe. Harper Collins Publishers, London. 288 pp.
- MC DONNELL R. J., PAINE, T. D. and GORMALLY M. J. 2009. Slugs. A Guide to the Invasive and Native Fauna of California. University of California, Division of Agriculture and Natural Resources, <http://anrcatalog.ucdavis.edu>, Publication 8336. 21 pp.
- NARDI G., BODON M. 2011. Una nuova specie di *Testacella* Lamarck, 1801, per l'Italia Settentrionale (Gastropoda: Pulmonata: Testacellidae). – *Bollettino Malacologico*, **47**: 150-164.
- QUICK H. E. 1960. British Slugs (Pulmonata: Testacellidae, Arionidae, Limacidae). – *Bulletin of the British Museum (Natural History)*, Zoology, **6** (3): 103-226.
- SHEA M. 2007. Exotic snails and slugs found in Australia. – *Malacological Society of Australasia Newsletter*, **131**: 3-11.
- THOMAS A. K., MC DONNELL R. J., PAINE T. D. and HARWOOD J. D. 2010. A Field Guide to the Slugs of Kentucky. University of Kentucky, The College of Agriculture, SR-103: 1-36.
- WELTER-SCHULTES F. 2012. European non-marine molluscs, a guide for species identification. Planet Poster Editions, Göttingen, 760 pp.

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