Morfometric of *Placuna placenta* from Wulan Estuary, Demak, Indonesia

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Abstract. Bivalves are easily found along Central Java's coast and are an ecologically and economically important marine group of organisms. One of them was *Placuna placenta,* the Window Pane Scallops. It is commonly consumed, and the shell of this species is manufactured for many handicrafts. The present work reports the morphometric and size class of *P. placenta* in the Wulan estuary, Demak. The samples were collected using a dredge from seven sampling sites and then were measured for their shell length. The *P. placenta's* shell is considerably inequivalve, thin, fragile, almost equilateral, rounded to saddle-shaped, and extremely compressed laterally. The umbones are low and submedian, and the outer surface is relatively smooth, with lamellate growth lines and occasionally fine radiating threads. The density of *P. placenta* was found to be varied with the sampling sites. The highest density coincided with high chlorophyll-a and the small and large class groups living in sampling sites 1, 2, and 7 for the small and 5, 6, and 10 for the big, respectively. The existence of the small size group in some sampling sites showed that it was the nursery ground for this species. Hence, it is urged to be conserved to maintain its stock.

1 Introduction

Estuaries have substantial economic worth, and tourism, fishing, and other leisure activities can profit from their resources. Estuaries-protected coastal waters serve as harbors, ports essential for trade and transportation, and crucial public infrastructure [1]. A significant marine resource in the estuary is bivalves. They have critical roles in the ecology of soft-bottom estuarine communities through their water filtration activities, impact on sediment features, and affect species structure [2].

One economically important bivalve species in the Wulan Estuary is the Windowpane Oyster, *Placuna placenta*, locally named Kerang Srimping. They are often found in sandy or muddy substrates in shallow estuarine lagoons or small bays and are extensively collected in the Indo-West Pacific regions such as Indonesia. It has two highly transparent, disc-shaped flat mineralized valves [3], and its inner surface shell has a V-shaped ligament. The right valve is almost flat, while the left is slightly convex [4]. Because it has 71% protein [5], the flesh is commonly eaten as a protein source for coastal communities. This species' methanol, hexane, and ethyl acetate extracts showed antibacterial activities in *Staphylococcus aureus* FNCC 0047 and *Escherichia coli* FNCC 0091 [6].

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In Indonesia, the *P. placenta* shell is commonly treated as wasted but has a variety of uses. They could be processed into pharmaceutical substances as a source of vitamins and collagen [7, 8], and the chitosan from this shell could be used for fertilizer *Apium graveolens* L. [9]. But mainly, the shell was utilized as handicraft materials such as curtains, trays, lampshades, and numerous decorative items.

Bivalves like *P. placenta* comprise a significant fisheries resource component [10]. Its habitats most likely to be damaged by human activities are estuarine and coastal soft-bottom communities, such as the Wulan Estuary [11]. As a result, bivalves now act as crucial biomarkers of anthropogenic impact [12]. Hence, this work will discuss the morphometric and size class of *P. placenta* in the Wulan estuary.

2 Materials and methods of research

The research was carried out during June and August 2021. The samples of *P. placenta* were collected using a 1.3 m width dredge from eleven sampling sites in Wulan estuary, Demak, Central Java, Indonesia (Figure 1). The collected samples (dead/empty shell and alive) were then sorted. The specimens were preserved using formalin 5% for 24 hours and then in the laboratory with formaldehyde 70% for further analysis. They were identified according to [4] and [13], i.e., the shell is almost circular, ligaments nymphs of the right valve gradually diverging from each other, with the posterior ridge longer than the anterior.

The sample was then measured for its shell length in the Marine Biology Laboratory of the Marine Science Department Faculty of Fisheries and Marine Science at Diponegoro University. The data then were classified according to three size classes, i.e., small (<30mm), medium (30-60 mm), and large/adult (>60 mm) represented the juveniles, young, and adult classes [14]. The result of the size class was then plotted on the map to mark their habitat and nursery ground.

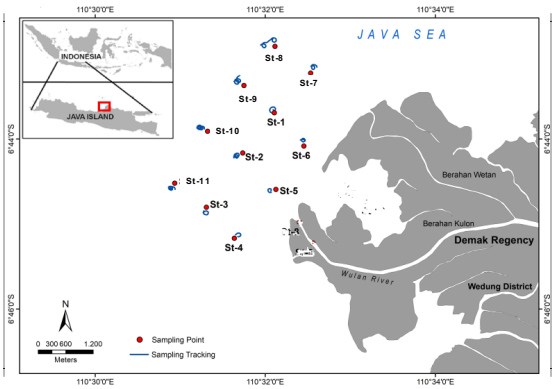


Fig.1. *Placuna placenta* sampling sites in Wulan Estuary, Demak

3 Results

Placuna placenta (Linnaeus. 1758) belongs to the Family of Placunidae. They are suspension feeders that inhabit calm, safe bays, and mangrove lagoons with muddy bottoms. Typically, they are lying with the right valve down. The following characteristics best describe the Placunidae. The right (lower) valve is flat or slightly concave, whereas the left (upper) valve is weakly inflated. The shell is thin and fragile, almost equilateral, rounded to saddle-shaped, extremely compressed laterally, and considerably inequivalve. Umbones are low and submedian [4]. The outer surface is relatively smooth, with lamellate growth lines and occasionally fine radiating threads. Perioatracum is discrete. The ligament is mostly internal,

forming an inverted V-shaped structure under the umbones, attached to ridge-like nymphs in the right valve and to corresponding grooves in the left. Hinge line straightish, without teeth. The interior of the shell is nacreous. They only have one rounded adductor muscle scar in the center of the inner shell. The pallial line lacked a sinus and was hazy. It has smooth internal margins.

The *P. placenta* in the Wulan Estuary has a thin and nearly round shell. The right valve's ligament nymph's rear ridge is longer than the anterior, and they gradually diverge from one another. Dead shells have tiny V-shaped structures inside that have unevenly sized legs. *P. ephippium*, which has a subquadrate, more squarish, or saddle-shaped shell, is occasionally mistaken for it [15]. The anterior and posterior ridges of the right valve's ligamentous nymphs are almost similar in length and rapidly diverge [16]. The size of the legs of the tiny V-shaped structures inside dead shells is similarly comparable.

The *P. placenta* lying on the surface of muddy to sandy-mud bottom, from low tide levels to a depth of 100 m. But in the Wulan Estuary, their habitat ranges were 2-20 m. In the Wulan Estuary, during June they were found in eight sampling sites, i.e. sampling sites 1, 2, 3, 5, 6, 7, 9, and 11. On August they were only found in sampling sites 1, 2, 6, 7, 8, 9, and 10. The density ranged from 0.08-5.7 ind.m^{-2} during June and 9,63-8,9 ind.m^{-2} in August (Figure 2). And they did not exist on Sampling Sites 4 and 8. The highest density in both months was in Sampling site 7. This is higher than found in Bela Estuary Indragiri Hilir Regency Riau Province [17], i.e., 0.1-0.7 ind.m^{-2}, and much higher than in Genuk Waters, Semarang [18], i.e. 0,0068-0,0582 ind.m^{-2}. Although [4] stated that this species is often found in dense communities, this did not happen in all sampling sites.

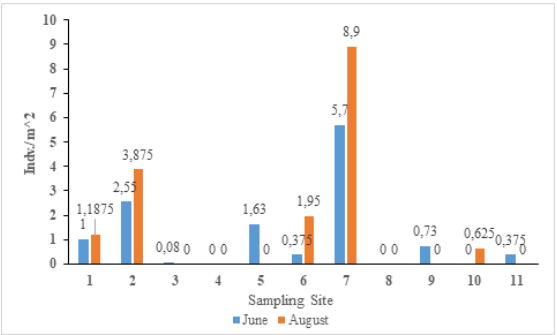
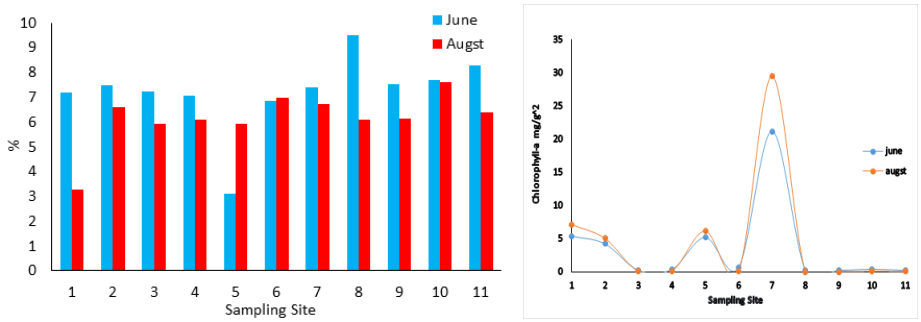


Fig.2. The density of *Placuna placenta* (ind.m^{-2}) in the Wulan Estuary

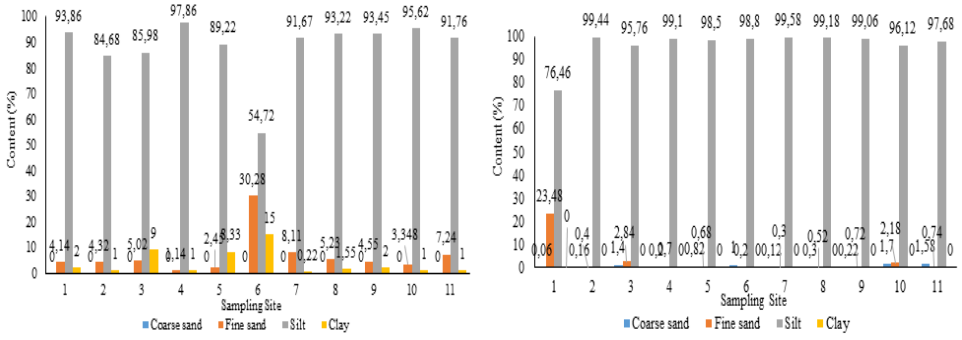
The total organic matter (TOM) and chlorophyll-a of the sediment were presented in Figure 3. It shows the variation of TOM among the sampling sites. Generally, the concentration of TOM was higher in June than in August, and on the contrary for Chlorophyll-a. The highest chlorophyll-a was in sampling site 7 with the highest density of *P. placenta*. [17] also found that the biggest density of this species was in the station with high phytoplankton concentration in the waters.

The sediment characteristic of the habitat of *P. placenta* in Wulan Estuary is presented in Figure 4. During both sampling months, the sediment was silty (>80%). This is similar to [17] work in the Bela estuary, Riau. Although bivalves prefer living microalgae, detritus might still be part of their diet [19]. *P. placenta* is a filter feeder that consumes organic debris, zooplankton, and phytoplankton [13]. Their primary food sources in their benthic environment can change throughout the year as a result of pelagic microalgae and organic matter sedimenting during slack tides and/or calm weather, the benthic matter being resuspended by wind and tides, and facultative deposit-feeders' seasonal burrowing behavior [20, 21, 22]



A B

Fig.3. The Total organic matter (%) (A) and Chlorophyll-a (mg/g) (B) of sediment at the sampling Site



A B

Fig.4. The Grain size concentration (%) of bottom sediment at the sampling Site during June (A) and August (B)

Overall, the shell length of *P. placenta* from Wulan Estuary was 1,2-10 cm, a specimen of June was 1,5-10 cm, and August was 1,2-9,8 cm (Table 1) . The translucent adult shell length of *P. placenta* was 10-18cm [4][16]. Same as in India, though reported in lengths between 11 to 13.9 cm, it is scarce. The result of the shell length size class revealed that there are some sampling sites (1, 2, and 7) dominated by small classes (< 3cm) during both sampling months (Table 2). The adult *P. placenta* size of > 6 cm was found in sampling sites 5 and 6 during June, and sampling sites 6 and 10 during August. When the data was put on the map, it could be seen that the sampling site with the small size *P. placenta* was located in one line, which presented as a nursery ground for this species (Figure 5).

Table 1. The Shell length of *Placuna placenta* (cm) in Wulan Estuary, Demak

Month	**Sampling Site**									
	1	**2**	**3**	**5**	**6**	**7**	**9**	**10**	**11**	**Min - Max**
June	1.6-7.5	1.8-8.05	6.5-7.1	5.9-8.7	4.8-10.0	1.5-9.0	5.5-8.0	-	2.0-8.5	1.5-10.0
August	1.5-8.9	2.3-8.67	-	-	3.6-9.8	1.2-9.7	-	2.3-5.7	-	1.2 9.80

Note: There were no *P. placenta* in Sampling sites 4 and 8.

Table 2. The Shell length Class of *Placuna placenta* (individual) at the sampling Site

Month	**Size class**	**Sampling Site**								
		1	**2**	**3**	**5**	**6**	**7**	**9**	**10**	**11**
June	< 3. 0	52	136	0	0	0	306	0	0	6
	3.1 – 6.0	4	57	0	4	2	24	8	0	2

	> 6.1	24	11	6	126	28	126	50	0	22
Total		80	204	6	130	30	456	58	0	30
Month	Size Class	Sampling Site								
		1	2	3	5	6	7	9	10	11
August	< 3. 0	44	187	0	0	0	547	0	0	0
	3.1 – 6.0	8	67	0	0	67	45	0	2	0
	> 6.1	43	56	0	0	89	120	0	48	0
Total		95	310	0	0	156	712	0	50	0

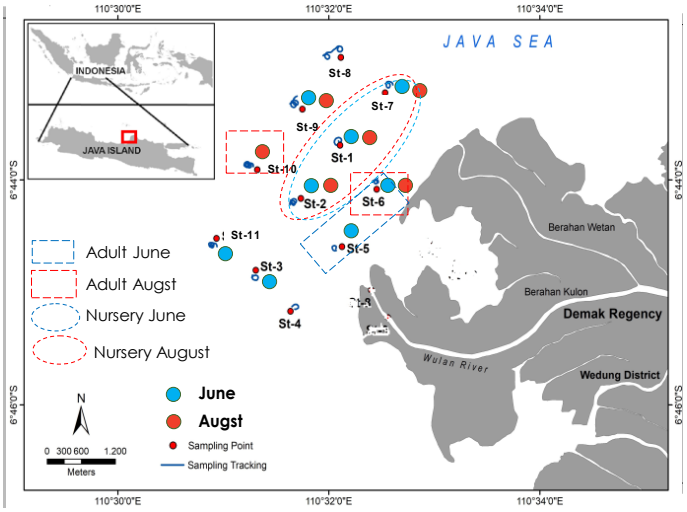


Fig.5. Sampling Sites with Juvenile and Adult *P. placenta* found

Study on *P. placenta* is still limited in Indonesia. In India, the size of *P. placenta* at first maturity is 6,8 cm in length for both sexes [13], and in the Philippines, it matures at a size of about 70 mm [23]. Adult *P. placenta* is ready to spawn at a size of 6-10 cm [24]. Hence, the sampling sites 5, 6, and 10 may be the spawning ground where the adult lives (Figure 5). The Windowpane oyster is a partially spawning type of bivalve. In Indonesia, such as in Makassar and Pangkajene Kepulauan Waters of South Sulawesi it is carried out from October to March [25]. Along the Okha coast in India, it spawns at the onset of the northeast monsoon in October [13].

After being spawned and fertilization, the larvae were in planktonic form. The larvae often undergo metamorphosis at 220-230 um, distinguished by the velum's removal and the emergence of an active foot [24]. Additionally, metamorphosed larvae dispersed exceptionally transparent and thin dissoconch development that was distinct from the prodissoconch by a small black ring. At the moment of metamorphosis, the settling larvae probably adhere bysally to the water's top and spend some time as plankton before settling on the mud bottom.

At around 600 µm, when the "sleeve" first appears on the antero-dorsal boundary of the shell, *P. placenta* enters its final sedentary stage of life history. In contrast to how mud is typically described, organisms live beneath a layer of mud or silt that is typically 15 to 20 mm thick on their shells in their natural habitat. The only way to tell if an organism is present is by the shallow semicircular depression in the mud corresponding to the area the organism's foot is cleared to keep the edges of its shell clean. Young animals' burrowing behaviors show that the animal's purposeful efforts to blend in rather than mud collecting on the shells are what really affects this camouflage. The settling larvae developed into juveniles in the nursery ground of Sampling sites 1, 2, and 7 in Wulan Estuary.

Bivalve, such as *P. placenta* has many functions in the estuary. By filtering and removing particles from the water column, bivalves, which are filter feeders, increase the clarity of the water. The inedible particles are mucus-bound and expelled as pseudofeces, while the edible particles are eaten and then excreted as feces. The sediments are enriched with bioavailable carbon and nitrogen in either situation because the particles are pulled from the water column and deposited into the benthos [26]. In addition to boosting an area's amenity value, better water clarity can promote the development of seagrasses and an abundance of phytoplankton, which serve as valuable habitats and food [27]. In the meantime, adding nutrient-rich substances to the sediments encourages denitrifying bacteria to work harder to change physiologically active nitrogen into inert dinitrogen gas. In addition, the increased structural complexity around the reef and the shell surface area create numerous places where anaerobic and aerobic activity can coexist [28].

The Windowpane oyster has a role in maintaining a balanced ecosystem through trophic levels. In the ecological chain, it is one food source for crustaceans and carnivore fish of the grouper group such as the family Lutjanidae [29]. Like other Indo-Pacific countries, Indonesia has extensively collected *P. placenta* from the wild. In other countries, such as the Philippines, the research on this species is not only focused on the stock assessment but also the development of hatchery and grow-out technology [23]. As the stock might be reduced caused of heavy exploitation, an attempt at conservation should be made, such as protecting the nursery and spawning ground and applying more environmentally friendly fishing gear.

4 Conclusion

The density of *P. placenta* in Wulan Estuary varied with the sampling sites. The highest density coincided with high chlorophyll-a and the small and large class groups living in sampling sites 1, 2, and 7 for the small and 5, 6, and 10 for the big, respectively. The existence of the small size group in some sampling sites showed that it was the nursery ground for this species. Hence, it is urged to be conserved to maintain its stock.

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