

# *Indonaia rectangularis* (Tapparone-Canefri, 1889), comb. nov., a forgotten freshwater mussel species from Myanmar (Bivalvia, Unionidae)

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## Abstract

*Unio rectangularis* Tapparone-Canefri, 1889 is a little-known nominal species of freshwater mussels described from a tributary of the Ayeyarwady River in Myanmar. This taxon was considered a synonym of *Gibbosula laosensis* (Lea, 1863), a margaritiferid species. However, the range of *Gibbosula laosensis* does not encompass the Ayeyarwady River watershed. Here we re-examine the holotype of *Unio rectangularis* and provide a conchological re-description of this species. Based on conchological features such as the shell shape, elevated umbo, and the structure of lateral and pseudocardinal teeth, we transfer this taxon to the genus *Indonaia* Prasad, 1918 and propose *I. rectangularis* (Tapparone-Canefri, 1889), **comb. nov.** It appears to be a rare freshwater mussel species with a restricted range, because it has not been found since the original description. Two additional species in this genus are known from Myanmar, i.e. *Indonaia andersoniana* (Nevill, 1877) and *I. subclathrata* (Martens, 1899).

## Keywords

Ayeyarwady River, Indochinellini, Margaritiferidae, Parreysiinae, Southeast Asia, Unionidae

## Introduction

*Gibbosula laosensis* (Lea, 1863) (Bivalvia, Margaritiferidae) is an endangered freshwater mussel species from Southeast Asia (Bolotov et al. 2014), which has recently been transferred from *Margaritifera* Schumacher, 1816 to *Gibbosula* Simpson, 1900 (Lopes-Lima et al. 2018). Several enigmatic nominal taxa and nomina dubia were linked to this species as its putative synonyms or closely related species, i.e. *Unio rectangularis* Tapparone-Canefri, 1889, *U. sula* Simpson, 1900, *U. sella* Haas, 1912, and *Margaritanopsis woodthorpi* Godwin-Austen, 1919 (Simpson 1900; Haas 1912; Godwin-Austen 1919; Prashad 1922). While the complete story of the three latter names remains to be discussed, a taxonomic reassignment of *Unio rectangularis* is presented here.

Leonardo Fea, an adventurous Italian pioneer and explorer, found a single shell of *Unio rectangularis* among large collections of non-marine molluscs from British Burma during his travels in 1885–1887 (Tapparone-Canefri 1889; Prashad 1922). Cesare Maria Tapparone-Canefri, a famous Italian malacologist, studied this sample and published a comprehensive paper (Tapparone-Canefri 1889) with a description of numerous new taxa of terrestrial and freshwater molluscs, including *Unio rectangularis*.

Later, Prashad (1922) revisited Tapparone-Canefri's unionid taxa in his broad-scale review of freshwater mussels described from British Burma. In the account on *Gibbosula laosensis*, Prashad (1922: 93) stated that: “The species described as *Unio rectangularis* by Tapparone-Canefri [...] is based on a single very young shell. It is undoubtedly to be referred to the genus *Margaritanopsis* and probably represents another species of the genus. Owing, however, to a single young shell being available I do not feel disposed to consider it as a distinct species...”. After that generic reassignment of *Unio rectangularis*, this species was completely forgotten, lost to malacological taxonomy, and it was not listed in the subsequent taxonomic checklists on freshwater mussels of the Oriental Region (Brandt 1974; Subba-Rao 1989; Bolotov et al. 2017a; Zieritz et al. 2018) and in the most authoritative global revisions (Haas 1969; Graf and Cummings 2007).

We revise the generic placement of *Unio rectangularis* and discuss its prospective taxonomic status based on morphological study of the type specimen.

## Material and methods

We studied the holotype of *Unio rectangularis* in the Museo Civico di Storia Naturale di Genova (MSNG), Genova, Italy. The images of the specimen were taken with Canon EOS 7D DSLR camera (Canon Inc., Japan). Shell measurements were performed with Adobe Photoshop CS using digital photographs of the holotype. Samples of *Indonaia andersoniana* (Nevill, 1877) ( $N = 37$  specimens) and *I. subclathrata* (Martens, 1899) ( $N = 7$  specimens) were studied in the Russian Museum of Biodiver-

sity Hotspots (RMBH), Federal Center for Integrated Arctic Research of the Russian Academy of Sciences, Arkhangelsk, Russia. Three shell dimensions at each specimen of the studied taxa (length, height, and width of the shell, all taken at the maximum diameter) were measured using calipers ( $\pm 0.1$  mm). The comparative analysis of shell morphology was carried out with regard to the main distinguishing traits, such as shell shape, umbo position, structures of pseudocardinal and lateral teeth, as well as muscle attachment scars (Konopleva et al. 2019).

## Results

### Family Unionidae Rafinesque, 1820

### Subfamily Parreysiinae Henderson, 1935

### Tribe Indochinellini Bolotov, Pfeiffer, Vikhrev & Konopleva, 2018

### Genus *Indonaia* Prashad, 1918

#### *Indonaia rectangularis* (Tapparone-Canefri, 1889), comb. nov.

Figure 1A–F

=*Unio rectangularis* Tapparone-Canefri 1889: 354.

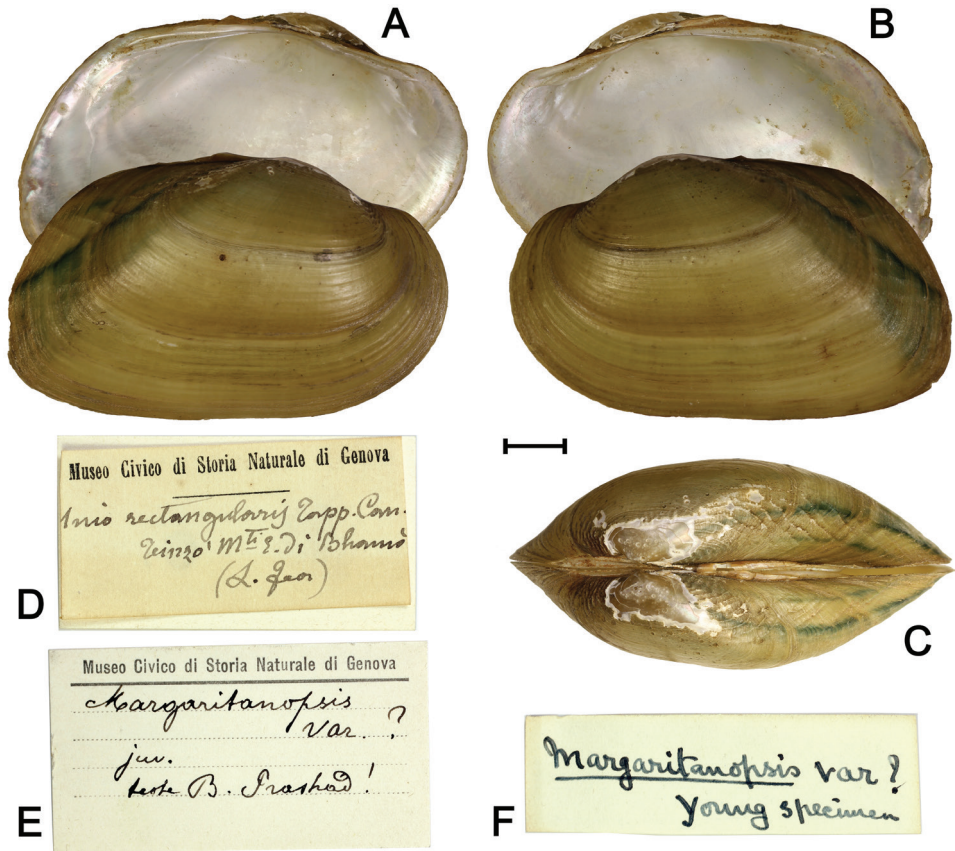
=*Margaritanopsis rectangularis* (Tapparone-Canefri, 1889). – Prashad 1922: 93, pl. 2, fig. 5.

**Type.** Holotype in MSNG, without ID number (Fig. 1A–C). Original label: “*Unio rectangularis* Tapp. Can. Teinzo, Mti E. di Bhamo (L. Fea)” (Fig. 1D). Secondary labels: “*Margaritanopsis* var.? juv. detto B. Prashad!” (Fig. 1E) and “*Margaritanopsis* var.? Young specimen” (Fig. 1F). The original label does not have a collecting date, but Fea’s sample of another freshwater mussel species from Teinzo residing in the MSNG is dated “Marzo 1886” that may also be applicable to the holotype of *U. rectangularis*.

**Type locality.** Teinzo (presently Teinthaw village), 24.3978N, 97.2519E, Moolay River (Mole Chaung in Burmese), hills E of Bhamo (L. Fea), alt. 110 m a.s.l., Ayeyarwady Basin, Myanmar (Tapparone-Canefri 1889).

**Diagnosis.** As Tapparone-Canefri (1889) stated, the shell of *Indonaia rectangularis* is not similar to any other freshwater mussel species known from Myanmar. This species cannot be mistaken with the two congeners, *Indonaia andersoniana* and *I. subclathrata* (Fig. 2), that were described from the Ayeyarwady Basin. Both these species differ from *Indonaia rectangularis* by a more elongated shell and less developed lateral, and pseudocardinal teeth. The pseudocardinal teeth in *I. rectangularis* are lamellar, thick, and very elongated. Additionally, a unique feature of *I. rectangularis* is the presence of regular ridges crossing the growth lines in the posterior-dorsal area forming a clear rectangular pattern that was never seen in other species (Fig. 1C).

**Redescription.** Shell length 34.2 mm, height 20.4 mm, width 16.2 mm. Shell thick, obovate, inequilateral, with broader posterior side. Dorsal margin slightly convex. Ventral margin nearly straight. Anterior margin rounded. Posterior margin slightly

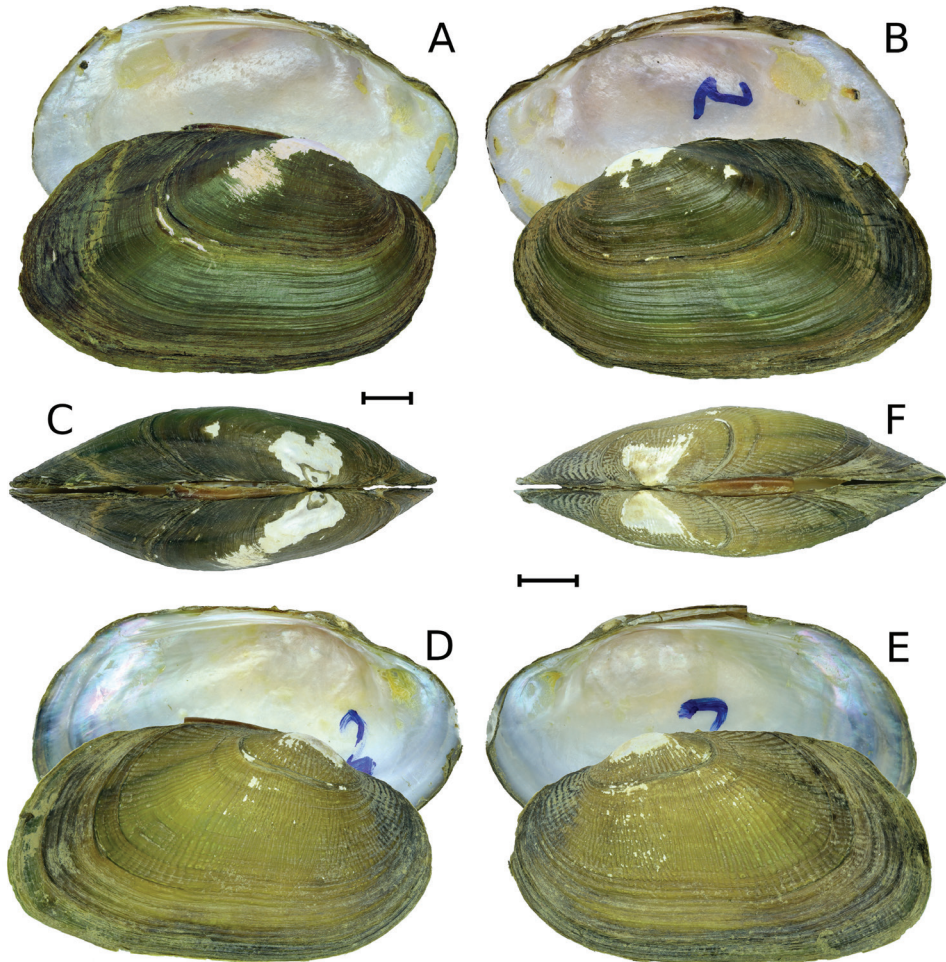


**Figure 1.** Holotype of *Indonaiia rectangularis* (Tapparone-Canefri, 1889), comb. nov. [MSNG]. **A**, **B** Shell, lateral view: inner side of the left valve and outer side of the right valve (**A**); vice versa (**B**) **C** shell, dorsal view **D** original label [probably by C.M. Tapparone-Canefri] **E**, **F** secondary labels [probably by B. Prashad]. Scale bar: 5 mm. (Photos: Ilya V. Vikhrev).

elevated posteriorly, with an inconspicuous wing. Umbo prominent, elevated, rounded, slightly eroded. Shell surface mostly smooth. In the posterior-dorsal area, regular ridges cross the growth lines and form a clear rectangular pattern. In the anterior-dorsal area, curved, lamella-like ridges closely spaced along growth lines. Periostacum light olive-brown, with two parallel, slightly curved green bands along posterior-dorsal area; inner band with a broad greenish extension posteriorly. Nacre silver-white. Umbo cavity deep. Anterior adductor scar round, shallow but well marked. Posterior adductor scar oval, very shallow, unclear. Mantle attachment scars absent. Pseudocardinal teeth are thick, lamella-like, very elongated, two teeth in the right valve and one tooth in the left valve. Lateral teeth well developed, thick, elongated and straight, one tooth in the right valve and two teeth in the left valve. Soft body morphology and anatomy unknown.

**Remarks.** *Unio rectangularis* was originally described based on a single specimen with a shell 34.2 mm long, 20 mm high and 16 mm wide (Tapparone-Canefri 1889). The single

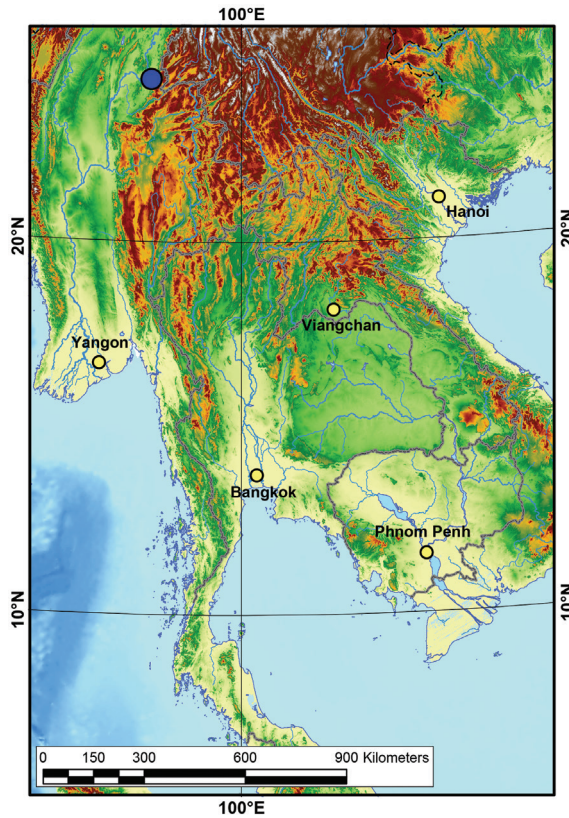




**Figure 2.** Specimens of *Indonaia andersoniana* (Nevill, 1877) and *I. subclathrata* (Martens, 1899) from Myanmar [RMBH biv450\_2 and RMBH biv347\_2, respectively]. **A, B** Shell of *I. andersoniana*, lateral view: inner side of the left valve and outer side of the right valve (**A**); vice versa (**B**) **C** shell of *I. andersoniana*, dorsal view **D, E** shell of *I. subclathrata*, lateral view: inner side of the left valve and outer side of the right valve (**D**); vice versa (**E**) **F** shell of *I. subclathrata*, dorsal view. Scale bar: 5 mm. (Photos: Ekaterina S. Konopleva).

shell labelled as *Unio rectangularis* and deposited in the MSNG studied here corresponds in dimensions to the specimen described by Tapparone-Canefri. The original label (Fig. 1D) also affirms that this shell is the holotype of *Unio rectangularis* designated by monotypy.

**Distribution.** This species is known only from the type locality, a tributary of the Ayeyarwady River (Fig. 3). It appears to be a rather restricted and rare species, because it has not been recorded since the original description, even during a recent broad-scale survey of freshwater mussels in Myanmar (Bolotov et al. 2017a, b, 2018; Konopleva et al. 2019). However, there has been no studies on freshwater mussels from the Mole River published since Tapparone-Canefri (1889).



**Figure 3.** Map of the type locality of *Indonaia rectangularis* (Tapparone-Canefri, 1889), comb. nov. (dark blue circle). The digital elevation model and other layers of the map were added from the Esri Data & Maps 10 dataset.

## Discussion

The results of our study reveal that *Unio rectangularis* is not a margaritiferid because it does not have mantle attachment scars, the most prominent diagnostic feature of the Margaritiferidae (Lopes-Lima et al. 2018). *Unio rectangularis* can be placed within the genus *Indonaia* based on conchological features, i.e. the shell shape, elevated umbo, and the structure of lateral and pseudocardinal teeth (Figs 1, 2). Prasad (1922) considered that the holotype of *Unio rectangularis* is a “very young shell”. However, all *Indonaia* species are rather small mussels (Fig. 2), and this holotype shell surely represents an adult specimen.

*Indonaia* represents the most divergent phylogenetic clade among the tribe Indochinellini (Bolotov et al. 2017a, 2018; Pfeiffer et al. 2018; Konopleva et al. 2019). This genus contains three species from India and three species from Myanmar (Konopleva et al. 2019). The taxonomic relationship of *Indonaia* with another Oriental genus, *Radiatula* Simpson, 1900, is still to be resolved, because molecular sequences of *Unio crispisulcatus* Benson, 1862, the type species of *Radiatula*, are still not available.

### Key to species of *Indonaia* from Myanmar

- 1 Shell surface with radial ridges covering the entire shell disc ..... *I. subclathrata* (Martens, 1899)\*
- Shell surface without radial ridges on the shell disc ..... **2**
- 2 Shell surface mostly smooth, while regular ridges cross the growth lines and form a clear rectangular pattern in the posterior-dorsal area, and curved, lamella-like ridges closely spaced along growth lines in the anterior-dorsal area .....  
..... *I. rectangularis* (Tapparone-Canefri, 1889), comb. nov.\*\*
- Shell surface smooth ..... *I. andersoniana* (Nevill, 1877)\*\*\*

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\* Manipur, Chindwin rivers, middle reaches of the Ayeyarwady River; common species (Konopleva et al. 2019)

\*\* Mole River, Ayeyarwady Basin; rare species

\*\*\* Middle reaches and downstream of the Ayeyarwady River; common species (Bolotov et al. 2017a, 2018; Konopleva et al. 2019)

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