Ruthenica, 2019, vol. 29, No. 4: 181-184.
Published online October 3, 2019

http: www.ruthenica.com

Notes on radula of *Boucardicus leopardus* Emberton, 2002 (Gastropoda: Cyclophoroidea: Alycaeidae) and systematic position of the genus *Boucardicus* Fischer-Piette et Bedoucha, 1965

Roman EGOROV

Chkalova str., 5-32, 141732, Lobnya, RUSSIA. E-mail: colus2004@yandex.ru

ABSTRACT. The SEM image and description of the *Boucardicus leopardus* radula is presented for the first time. The radula appeared morphologically similar to those of representatives of Alycaeidae. At the same time representatives of *Boucardicus* differ significantly from South-East Asian Alycaeidae. It is suggested, that presently *Boucardicus* is not monophyletic and includes representatives of different genera and possibly families.

Introduction

The genus *Boucardicus* Fischer-Piette et Bedoucha, 1965 contains 197 recognized species and 5 subspecies [Balashov, Griffiths, 2015], however, the radula has not been illustrated or described previously. In 2017 I obtained a well preserved specimen of *Boucardicus leopardus* Emberton, 2002 from which the radula was extracted.

Materials and methods

The specimen was collected in primary rainforest near GERP (Groupe d'Etude et de Recherche sur les Primates de Madagascar) station, at 890–1210 m altitude in Maromizaha Reserve, in Toamasina Province.

The radular characters were examined and photographed using scanning electron microscope (SEM). Radula was extracted, prepared, and photographed by Yuri Kantor using the methods developed and described in Kantor and Puillandre [2012].

Results

The radula is taenioglossate, all teeth are sharply cusped. The radular formula is 2-1-1-1-2 (Fig. 1A). The central tooth (C) is triangular in shape with five cusps at the cutting edge, practically equal in width and length; however marginal cusps (mc) are somewhat longer than central ones (Fig. 1B). Lateral tooth (L) is irregular spade-shaped, with five cusps on the cutting edge: four cusps are almost equal in size with the fifth marginal cusp being the smallest (sc). The inner marginal (IM) tooth is broadly spade-shaped with four cusps, of various size. Fifth cusp is rudimental and present as broad and narrow plate (p) (Fig. 1C). Central, lateral, and inner marginal teeth are almost equal in width. The outer marginal tooth (OM) looks like elongated rake-like narrowing plate with three long pointed cusps on the cutting edge.

Discussion

Originally the genus *Boucardicus* was described without being assigned to a family. However, in the discussion, the authors [Fischer-Piette, Bedoucha, 1965: 63] indicate the close alliance of the new genus to the genus *Acroptychia* Crosse et P. Fischer, 1877. In fact, the type species of the genus *Boucardicus* (*notabilis* E. A. Smith, 1892; Fig. 2) was originally described as *Acroptychia*. The genus later [Fischer-Piette *et al*., 1993: 3] was assigned to the family Cyclophoridae *s.l.* Emberton [2001] clarified the taxonomic position of the genus, assigning it to the subfamily Alycaeinae. Egorov [2009: 7] conditionally assigned the genus to the family Hainesiidae and noted that the systematic placement of the genus is unclear. The shell morphology had proven to be unreliable for assessing the phylogenetic relationships of cyclophoroid gastropods, as very similar constriction behind aperture can be observed in different groups. Combined conchological, radular, and anatomical criteria must be used for this purpose. Egorov [2009] also suggested that the genus *Boucardicus* may contain representatives of several families, in particular, assimineids and diplommatinids. In support of this assumption, the author points to the presence of a paucispiral operculum (Fig. 3 F) in most species of the genus, which is not characteristic of cyclo-

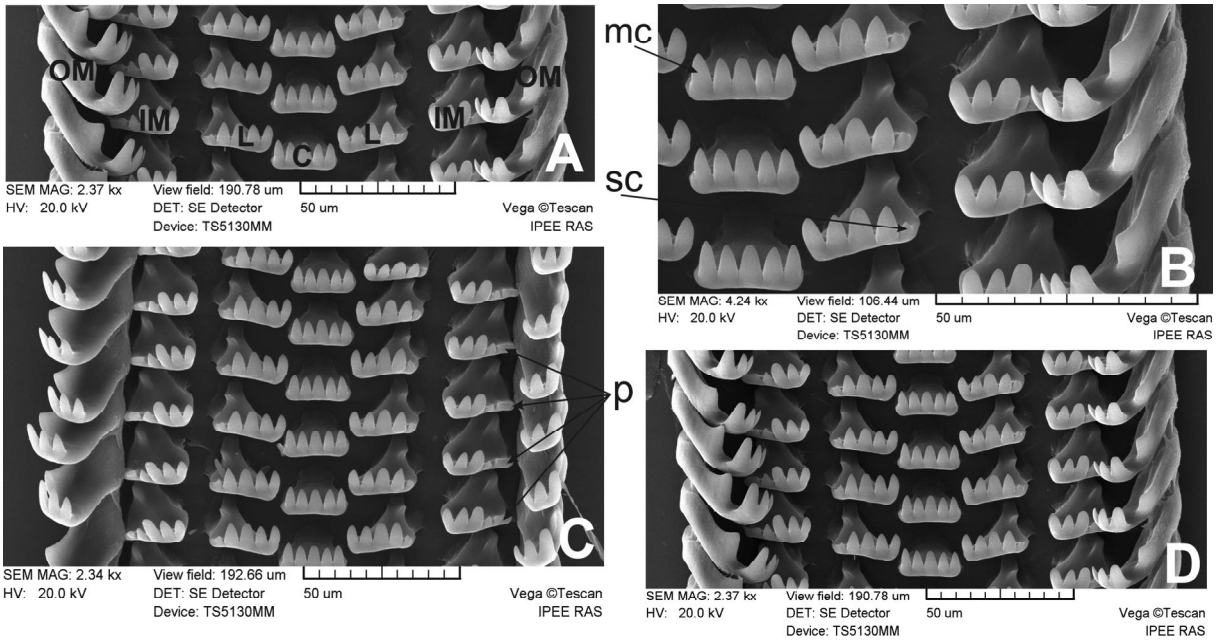

FIG. 1. Radula of *Boucardicus leopardus* Emberton, 2002. **A**. Transversal row of teeth (C – central tooth, L – lateral teeth, IM – inner marginal teeth, OM – outer marginal teeth). **B**. Dentition of teeth (mc – marginal cusps of the central tooth, sc – smallest cusp of laterals). **C**. Dentition of inner marginal teeth (p – marginal rudimental plate-like cusp). **D**. general view of the middle part of the radula.

РИС. 1. Радула *Boucardicus leopardus* Emberton, 2002. **A.** Поперечный ряд зубов (C – центральный зуб, L – латеральные зубы, IM – внутренние маргинальные зубы, OM – внешние маргинальные зубы). **B**. Зазубренность режущего края зубов (mc – краевые зубцы центрального зуба радулы; sc – наименьший маргинальный зубец латерального зуба). **C**. Зазубренность внутренних маргинальных зубов (p – пластинчатый краевой рудиментарный зубец). **D**. Общий вид средней части радулы.

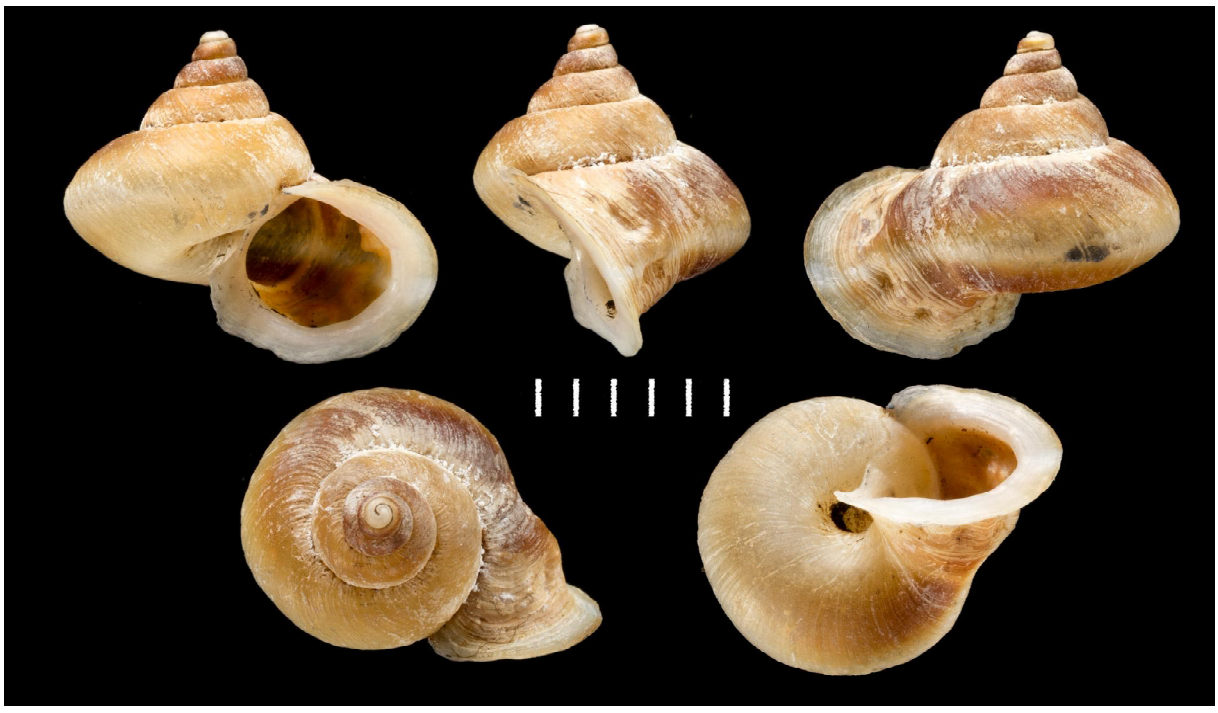

FIG. 2. Shell of *Boucardicus notabilis* (Smith, 1892): syntype of *Acroptychia notabilis* Smith, 1892, Tamatave, Madagascar, purchased of E. Gerrard Jun., collected by A. Majastre, NHMUK 1891.11.5.13-14, courtesy of the Natural History Museum, London.

РИС. 2. Раковина *Boucardicus notabilis* (Smith, 1892): синтип *Acroptychia notabilis* Smith, 1892, Таматаве, Мадагаскар, куплено E. Gerrard мл., собрано A. Majastre, NHMUK 1891.11.5.13-14, фото the Natural History Museum, London.

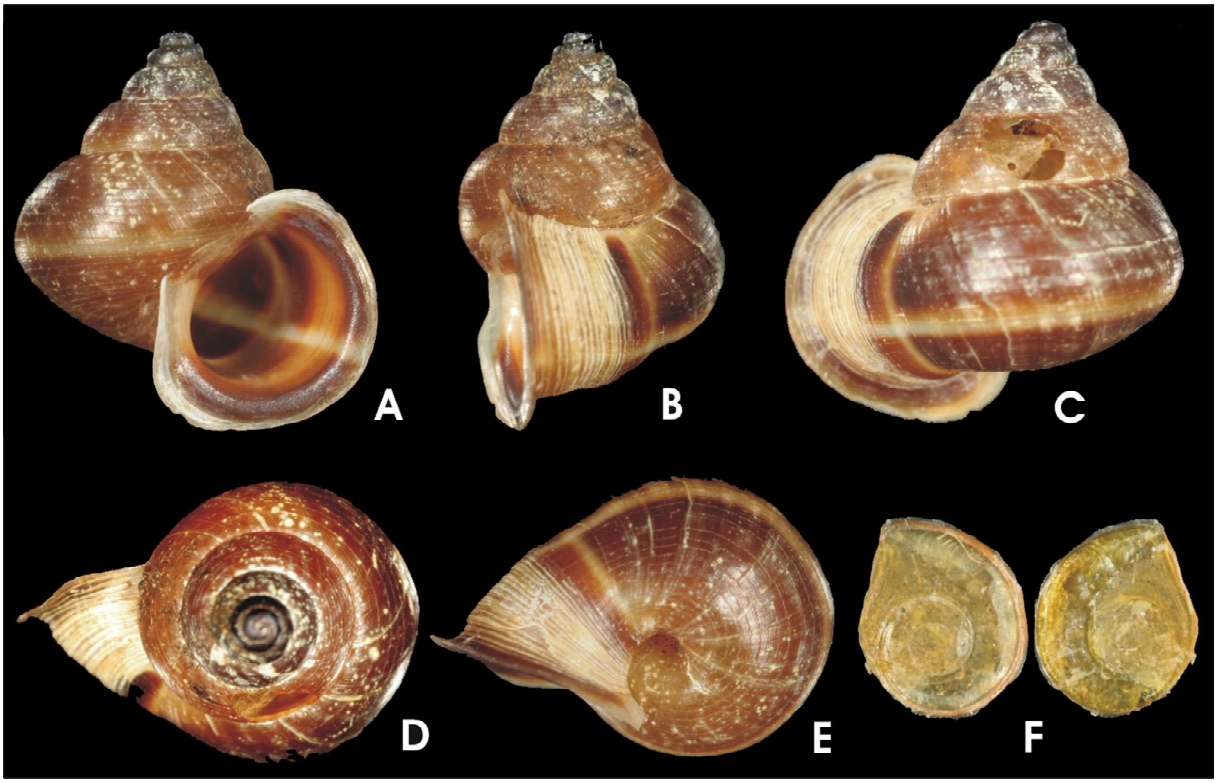

FIG. 3. The shell and operculum of dissected specimen of *Boucardicus leopardus*, Toamasina Province, Madagascar. **A–E.** Shell (height of shell 8.0 mm, width of shell 7.4 mm). **F**. Operculum.

РИС. 3. Раковина и крышечка исследованного экземпляра *Boucardicus leopardus*, провинция Тоамасина, Мадагаскар. **A–E**. Раковина (высота раковины 8.0 мм, ширина раковины 7.4 мм). **F**. Крышечка.

phorids, but common in assimineids, diplommatinids and a number of other groups. However, it is now become obvious that this assumption was erroneous. The *Boucardicus* radula character unequivocally indicates its relationship to the genus *Alycaeus* and that both genera belong to the same group. The variety of types of opercula in different species of the genus *Alycaeus* were shown by Foon and Liew [2017: 7-8] using the example of Malaysian species of this genus. The radula of *Boucardicus leopardus* Emberton, 2002 is quite similar to that of *Alycaeus conformis* (Fulton, 1902), illustrated by Venmans [1956]. A common and unifying feature in radulae of two species is the presence of numerous approximately equal sized cusps on the cutting edge of the central tooth, as well as its shape (Fig. 1 D). The radulae of representatives of the family Alycaeidae treated in the work of Venmans, can be divided into three types, two of which are similar to each other and are characterized by the presence of cusps on the cutting edge of all the teeth of the radula. The third type, of the type species of the genus *Alycaeus* (*Cyclostoma gibbum* Eydoux, 1838, non Draparnaud, 1805 = *A. eydouxi* Venmans, 1956), differs from the others and, according to Venmans, is characterized by the absence of cusps on the cutting edge of all radular teeth. However, according to Páll-Gergely (pers. comm.), the radula of *Alycaeus eydouxi* he studied is fundamentally different from the radula depicted and described by Venmans. Thus it is not clear which species was studied by Venmans and it is preliminary to conclude that radulae of Alycaeidae is highly variable.

The similarity of conchological characters, such as the presence of a constriction behind the aperture, the general shell morphology, and the similarity of the radula convincingly proves the relationship of the endemic Madagascar genus *Boucardicus* with the Asiatic genus *Alycaeus s. l.* It is interesting to note that constriction behind aperture in the species of *Boucardicus* can be differently expressed in various species from distinct to obsolete or absent (Figs. 2, 3 A-E). However, a significant difference from typical Asian members of the family is the absence of a suture tube and any other specialized breathing shell-devices among the members of the genus *Boucardicus* [Emberton, 2002; Páll-Gergely *et al*., 2016]. This is yet another reason to emphasize the necessity for the review of the composition of the genus and its differential diagnosis. Moreover, Emberton [2001] states that “among 12 dis-

sected species of *Boucardicus*, morphology of the female reproductive system was extremely variable (11 of 14 character states autapomorphic)".

Considering above said, the genus *Boucardicus* is most likely a member of the family Alycaeidae, however it is different from its South-East Asian genera and forms a separate branch.

Acknowledgements

In conclusion, I would like to express my deep and sincere gratitude to Mr. Simon Aiken (Mold, UK) for the material provided for the study, Senior Curator Dr. Jonathan Ablett (Natural History Museum, London, UK) for provided data on syntypes of the type species of the genus *Boucardicus*, Dr. Yuri Kantor (A.N. Severtsov Institute of Ecology and Evolution of RAS, Moscow, Russia) for preparing and SEM photography of the radula, Dr. Alexander Sysoev (Zoological Museum of M.V. Lomonosov State University, Moscow, Russia) for photographing of the shell and operculum of studied specimen of *Boucardicus leopardus*, Dr. Barna Pőll-Gergely (Plant Protection Institute, Centre for Agricultural Research, Hungarian Academy of Sciences, Budapest, Hungary) for valuable discussions on the topics discussed in this article.

References

Balashov I., Griffiths O. 2015. Two new species of minute land snails from Madagascar: *Boucardicus monchenkoi* sp. nov. and *B. ambindaensis* sp. nov. (Caenogastropoda: Cyclophoridae). *Zootaxa*, 4052 (2): 237–240. Doi: 10.11646/zootaxa.4052.2.9

Egorov R. 2009. A review of the genera of the recent terrestrial pectinibranch molluscs (synopsis mainly based on published data). Littoriniformes: Hainesiidae, Aciculidae, Cyclophoridae, Craspedopomatidae. *Treasure of Russian Shells*, Supplement 3 (II). Colus-Doverie, Moscow: 1–57.

Emberton K. C. 2001. Exploratory phylogenetic and biogeographic analyses within three land-snail families in southeasternmost Madagascar. *Biological Journal of the Linnean Society*, 72: 567–584. Doi: 10.1111/j.1095-8312.2001.tb01339.x

Emberton K. C. 2002. The genus *Boucardicus*, a Madagascan endemic (Gastropoda: Cyclophoridae: Alycaeinae). *Archiv für Molluskenkunde*, 130: 1–199.

Fischer-Piette E., Bedoucha J. 1965. Mollusques terrestres operculés de Madagascar. *Mémoires du Muséum National d'Histoire Naturelle*, *Nouvelle série, Série A, Zoologie*, 33, fasc. 2: 49–91, pls. I-V.

Fischer-Piette E., Blanc Ch. P., Blanc F., Salvat F. 1993. Gastéropodes terrestres prosobranches. *Faune de Madagascar, Publiée sous les auspices du Gouvernment de la République Malgache*, 80. Paris: 1–284.

Foon J. K., Liew Th.-S., 2017. A review of the land snail genus *Alycaeus* (Gastropoda, Alycaeidae) in Peninsular Malaysia. *ZooKeys*, 692: 1–81.

Kantor Yu. I., Puillandre N. 2012. Evolution of the radular apparatus in Conoidea (Gastropoda: Neogastropoda) as inferred from a molecular phylogeny. *Malacologia*, 55(1): 55–90.

Páll-Gergely B, Naggs F, Asami T. 2016. Novel shell device for gas exchange in an operculate land snail. *Biology Letters*, 12: 20160151. Doi:10.1098/rsbl.2

Venmans L. A. W. C., 1956. Notes on *Alycaeus*. *Proceedings of the Malacological Society of London*, 32(3): 81-87.

Замечания о радуле *Boucardicus leopardus* Emberton, 2002 (Gastropoda: Cyclophoroidea: Alycaeidae) и систематическом положении рода *Boucardicus* Fischer-Piette et Bedoucha, 1965

Роман ЕГОРОВ

Чкалова ул., 5-32, 141732, г. Лобня, РОССИЯ. E-mail: colus2004@yandex.ru

РЕЗЮМЕ. Впервые приводится описание и иллюстрация радулы *Boucardicus leopardus*. Установлено, что радула рассмотренного вида близка по строению к радулам представителей семейства Alycaeidae. Также показано, что представители *Boucardicus* существенно отличаются от представителей Alycaeidae из Юго-Восточной Азии. Высказано предположение, что в настоящее время род *Boucardicus* представляет из себя сборную группу, включающую представителей разных родов, а возможно, и семейств.