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Shell Morphology *Rectidens*  
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# The Distinctive Character of Shell Morphology *Rectidens sumatrensis* (DUNKER, 1852) Against *Elongaria orientalis* (LEA, 1840) (Two Local species, Bivalvia: Unionidae) from the Brantas River, Indonesia

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**Abstract.** This research is directed to recognize the main characters of shell morphology that can easily be used to distinguish the two local species of Bivalvia Unionidae in the Brantas River in East Java (Indonesia) which are very similar, namely *Rectidens sumatrensis* and *Elongaria orientalis*. A total of 49 individuals sampled specimens of both species were characterized based on identification guide Jutting (1953). About of 30 of shell morphological characters were observed, there are three characters identified in specimens *Rectidens sumatrensis* that can be used to distinguish from the specimen *Elongaria orientalis*, namely the presence of wrinkles noticeable on the surface structure of the interior of the shell; anteriorly of the greatest diameter of the shell, there is generally a shallow concavity in the flanks; and the two cardinal teeth in each valve shells left and right are relatively undeveloped.

## INTRODUCTION

There are two kinds of reasons that became the basis for selecting the title of the article in this paper. The first reason, is a difficulty experienced by the author while the identification and characterization of bivalve specimens Unionidae of Brantas River in East Java [1]. Unionidae bivalve species identification of the Brantas river that time only using Jutting's guide [2], because only those documents which up to now can be used as a reference for the identification of freshwater bivalvia species in Java. The results showed that the specimens from three species of bivalves Unionidae Brantas river that previously reported [2], namely *Contradens contradens*, *Pseudodon vondembuschianus*, and *Pilsbryconcha exilis*, each having morphological characters are distinctly different and can easily be recognizable and distinguishable from other species. Meanwhile, specimens from the remaining two species, namely *Elongaria orientalis* and *Rectidens sumatrensis*, both have similarities in many morphological characters, so as to be able to distinguish clearly between the two is very difficult. There are a number of individuals in the collection of specimens of both species that have a combination of morphological characters are exactly the same as the Jutting's guide [2], but there are also specimens (with higher numbers) that has a combination of morphological characters that overlap and difficulty to be established whether as *Elongaria orientalis* or as *Rectidens sumatrensis*.

In its explanation, [2] provides recognition that all bivalve freshwater described in the document, its specimen did not be obtained from the field directly, but rather a collection of a number of renowned museums, such as: the Museum Zoologicum at Bogor Java, the Rijksmuseum van Natuurlijke Historie at Leiden, the Naturemuseum Senckenberg at Frankfurt-Main, the Staatliches Museum für Naturkunde at Stuttgart, the Naturhistorische Museum at Basle, the Museum of Comparative Zoology at Cambridge, and the Zoologisches Museum at Zurich. The most of authors, generally do naming and determination species only through shell

morphology characterization of the collected specimens in the museum and had an incomplete understanding of morphological variation within and between populations fresh water mussel in nature [3]. [4] also uses a number of the museum's collection to verification activity against a number of characters used in phylogenetic-morphology analysis of Palaeoheterodonta (Bivalvia: Unionoidea + Trigonioidea) in a number of publications. Thus, it is reasonable that the author has an incomplete understanding of morphological variation within and between freshwater mussel populations in nature, since they do naming and determining species only through the shell morphology characterization of specimens stored in the museum. Morphological characters on bivalve shells unionoid often show a wide spectrum. Morphologic characters such as size and shape, sculpture, hinge teeth, as well as the micro-structure of shells on bivalves unionoid often show variability striking, both among different species as well as within a single species [5,3]. Extreme phenotypic plasticity in the morphology of the shells of mollusks in general also contribute an additional problem for the field of taxonomy studies [6]

The second reason that into consideration in the selection of the title of the article in this paper is that at this moment in our institutions, namely the Laboratory of Ecology, Department of Biology, Faculty of Science and Technology, Airlangga University, has provided a collection of a number of specimen shells of bivalves unionidae of the Brantas river which represents both species being discussed. Status of the species of each specimen representing both species have been known based on DNA analysis using gene fragment COI (Cytochrome c oxidase subunit I) as a DNA marker (data not published), but the morphological characterization shells from the collection of specimens has not been done.

This article is intended to reveal the main characters of the shell morphology that can easily be used to distinguish and identify the status of the two local species of bivalves Unionidae from Brantas river, namely *Rectidens sumatrensis* and *Elongaria orientalis*. Rapid detection of species has a great importance in the field sampling activities, at least in an attempt to minimize the number of specimen samples to be collected and also of significant importance in the success of conservation programs.

## MATERIALS AND METHODS

### Material

Specimen samples Unionidae bivalve shells used in this study amounted to 49 specimens, which are specimen deposits from previous research activity by author [7] (unpublished data), were collected from six locations in Brantas river. Species status of each specimen sample Unionidae bivalves have already known based on the DNA analysis using COI gene fragment as a DNA marker, they are *Rectidens sumatrensis* and *Elongaria orientalis*.

### Preparation of Observation Guide

A detailed list of observation points in the variable's guide is deduced from the observation work guide following Jutting [2], which is a way to change and take points the observation variable from descriptive narrative explanation. Observation variable points of morphological characters of the shell were divided into two groups variables as listed in the following description.

- A. The points of observation variables of shell morphological characters that identic among species *Rectidens sumatrensis* and *Elongaria orientalis*:
- A.1 The shape of the shell: oval-elongated, rounded in front and often pointed behind
  - A.2 Having striated concentrically according to the growth lines
  - A.3 The properties of the older shell: a little thicker, less transparent, and less glossy
  - A.4 The dorsal and ventral margin: almost parallel, rather arcuate in dorsal margin, particularly in the old shell, the lower margin straight or slightly concave
  - A.5 Ligament: approximately midway between the apex and the meeting point between the dorsal and posterior margin.
  - A.6 The location of the apex: at 1/5 to 1/4 of the entire shell length
  - A.7 Regional umbo: less eroded
  - A.8 The shell of the young: there are 2 to 5 irregular nodules diverge from apex over the umbo,

- forming the commencement of the two diverging ridges
- A.9 Interior shell: iridescent, the colour varying from white to pink, yellow, or green
  - A.10 Muscle scars: in the upper half of the shell, connected by a fine pallial line without sinus
  - A.11 Hinge teeth in the left valve: there are 2 cardinals and 2 lateral
  - A.12 Hinge teeth in the right valve: there are 2 cardinals and 1 lateral
  - A.13 Lateral teeth: entirely smooth
  - A.14 Teeth cardinal: groove/slit transversely or slightly inclined.
- B. The points of variables observation of shell morphological characters that differ among species *Rectidens sumatrensis* and *Elongaria orientalis* [R: *Rectidens sumatrensis*; and E: *Elongaria orientalis*].
- B.1 The location of the thickest part of the shell: located in front of the middle shell (R); or at the mid-point of the shell (E).
  - B.2 The existence of the flank in front of the thickest part of the shell: none (R); or present (E)
  - B.3 The color of the shell: brownish, greenish or olive (R); or green-brown to brown, the young specimens bright green-blue (E).
  - B.4 Alternating zones of green-brown in the shell: none (R); or present (E).
  - B.5 The strength of 2 to 3 keels of the apex, spread to the back indirectly: more prominent, and the adult specimens are worn out to the edge (R); or weaker and quickly disappeared (E)
  - B.6 Properties of epidermis: non fibrous (R); or greenish-brown color fibrous (E)
  - B.7 Anterior margin: real-rounded, with an unclear "nose" at the meeting point with dorsal margin (R); or slightly rounded with clear "nose" at the meeting with dorsal margin (E).
  - B.8 Posterior margin: pointed, with clear boundaries toward dorsal and ventral side (R); or tapered, with no clear boundaries toward the side of dorsal and ventral (E)
  - B.9 Rostrum in the posterior part of the shell: in special cases, generally less evident (R); or almost always evident (E).
  - B.10 Umbo in adult shells: less eroded (R); or almost always eroded (E).
  - B.11 Umbonal sculpture: ornamented of 8 to 10 undulations with irregular pattern (R); or ornament is less developed, but the valve is not smooth (E).
  - B.12 Interruptions in the left cardinal valve: there is no wide gap (R); or there is a clear interruption (E)
  - B.13 Cardinal posterior in left valve: more prominent (R); or somewhat weaker and more elongated (E)
  - B.14 Cardinal in the right valve: originated from anterior point where apex lines meet the hinge (R); or starts at the point where the apex and hinge line meets (E).

### **Characterization of shell specimen**

Each of shell specimens were characterized by means of observation, measurement (as needed), as well as doing matching suitability the result of activity according to the points of observation variable (the points list of variable's observation in A dan B above).

This characterization activities are intended only for searching and finding points of variable characters are consistent for each shell, each species. In addition to observing the points variable observation of morphological characters shell as having been derived from [2], is it also carried out observations of variable extra that is not listed in [2], but it is an important character and become a factor distinguishing of both species observed.

### **Data analysis**

The data generated in this study, all were analyzed qualitative-descriptively in order to obtain clarification on issues raised, based on patterns of data obtained from pure observations with no explanation of how or why such facts exist or occur, and by not giving any treatment.

Determination of a particular shell morphological characters as a distinctive character for certain species based on its consistency between the determination of the status based on shell morphology according [2], and the results of the determination of the status of species by genetic analysis has been determined. Note that: when the identity of the species of each specimen were matched through the points of morphological characters is the same as the identity of a specimen that has been established then the determination is code the positive (+) means that there is a match, and if the identity is generated does not match the determination of the rated negative (-), which means there is no conformity. The consistency of the conformity between the results found from every points of the shell morphological characters with the status or identity of the specimen that has been set will be used as a key character and serve as a differentiating factor species.

## RESULTS AND DISCUSION

Forty-nine shells specimens of two local species of bivalve Unionidae origin Brantas river has been studied, namely *Rectidens sumatrensis* and *Elongaria orientalis*, each sequentially numbered 1 and 48 individuals (Figure 1). In Figure 1, *Rectidens sumatrensis* specimen is marked with "white arrows" and with the serial number 10. While, all the remaining specimens are representative of *Elongaria orientalis*. As it is shown in Figure 1, showed that display shell morphology of both species are almost similar and difficult to distinguish.

The results of the determination of the status of the suitability of the identity of each specimen based on the comparison between the identities of the species by genetic analysis (set out above) and the identity of the species which is produced by matching each point of morphological characters shells on each specimen by criteria [2] served as Table 1. From the data of morphological characterization shell defined in the Table 1, only the data derived from the characterization of the points the second character (points B), which points the different characters in between each species: *Rectidens sumatrensis* and *Elongaria orientalis* according to [2]. The characterization results on the points character first group (points A), the result is exactly the same as the criteria [2], which points the morphological characters of the shell is actually owned by the two species studied so no need for discussion. Data in the Table 1 implies that the code of positive (+) when the species identity of each specimen were matched through the morphological character points equal to the identity of the specimens that have been established, and code negative (-) if the resulting identity is not appropriate.

Based on the Table 1, it is known that there is only one shell morphology character points, which points B.2 results of conformity always consistent on all the specimens examined, both on the specimens of *Rectidens sumatrensis* and *Elongaria orientalis*. Compliance results are always positive, ie the identity of any specimen of species which are matched through the points of morphological characters is always the same as the identity of the specimens that have been assigned based on data already available.

Observations further more detailed on the characters of morphology that are not included in the criteria [2], found three extra features that appear very different between the two species (*Rectidens sumatrensis* and *Elongaria orientalis*), namely: (i) the characteristic of the teeth cardinal, both left and right cardinal, in which the teeth are less developed in *Rectidens sumatrensis* than in *Elongaria orientalis* (Figure 2); (ii) the presence of wrinkles on the part of the internal shell (Figure 3.2-3) that was evident at *Rectidens sumatrensis*, while the shell *Elongaria orientalis* looked smooth; and (iii) the existence flank clearly visible in the anterior direction from the position of the thickest shell, these traits observed in *Elongaria orientalis* (Figure 3.4) and barely observed in *Rectidens sumatrensis* (Figure 3.3).



FIGURE 1. 49 collection specimen shells of bivalves Unionidae Brantas river used as research material. The status or identity of the species of each specimen is predetermined based on the results of the analysis of DNA (gene COI), and is composed of two species, respectively *Rectidens sumatrensis* (there is only one individual; number of specimens: 10; marked with arrows and white), and *Elongaria orientalis* (totaling 48 individuals) (photography by author).

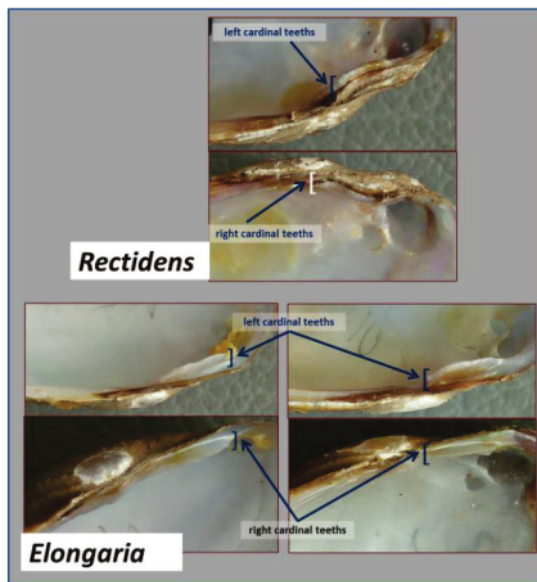
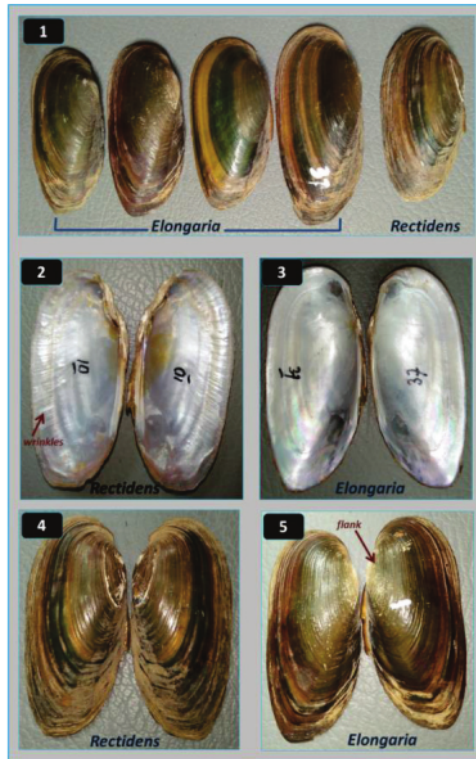


FIGURE 2. The cardinal teeth on the left and right valves in *Rectidens sumatrensis* and *Elongaria orientalis* specimens. It appears that the cardinal teeth of the *Rectidens sumatrensis* specimen less developed than in the *Elongaria orientalis* specimens.

**TABLE 1.** Determination of the status of the suitability of the identity of each specimen based on the comparison between the identity of the species by genetic analysis (pre-set) with the species identity matching results from morphological characters shells according to criteria Jutting (1953) (which is done at this time). Conditions: result (+) indicates there are appropriate, and (-) indicates no appropriate. [B. 1-14 is a shell morphological characters according Jutting (1953); 1: Location of the thickest part of the shell; 2: Basin in the hips (flanks); 3: The color of the shell; 4: The zones alternate green-brown; 5: 2-3 Strength keel from the apex to the back; 6: brown-green epidermis and stringy; 7: Margin anterior; 8: posterior margin; 9: The shape of the rostrum to the posterior shell; 10: The nature umbo on adult shells; 11: Umbonal sculpture; 12: The gap between the cardinal left valve; 13: Cardinal left posterior valve; 14: The beginning of the cardinal on the right valve; E: specimens representing *Rectidens sumatrensis* and R: specimens representing *Elongaria orientalis*]

Specimen Numbers	Species status	Status suitability of each specimen according to the comparison of morphological characters shells (B.1—14)													
		B.1**	B.2*	B.3	B.4	B.5	B.6	B.7	B.8	B.9	B.10	B.11	B.12	B.13	B.14**
01	<i>Elongaria</i>	-	+	-	-	+	-	+	+	+	-	-	-	+	+
02	<i>Elongaria</i>	-	+	+	-	+	+	+	-	-	+	+	-	+	+
04	<i>Elongaria</i>	-	+	-	+	-	-	+	-	-	-	+	-	+	+
05	<i>Elongaria</i>	-	+	+	+	-	+	-	+	-	-	+	-	+	+
06	<i>Elongaria</i>	-	+	+	-	+	+	+	+	+	+	-	+	-	+
07	<i>Elongaria</i>	-	+	+	+	-	+	-	+	-	-	-	-	+	+
08	<i>Elongaria</i>	-	+	+	+	-	-	+	-	-	-	-	-	+	+
09	<i>Elongaria</i>	-	+	+	+	+	+	-	-	+	+	+	-	+	+
10	<i>Rectidens</i>	-	+	+	+	+	-	-	+	+	+	+	+	-	-
11	<i>Elongaria</i>	-	+	+	-	+	+	-	+	+	+	+	-	-	+
12	<i>Elongaria</i>	-	+	+	-	-	+	-	+	+	+	+	+	-	+
15	<i>Elongaria</i>	-	+	+	+	+	-	-	+	+	+	+	-	+	+
16	<i>Elongaria</i>	-	+	+	-	+	+	-	-	+	+	+	-	-	+
17	<i>Elongaria</i>	-	+	-	+	-	+	+	+	+	+	+	+	-	+
18	<i>Elongaria</i>	-	+	+	-	+	+	-	+	+	+	+	-	-	+
19	<i>Elongaria</i>	-	+	-	+	-	+	+	+	-	-	-	-	-	+
20	<i>Elongaria</i>	-	+	+	-	+	+	+	-	+	+	+	+	-	+
21	<i>Elongaria</i>	-	+	-	-	+	+	-	+	-	-	-	+	-	+
23	<i>Elongaria</i>	-	+	-	+	-	-	-	-	-	-	-	-	-	+
24	<i>Elongaria</i>	-	+	+	-	-	+	-	+	+	+	+	+	-	+
26	<i>Elongaria</i>	-	+	-	+	-	+	+	+	-	-	-	-	+	+
28	<i>Elongaria</i>	-	+	-	+	-	+	+	-	-	-	-	-	+	+
29	<i>Elongaria</i>	-	+	+	+	-	-	+	+	-	-	-	-	+	+
30	<i>Elongaria</i>	-	+	-	+	-	-	-	-	-	-	-	+	-	+
31	<i>Elongaria</i>	-	+	-	+	+	-	+	+	-	-	-	-	+	+
32	<i>Elongaria</i>	-	+	-	-	-	+	-	-	+	+	+	+	-	+
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35	<i>Elongaria</i>	-	+	-	+	+	+	+	+	-	-	-	-	+	+
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38	<i>Elongaria</i>	-	+	-	+	-	-	-	-	-	-	-	+	-	+
40	<i>Elongaria</i>	-	+	+	+	+	+	+	-	+	+	-	-	+	+
41	<i>Elongaria</i>	-	+	-	-	+	-	+	+	-	-	-	-	+	+
44	<i>Elongaria</i>	-	+	-	-	+	+	-	+	-	+	+	-	+	+
47	<i>Elongaria</i>	-	+	+	-	+	-	-	-	+	+	-	-	-	+
48	<i>Elongaria</i>	-	+	+	+	+	+	-	+	-	+	+	+	-	+
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51	<i>Elongaria</i>	-	+	-	+	+	-	-	-	-	-	-	-	+	+
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55	<i>Elongaria</i>	-	+	+	+	+	-	+	+	-	-	-	-	+	+
58	<i>Elongaria</i>	-	+	+	-	+	+	+	-	-	+	+	-	-	+
59	<i>Elongaria</i>	-	+	-	+	+	+	+	+	-	-	-	-	+	+
64	<i>Elongaria</i>	-	+	-	+	+	-	+	-	-	-	-	+	+	+
69	<i>Elongaria</i>	-	+	+	-	+	+	-	-	-	+	+	+	+	+
71	<i>Elongaria</i>	-	+	+	-	+	+	-	-	-	+	+	-	-	+
72	<i>Elongaria</i>	-	+	+	-	+	+	-	-	-	+	+	+	-	+
73	<i>Elongaria</i>	-	+	+	+	-	+	-	-	-	-	-	-	+	+
74	<i>Elongaria</i>	-	+	-	+	+	+	+	-	-	-	-	-	+	+
75	<i>Elongaria</i>	-	+	+	-	-	+	+	-	+	+	+	+	-	+

Notes : \* unique shell character, serves as determinants of species  
 \*\* common shell character, possessed by both species



**FIGURE 3.** The number of distinguishing shell characters between *Rectidens sumatrensis* and *Elongaria orientalis* specimens. (1) Comparison of shell morphology that is not relatively different; (2 & 3) the presence of wrinkles on the interior of the shell that is only apparent in *Rectidens sumatrensis* specimen; (4 & 5) the existence of the flanks, which seem more real to the *Elongaria orientalis* specimen.

Based on the results described, it can be stated that the guide description for freshwater species identification gravestones contained in the Brantas River have a number of shortcomings that still must be completed, in particular the details of the characteristics distinguishing between specimen shells *Rectidens sumatrensis* and *Elongaria orientalis*. Almost all of the characteristics (as many as 13 of the 14 characters) that characterizes the *Rectidens sumatrensis*, everything is observed also in the majority of specimens *Elongaria orientalis*. And on the other hand, there are other shells characters that have not been disclosed by Jutting, but the character is the distinguishing characteristics between the two species.

Important information obtained based on personal experience of the author during the sampling bivalves Unionidae is that the abundance *Rectidens sumatrensis* in the Brantas River is very little compared to the *Elongaria orientalis* population. Thus, knowledge of shell morphological characters in detail, especially the character that become a distinguishing factor of each of these species is very important. This is due to the many morphological characteristics in common shells found in both species. In present, conservation status of the *Rectidens sumatrensis* in the IUCN Red List [8] was recorded in the category "Data Deficient". On the other hand, important information related to *Elongaria orientalis*, which needs to be conveyed is that this species is a endemic to the island of Java (Indonesia) [9,10], and conservation status of this species in the IUCN Red List still recorded as unknown [11].



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