Research Article

Population Structure and Length-Weight Relationships of *Anadara granosa* and *Meretrix lamarckii* from the Bay of Bengal

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Abstract | Mussels play a significant role in marine benthic ecological construction because they accumulate into beds, changing the nature and intricacy of the bottom. Population structure and length-weight relationships of two mussels (*Anadara granosa* and *Meretrix lamarckii*) in the Bay of Bengal, Bangladesh were investigated based on occasional data from January to December 2020. Samples were collected from the sampling sites (Sathkhira and Cox'sBazar) with the help of laborer in the presence of Principal investigator and research assistant. This study also revealed the maximum recorded length of *A. granosa* and first report of *M. lamarckii* from the worldwide water bodies. We observed maximum length of *A. granosa* was 7.50 cm (maximum recorded length) and 6.83 cm for *M. lamarckii*. Allometric coefficient (*b*) value was 2.61 and 2.83 for *A. granosa* and *M. lamarckii*, respectively that indicating the growth was negative allometric for both species. This study would be helpful for the fisheries researcher and biologist to conserve and sustainable management of these species.

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Introduction

Marine habitats are the main aquatic ecosystems on Earth that are marked by water with a high salt content. These environments compete with habitats in freshwater, which have a smaller content of salt. Marine waters occupy about 70 % of the Earth's surface and provide for about 97 % of the Earth's water supplies and 90 % of the Earth's habitable ground (Facts and Figures, 2018). Marine habitats involve near-shore environments such as salt marshes, mudflats, seagrass meadows, mangroves, intertidal rock systems and coral reefs (United Nations, 2017). Bangladesh has an approximately 710 km long coastline and an Exclusive Economic Zone (EEZ) of 121,110 km^2, distinguished by uniquely distinct habitats of considerable ecological and economic value and potential (Islam and Shamsuddoha, 2018; Mawa *et al*., 2021). Bangladesh's coastal fauna consists of a total of 453 species of animals, 42 species of rodents,

35 reptiles and 8 species of amphibians. To date, a total of 301 mollusk species and over 50 economically significant crustacean species and 76 estuarine fish species have been reported in the coastal region (Quader, 2010). Mollusk populations make up an important portion of the world's fisheries today. They are of considerable importance to humans, and several animals in the national economy will play a key role. From the perspective of food alone, since prehistoric times, mollusks have been of great significance to people. Meat from mollusks is commonly used as marine food for humans. In addition to this, for a host of other uses, mollusks are still used. Some bivalves, such as pearl oysters, produce natural pearls with prices of up to several hundred dollars each. Mollusks are also used for lime, meat, shrimp and fish feed preparation (Shahabuddin *et al.*, 2010). Through filtration, mussels decrease the concentration of seston and release ammonia, a beneficial phytoplankton resource, into the water through excretion (Malathi and Thippeswamy, 2013). Mussels therefore play a significant role in the transfer of energy and matter at large population densities. The blood cockle is a filter fed species and heavy metal exposure of the extremely active mudflats continues to collect into their body. This might be a major heavy metals sink in the ecosystem, as well as a sign of river pollution (Liu *et al.*, 2003). *M. Lamarckii* is an essential mollusk of marine bivalves with abundant protein and useful medicinal properties, commonly known as delicious seafood (Zhang *et al.*, 2014). With the adult becoming benthic and relatively immobile, it has a limited pelagic level of around 5-6 days (Shao *et al.*, 2017).

Population structure helps to compare morphological features among species or different stocks of same species from different habitats (Hossen *et al.*, 2019; Sabbir *et al.*, 2020). It is also act as an indicator of species stock status and breeding period (Ranjan *et al.*, 2005). Length-weight relationships (LWRs) is very essential for the studies on stock assessment and population dynamics (Hossen *et al.*, 2019; Sabbir *et al.*, 2020) which allow the calculation of weight consistent to a given length (Hasan *et al.*, 2020). Length-weight relationships (LWRs) are a simple method to convert length observation into predictive weight when it is difficult to record weight in the field which is also useful for stock assessment models (Pauly, 1993). Furthermore, the LWRs are mostly helpful for the researcher for observing the well-being of fishes (Ecoutin *et al.*, 2005; Islam *et al.*, 2020; Hasan *et al.*, 2020; Hassan *et al.*, 2020).

Although there are some works have been done of these species on different aspects but there was no study at a time from two habitats. The main goal of this study illustrates the population structure and length-weight relations of two mussels (*A. granosa* and *M. lamarckii*) from the Bay of Bengal, Bangladesh.

Materials and Methods

Sampling and measurement

Samples were collected from the Bay of Bengal (Figure 1) *A. granosa* was collected from the Sundarban mangrove forest coastal region and *M. lamarckii* from the Cox's Bazar region of Bay of Bengal during January to December 2020 with help the commercial fishers. For each individual, total shell length (SL) and total body weight (BW) were taken using digital slide calipers (0.01 cm) and an electronic balance (0.01 g).

Population structure was estimated by length frequency distribution (LFD). The LFDs were constructed using 0.5 cm intervals of SL.

LWR was estimated by: $W = a \times L^b$. We also estimated, 95% confidence limits of a and b and co-efficient of determination (r^2). According to Froese (2006) extremes outlier were minimized from the regression analyses.

Microsoft Excel and Graphpad prism was used to produce figures and statistical analysis, respectively. The level of significance at 5% ($p<0.05$) was considered for all statistical analyses.

Results and Discussion

Population structure

Length frequency distribution of *A. granosa* and *M. lamarckii* was shown in Figure 2. A total 830 (*A. granosa*) and 230 (*M. lamarckii*) specimen were collected to accomplish this study. Shell length (SL) range was 2.50-7.50 cm for *A. granosa* 2.64-6.83 cm for *M. lamarckii*. Most of the individuals were found in 4.0 to 5.0 cm for *A. granosa* and 4.50-5.50 cm for *M. lamarckii*. The maximum length (7.50 cm) of *A. granosa* was the recorded maximum length of all the past works of this species (Table 1).

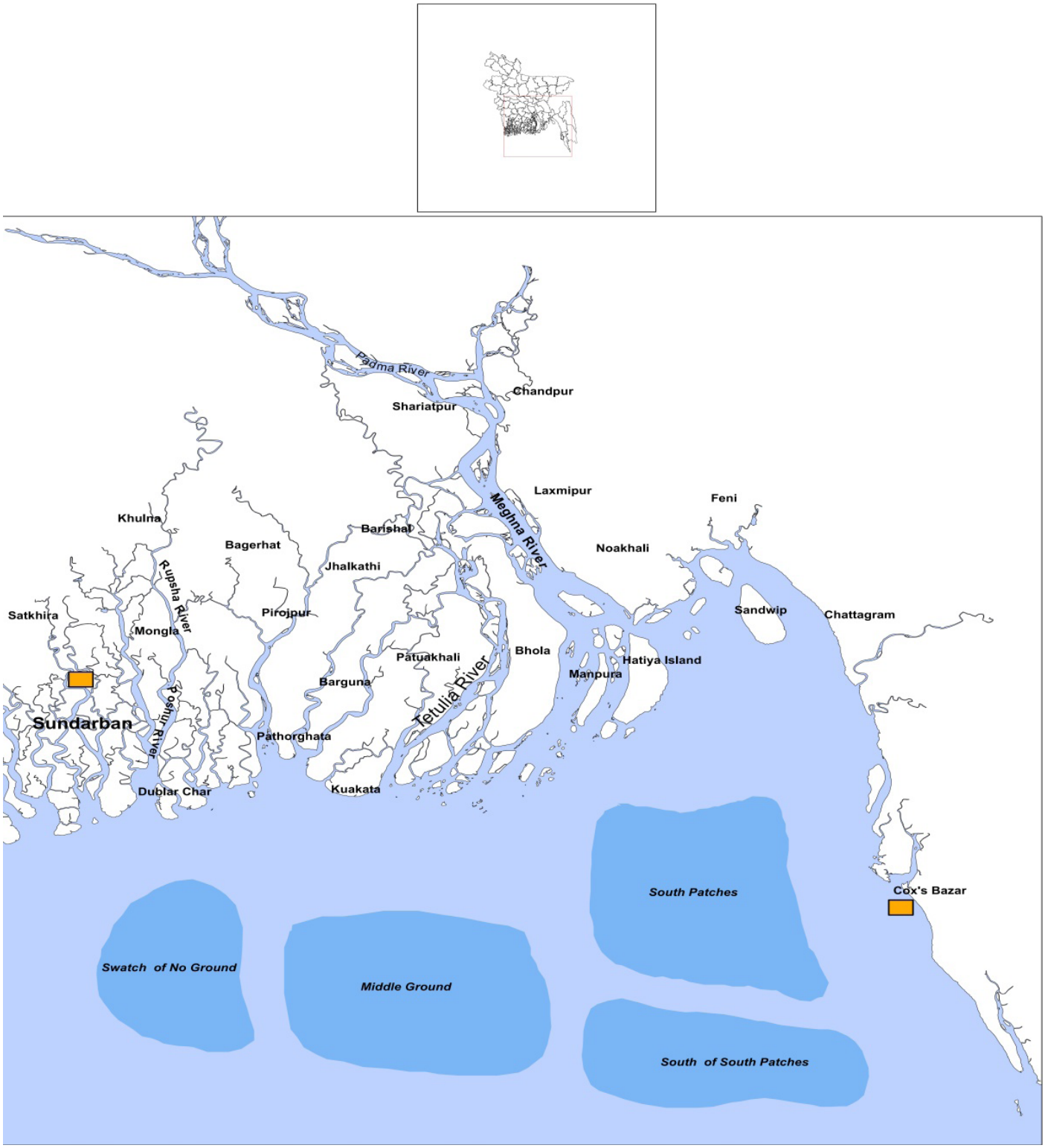

Figure 1: *Sampling sites of Anadara granosa and Meretrix lamarckii from the Bay of Bengal (Rectangular indicate the sampling stations).*

Length-weight relationship (LWR)

Shell total length and body weight, regression parameters (*a* and *b*), and 95% confidence level, and coefficients of determination (r^2) of mussels were showed in Table 2. The LWR displayed BW = $0.7765(TL)^{2.61}$ (r^2=0.969) and BW = $0.3538(TL)^{2.83}$ (r^2=0.853) for *A. granosa* and *M. lamarckii,* respectively by the plotting of length against weight values (Figure 3). We found, *a* was 0.7765 for *A. granosa* and 0.3538 for *M. lamarckii*, and *b* was 2.61 for *A. granosa* and 2.83 for *M. lamarckii* that indicating the growth was negative allometic for both species in the Bay of Bengal. We also observed, highly correlation between TL *vs*. BW for both *A. granosa* (r_s=0.981 and p=<0.0001) and *M. lamarckii* (r_s=0.886 and p=<0.0001).

Population structure and length-weight relationships (LWR) of *A. granosa* from Bay of Bengal and

Table 1: *Maximum length of blood cockles Anadara granosa derived by other authors in different study areas.*

Location	Maximum shell length (cm)	Reference
Penang Island, Malaysia	3.75	Pathansali (1966)
Kuala Juru, Malaysia	3.10	Oon (1980)
Kuala Sepetang, Malaysia	3.05	Oon (1980)
Kuala Selangor, Malaysia	4.12	Broom (1985)
Kakinada Bay, India	4.95	Narasimham (1988)
Blue Mud Bay, Australia	4.12	Faulkner (2009)
Penang Island, Malaysia	3.15	Mirzaei *et al.* (2014)
Bay of Bengal, Bangladesh	7.50*	Current study

**New maximum recorded length from the natural habitat*

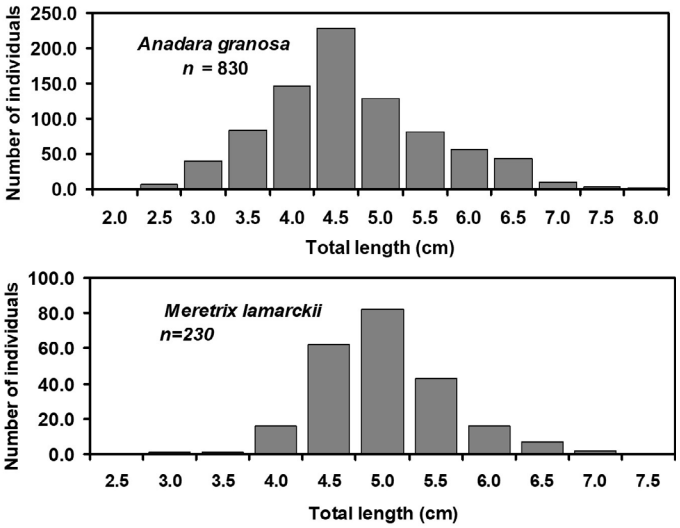

Figure 2: *Length-frequency distributions of Anadara granosa and Meretrix lamarckii from the Bay of Bengal*

M. lamarckii from any waters bodies of the world are not available in the literature. Therefore, for the first time, this study provides information on population structure and LWR of two mussel species from the Bay of Bengal. A total of 830 (*A. granosa*) and 230 (*M. lamarckii*) individuals were collected for the performed this research. In this study, maximum shell length was 7.50 cm for *A. granosa*, which was larger than all previous recorded maximum length *i.e.* Pathansali (1966) reported that the length of *A. granosa* was 3.75 cm in Penang Island, Malaysia. Oon (1980) revealed 3.1 cm in Kuala Juru, Pulau Pinang and 3.05 cm in Kuala Sepetang, Perak. Broom (1985) reported 4.12 cm in Kuala Selangor, Malaysia. Narasimham (1988) described maximum length as 4.95 cm in Kakinada Bay, India. Faulkner (2009) reported maximum length was 4.12 cm in Blue Mud Bay, Australia. Mirzaei *et al.* (2014) revealed that the maximum length was 3.15 cm in Malaysia, Balik Pulau. In that case of *M. lamarckii* we found the maximum length 6.83 cm SL. It is not possible to compare due to the lack of available literature on this species (*M. lamarckii*).

Our research will be used by fisheries managers, biologists, and conservationists to develop suitable management strategies and regulations for the long-term protection of these two mussel species in the Bay of Bengal and surrounding ecosystems.

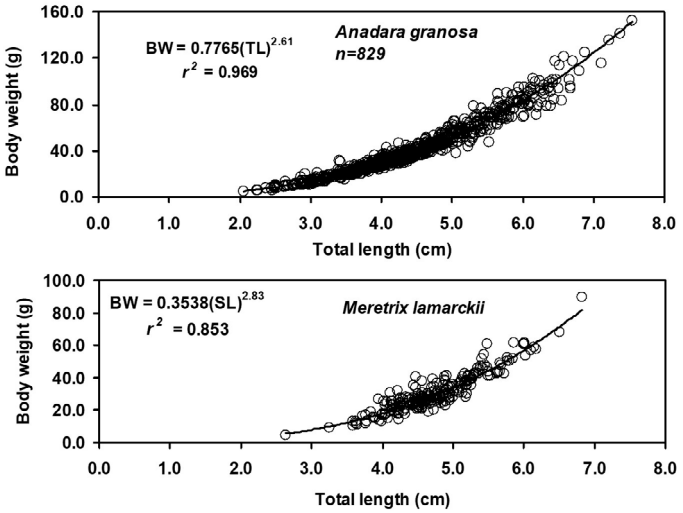

Figure 3: *Length-weight relationships of Anadara granosa and Meretrix lamarckii from the Bay of Bengal.*

Acknowledgments

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Table 2: *Descriptive statistics and estimated parameters of length-weight relationships of Anadara granosa and Meretrix lamarckii in the Bay of Bengal, Bangladesh.*

Species	n	Shelll length (cm)		Body weight (g)		Regression parameters		95% CL of a	95% CL of b	r^2
		Min	Max	Min	Max	a	b			
Anadara granosa[A]	830	2.50	7.50	4.89	152.13	0.7765	2.61	0.7411-0.8135	2.5783-2.6417	0.969
Meretrix lamarckii[B]	230	2.64	6.83	4.80	89.77	0.3538	2.83	0.2786-0.4491	2.6803-2.9878	0.853

[A], First report of LWR in Bay of Bengal; [B] First report of LWR in the world wide; a and b regression parameter; CL, confidence limit; n, number of specimens; r^2 co-efficient of determination

Novelty Statement

This the first report of population structure and LWR for *Meretrix lamarckii* in the world wide waterbodies and for *Anadara granosa* in the Bay of Bengal.

Authors' Contribution

Muhammad Rabiul Hasan and Zannatul Mawa: Conceptualized the review and analyzed the data.
Muhammad Rabiul Hasan and Muhammad Ashekur Rahman: Collect data.
Muhammad Rabiul Hasan: Wrote the manuscript.
Muhammad Yeamin Hossain: Edited the manuscript.
Selina Yeasmin and Yahia Mahmud: Reviewed the manuscript.
Finally, all authors read, revised, and approved the manuscript.

Conflict of interest
Authors declared that there is no conflict to publish this article.

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