

# DIVERSITY OF THE UNIONID FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE) IN BRANTAS RIVER, EAST JAVA, INDONESIA

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## ABSTRACT

The aims of this study are to provide data and information about diversity, dominance, and distribution of the Unionidae mussels species in Brantas River, East Java, Indonesia. Mussel samples were collected from 14 sampling stations along the Brantas River, starting from upstream in Tulungagung to downstream in Surabaya ( $\pm 170$  km) in April-May 2012. The results showed that five species of mussels, namely: *Conradens Conradens*, *Elongaria orientalis*, *Rectidens sumatrensis*, *Pseudodon vondembuschianus* and *Pilsbryconcha exilis* were observed in the Brantas River. *Conradens Conradens* was the "dominant" species, followed by *Elongaria orientalis* as a "common" species, and *Rectidens sumatrensis*, *Pseudodon vondembuschianus* and *Pilsbryconcha exilis* as "rare" species. Distribution of each species in the Brantas River tends to be concentrated in downstream of the river, mainly located in station 13. According to the IUCN Red List, *Rectidens sumatrensis* was categorized in "Data Deficient", while *Pseudodon vondembuschianus* and *Pilsbryconcha exilis* were categorized in "Least Concern".

Keywords: Unionidae, Freshwater mussels, Brantas River, diversity

## INTRODUCTION

The class of freshwater Bivalvia represents at least 1026 species and divided among 5 orders, namely Arcoida, Myoida, Mytiloida, Unionoida, and Veneroida (Bogan, 2008). Almost 80% of the freshwater bivalves are member of Unionoida. They live in rivers and lakes of all continent except Antarctica (Bogan, 2008; Graf and Cummings, 2006, 2007; Grabarkiewicz and Davies, 2008).

Freshwater mussels play an important role in maintaining the balance and stability of the environment. The presence of freshwater mussels in the bottom of waters provides a useful habitat for a number of other aquatic animals such as periphyton, crustaceans, and fish (Grabarkiewicz and Davies, 2008). Burrowing activity of the mussels are also able to create a stirring mechanism of interstitial water, release nutrients and acid compound from the substrate (Vaughn and Hakenkamp, 2001), and provide integral resources that connecting between pelagic and benthic habitats (Nelepa *et al.*, 1991; Howard and Cuffey, 2006).

Over the last few decades, freshwater mussels have attracted the attention of many researchers, not only because of the conservation status reasons (Williams *et al.*, 1993; Araujo and Ramos, 2000; Clayton *et al.*, 2001; Metcalfe-Smith *et al.*, 2003; Raithel and Hartenstine, 2006; Fisher, 2006; and Galbraith *et al.*, 2008), but also extremely interesting from a biological perspective. Unionoida have a unique life cycle, mussels have a very typical life history in which most members of the species requires hospes for glochidia development since the larvae is an obligate parasites on fish hospes (Neves and Widlak, 1988; Parmalee and Bogan, 1998; Zanatta and Muphy, 2006; Bařınar and Düzgünes, 2009). Strayer *et al.* (2004) revealed that freshwater Bivalvia belong to a group of organisms that have the highest risk of extinction. In the whole world, there is a tendency that freshwater mussels populations decline. Even the large body size unionid has been in endangered status (Grabarkiewicz and Davies, 2008).

Very few information concern the existence and characteristics of the freshwater mussels species in Indonesia. The main studied about the freshwater mussels in Indonesia, particularly in Java was reported by Jutting (1953) and reported that found six species, namely *Conradens Conradens*, *Elongaria orientalis*, *Phisunio eximius*, *Pilsbryconcha exilis*, *Pseudodon von-*

*dembuschianus*, and *Rectidens sumatrensis*. All species are member of Unionidae. "The Mussel Project Web Site" (<http://www.mussel-project.net/>) was compiled by Graf and Cummings (2011) noted six species of Unionidae mussels in Java. Five of them similar to those revealed by Jutting (1953). The species which is not mentioned by Jutting (1953) is *Pilsbryconcha carinifera*.

The objectives of this study were to present current status of freshwater mussel species found in the Brantas River.

## MATERIALS AND METHODS

### Sampling of Freshwater Mussels

Freshwater mussel were collected from 14 sampling stations along the Brantas River (170 km) in April–May 2012. The position of sampling stations were represented in Fig. 1 and Table 1. Mussels were collected from bottom substrate on both sides of the river edge (water depth  $\leq 130$  cm). Divers positioned a 1 x 1 m<sup>2</sup> frame on river bottom and collected all mussels within the frame area. Two replication were conducted during mussels collection. All samples were cleaned and put in a porous plastic bag. After arrived at the laboratory, the samples were preserved with 6% formaldehyde and stored in a 40 L plastic container.

### Identification and Characterization of Freshwater Mussels Species

Mussels from each location were washed with clean water to remove formaldehyde. Specimens then were grouped based on the similarity of shells morphology, and identified using Jutting's guidance (Jutting, 1953).

Each species of Unionidae was described based on shell morphometric (i.e. the length, width, and height dimensions), as well as the exterior and interior characters of shell according to Jutting (1953). Length, width, and height dimensions of shells were measured using dial calipers; and the exterior and interior shells characteristic were observed using Olympus SZX9 microscope.

### Data Inumeration and Analysis

The number of individual of each species from each sampling station was recorded, then they were presented in used to calculated the units of abundance (number of individual/m<sup>2</sup>).

Dominance status of the mussel species was determined by dominance index (Di, in units of %), which is the quotient

between the value of species abundance ( $n_i$ , in units of individuals number/m<sup>2</sup>) with a total abundance of all species ( $N$ , in units of individuals number/m<sup>2</sup>) and multiplied with 100%, as in the following formula.

$$D_i = \frac{n_i}{N} \times 100\%$$

Dominance status of a species was determined by criteria of Torgersen et al. (2006), which is a species categorized as a “dominant” species when  $D_i$  more than 50%; sub-dominant species or “common” when  $D_i$  between 10–50%, and non-dominant species or “rare” when  $D_i$  less than 10%.

Population distribution of the Unionidae mussel species in Brantas River were described based on existence and abundance of each species at each sampling station along the Brantas River.

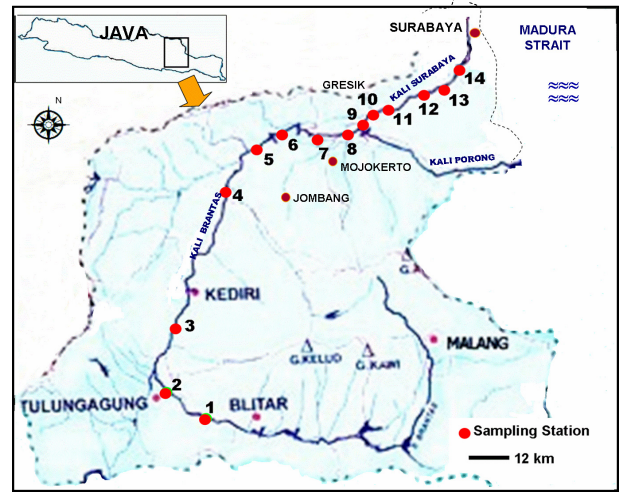


Figure 1. Map of sampling stations in Brantas River (take from Anonymous, 2013).

Table 1. Sampling locations of Unionidae mussels in Brantas Rivers, East Java.

Stations	Latitude, Longitude	Sampling sites (District/City)
1	S 08°07'04.8", E 112°06'48.5"	Rejo Tangan (Tulungagung)
2	S 08°03'14.1", E 111°57'39.4"	Sumber Gempol (Tulungagung)
3	S 07°56'23.4", E 111°57'39.4"	Mojo (Kediri)
4	S 07°34'05.8", E 112°07'31.1"	Patian Rowo (Kertosono)
5	S 07°29'14.2", E 112°12'14.3"	Plandaan (Jombang)
6	S 07°26'56.9", E 112°15'01.4"	Ploso (Jombang)
7	S 07°27'21.6", E 112°20'15.7"	Kesamben (Jombang)
8	S 07°27'22.3", E 112°26'22.5"	Mlirip (Mojokerto)
9	S 07°26'02.3", E 112°27'42.1"	Jetis (Mojokerto)
10	S 07°24'35.3", E 112°30'51.4"	Wringin Anom (Gresik)
11	S 07°23'53.9", E 112°31'23.6"	Wringin Anom (Gresik)
12	S 07°22'38.9", E 112°37'03.1"	Driyorejo (Gresik)
13	S 07°21'02.9", E 112°40'06.8"	Waru Gunung (Surabaya)
14	S 07°18'37.0", E 112°44'38.7"	Joyo Boyo (Surabaya)



Figure 2. Specimens of Unionidae mussels were collected from Brantas Rivers, sampling period from April to June 2012 (A. Examples of samples from one plot at Station 10; B. *Contradens contradens*; C. *Elongaria orientalis*; D. *Rectidens sumatrensis*; E. *Pseudodon vondembuschianus*; F. *Pilsbryconcha exilis*).

**RESULTS**

Along the study area, mussel were found only in 11 of 14 sampling stations, which start from Station 3 (Mojo, Kediri) to Station 13 (Waru Gunung, Surabaya (Table 2). The number of

all unionid mussels (samples per m<sup>2</sup>) in each station (without distinguishing different species) were varied, the lowest number was at Station 3 (5 individuals), and the highest at Station 10 (47 individuals).

Based on the morphology shells, it is known that there are five species of Unionidae mussels in Brantas River, those are *Conradens conradens*, *Elongaria orientalis*, *Pilsbryconcha exilis*, *Pseudodon vondembuschianus* and *Rectidens sumatrensis* (Figure 2).

The presence and abundance of each species at each sampling stations were varied. Sampling stations with the highest number of mussels species (5 species) are stations 10, 12, and

13, all of which are in the streams of Kali Surabaya (Figure 1). Station 10, is a station that not only supporting the highest number of individuals (47 individuals per m<sup>2</sup>), but also supports the overall of the freshwater mussels species in the Brantas River. The sampling station which supporting the lowest number of species is Station 3 with one species only, that was *C. conradens*, and with the lowest individual number of mussel specimens, which are only 5 individuals per m<sup>2</sup>.

Table 2. Abundance of each species (ni; individuals number/ m<sup>2</sup>), percentage of abundance (%), and total individuals of all the species (units: individuals number/m<sup>2</sup>) of the unionid freshwater mussels in each sampling station in Brantas River in April–June 2012 period.

Stations	Abundance (ni) and percentage of abundance (%) each mussel species in each sampling station										Individual total of all species	
	<i>Cc</i>		<i>Eo</i>		<i>Rs</i>		<i>Pv</i>		<i>Pe</i>			
	<i>ni</i>	%	<i>ni</i>	%	<i>ni</i>	%	<i>ni</i>	%	<i>ni</i>	%		
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	5	100	0	0	0	0	0	0	0	0	0	5
4	7	64	1	9	0	0	1	9	2	18	11	11
5	19	44	24	56	0	0	0	0	0	0	43	43
6	16	64	8	32	0	0	1	4	0	0	25	25
7	14	70	5	25	0	0	1	5	0	0	20	20
8	2	15	7	54	4	31	0	0	0	0	13	13
9	9	90	1	10	0	0	0	0	0	0	10	10
10	39	83	4	9	2	4	1	2	1	2	47	47
11	9	82	1	9	0	0	1	9	0	0	11	11
12	7	28	9	36	6	24	2	8	1	4	25	25
13	2	18	3	27	4	36	3	27	1	9	11	11
14	0	0	0	0	0	0	0	0	0	0	0	0

*Cc.* : *Conradens conradens*; *Eo* : *Elongaria orientalis*; *Rs* : *Rectidens sumatrensis*; *Pv* : *Pseudodon vondembuschianus*; *Pe* : *Pilsbryconcha exilis*.

Table 3. Data on abundance, dominance index, number of presence on sampling stations, and dominance status each species of unionid freshwater mussel in Brantas River in total with not distinguishing sampling stations.

Species	Abundance (individual/m <sup>2</sup> )	Dominance index (%)	Number of presence on sampling stations	Dominance status
<i>C. conradens</i>	9.21	58	11	'Dominant'
<i>E. orientalis</i>	4.5	28	10	'Common'
<i>R. sumatrensis</i>	1.14	7	4	'Rare'
<i>P. vondembuschianus</i>	0.71	5	6	'Rare'
<i>P. exilis</i>	0.36	2	4	'Rare'
<b>Total</b>	<b>15.93</b>	<b>100</b>	—	—

Table 4. Data of shell morphometric [length (L), height (H), and diameter (D)] species of unionid freshwater mussels in the Brantas Rivers, East Java, in April–June 2012 period.

Species	Shell Morphometric						Ratio L : H : D
	L (mm)		H (mm)		D (mm)		
	Range	Average	Range	Average	Range	Average	
<i>C. conradens</i>	29.8–64.3	49.2	15.8–43.0	26.3	09.6–35.3	16.4	3.0 : 1.5 : 1
<i>E. orientalis</i>	34.3–70.0	54.9	14.4–28.9	23.5	09.8–24.6	16.0	3.4 : 4.2 : 1
<i>R. sumatrensis</i>	51.6–74.9	60.8	21.6–31.2	25.5	12.7–21.4	17.0	3.6 : 1.5 : 1
<i>P. exilis</i>	33.9–61.31	42.3	14.9–25.3	18.4	8.6–22.5	12.6	3.3 : 1.4 : 1
<i>P. vondembuschianus</i>	37.6–85.4	59.5	10.0–28.2	64.4	10.4–28.2	33.0	1.8 : 1.9 : 1

Based on the presence and abundance of each mussels species in all sampling locations (Table 2; Figure 3), it was known that *C. conradens* is a species occupying the highest station number, which was at 11 sampling stations and are sequentially or continuously from the Station 3 to Station 13. A relatively high of individuals abundance there were at stations 5, 6, and 7, and a peak of individual abundance were at station 10. *C. conradens* has greatest abundance of individuals (9.21 individuals/m<sup>2</sup>) with dominance index of 58% (Table 3).

The species with second grades in terms of presence in sampling station numbers and abundance of individuals is *E. orien-*

*talis* which were found continuously at 10 stations, from station 4 to 13 (Table 2; Figure 3). The highest abundance of *E. orientalis* is in the station 5, and respectively followed by the stations 6, 8, and 12. Total individual abundance of this species from all (14) sampling stations is 4.50 individuals/m<sup>2</sup> and the dominance index is 28% (Table 3). Next species, are *R. Sumatrensis* with the total individual abundance of 1.14 individuals/m<sup>2</sup>, the dominance index of 7% (Table 2), and only occupies the 4 sampling stations (not continuous) (Table 1); *P. Vondembuschianus* with the total abundance of 0.71 individuals/m<sup>2</sup>, dominance index of 5%, and is found at 6 sampling stations



(not continuous), and *P. exilis* with the total abundance of 0.36 individuals/m<sup>2</sup>, dominance index of 2%, and is found at 4 sampling stations (not continuous).

Based on the dominance criteria of Torgersen *et al.* (2006), *C. contradens* is a 'dominant' species; *E. orientalis* is a 'common' or 'sub-dominant' species, whereas *R. sumatrensis*, *P. vondembuschianus*, and *P. exilis* are 'rare' or 'non-dominant' species (Table 3).

Shell morphometric data (Table 4) showed that body size di

mensions (length, height, and diameter of shells) of each species of Unionidae mussel in the Brantas River are as follows. *C. contradens*, reaching a body length of 64.3 mm, height of 43.0 mm, and 35.5 mm diameter reached; dimensional of shell size of *E. orientalis*: length, height, and diameter reached (70.0: 28.9: and 24.6 mm); *R. sumatrensis* (74.9: 31.2: 21.4 mm); *P. vondembuschianus* (85.4: 28.2: 28.2 mm), and *P. exilis* (61.31: 25.3: 22.5 mm). As shown in Table 4, the largest mussel in Brantas River was *P. vondembuschianus*.

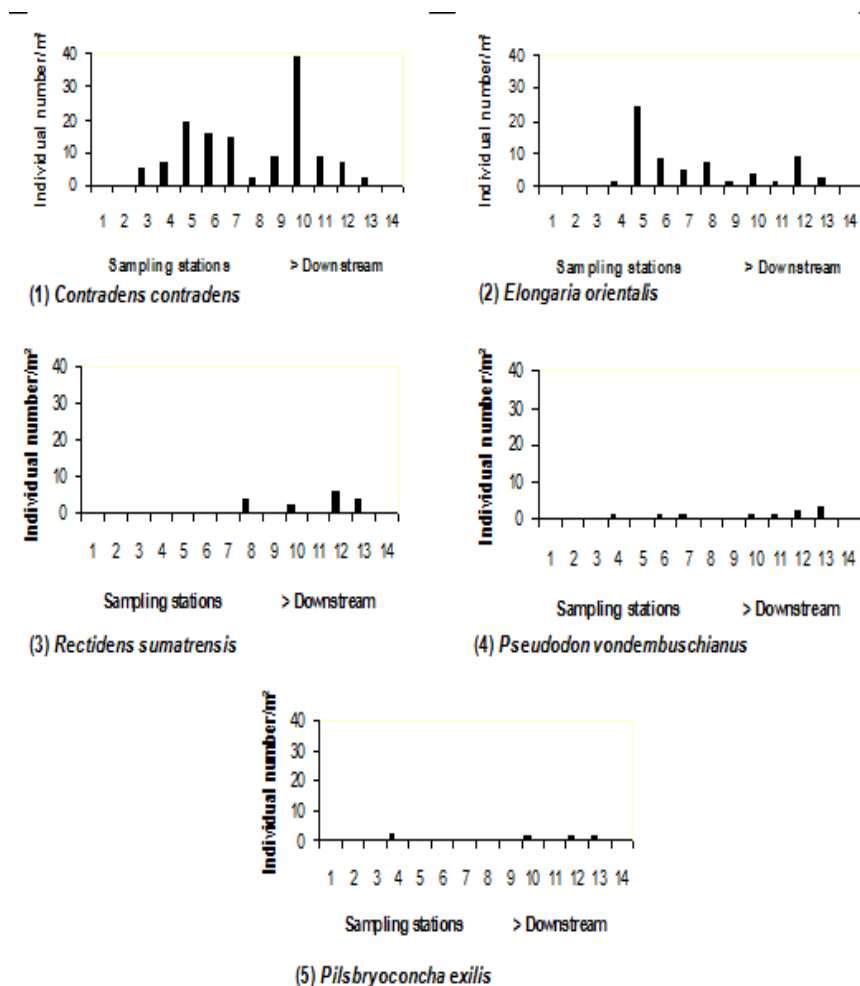


Figure 3. Distribution and abundance (individual number/m<sup>2</sup>) of each unionid freshwater mussels species along Brantas Rivers, East Java, in April–June 2012 period.

## DISCUSSION

There were five different species of the Unionidae mussels which successfully collected from Brantas River, those are *Contradens contradens*, *Elongaria orientalis*, *Pilsbryconcha exilis*, *Pseudodon vondembuschianus* and *Rectidens sumatrensis*. The five species of the Unionidae mussels were exactly same ever revealed by Jutting (1953). Or in other words, five species of Unionidae mussels in the Brantas River revealed by Jutting in 1953, all of them successfully collected back in the same location. Although Jutting (1953) did not specify describe the distribution of freshwater mussels in Brantas River in detail, but Jutting mentioned that the five species of freshwater mussels were exists in the area of Surabaya. The results also showed the same thing that the distribution of five species of Unionidae mussels in the Brantas River tend to be concentrated in the Kali Surabaya streams (Stations 10-13), and especially in Surabaya region (Station 13; Waru Gunung) which supports five different species of Unionidae mussels. However, there are indications of a decrease in the

range of distribution of mussels species that exist in the Brantas River, where *E. orientalis* has been reported by Jutting (1953) was presence in along dike of a Waduk Wlingi (Blitar district); and *P. exilis* was reported in Kali Mas (Surabaya city). But at this moment, it is no obtained an indication of the existence of those species in the same place.

Three of five species of the Unionidae mussels in the Brantas River were recorded in the list of 'IUCN Red List', i.e. *Rectidens sumatrensis*, listed in species category of 'Data Deficient' (<http://www.iucnredlist.org/details/189315/0>) (Bogan, 2011), which describes very few information about the distribution and/or population status of this species. So, it is very necessary and important to conduct further studies on this species. The next species is *Pilsbryconcha exilis* that be recorded in species category of 'Least Concern' (<http://www.iucnredlist.org/details/171874/0>) (Do, 2011), and similarly *Pseudodon vondembuschianus* also recorded in species category of 'Least Concern' (<http://www.iucnredlist.org/details/171886/0>) (Bogan, 2012). This information

showed that the distribution and abundance of these species are so limited, that required special attention to keep from decreasing.

The results showed that the population size of three species of these freshwater mussels in Brantas River is small, and also its distribution degree is limited. In total, *Rectidens sumatrensis* have an abundance of 1.45 individuals number/m<sup>2</sup> and compose 7% of all mussels' species in Brantas River, *P. vondembuschianus* has an abundance of 0.9 individuals number/m<sup>2</sup> and compose 5%, while *P. exilis*, abundance of 0.43 individuals number/m<sup>2</sup> and compose only 2% of the mussels of the Brantas River. *R. sumatrensis* and *P. exilis* occupy four of fourteen sampling stations in the Brantas River, while *P. Vondembuschianus* present at the six stations. Based on the abundance of individuals' number and dominance index, three species in the Brantas River are classified as "rare species" (Table 3). It still needs more information related to the factors that influence on the survival of Unionidae mussels species in Brantas Rivers, especially to threatened species.

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