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Distribution and Fishing Pressure of Hard Clam, *Meretrix Meretrix* in Marudu Bay, Sabah

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Abstract

Marudu Bay is situated within the Tun Mustapha Marine Park and the Malaysian region of the Coral Triangle Area. The bay is known for its diversed fisheries resources including bivalves. Although some of these bivalves species are commercially important, their distribution, fishing pressure and stocking status are not well documented. Hence, the current study was conducted to determine the occurrence, distribution and the stock status of one commercially important clams, Asian hard clam, *Meretrix meretrix* at the bivalve fishing grounds at the pocket part of the Marudu Bay. Samplings were conducted using a fishing gear locally known as "*kerek"* covering an area of 500 sequare meter per sampling site. The results of the current study indicated that *M. meretrix* was the dominant clam species in the fishing grounds. It was noted that *M. meretrix* in most of the sampling sites was heavily exploited and could reach to a state of beyond recovery if no appropriate fishery management plan is immediately introduced. Moreover, current study also noticed that the fishing gear, *kerek* used by local fisherman for harvesting clam is destructive and might pose a threat to non-target individuals such as juvenile *M. meretrix* and any other creatures that share the same habitat.

Keywords: *Meretrix meretrix*; Marudu Bay; Size distribution; Fishing pressure

1.0 INTRODUCTION

The coastal waters of Sabah particularly Marudu Bay are known to contain high species diversity including bivalves (Zakaria and Rajpar, 2015). Some of these bivalves particularly the Asian hard clam, *Meretrix meretrix*, is a commercially important species (Liu et al., 2006) and currently under fishing pressure. *M. meretrix* are usually collected from the coastal environment by fisherman and sold to seafood restaurants and local wet markets throughout Sabah. Continuous harvesting of the natural stock of bivalve has been reported to threaten the sustainability of the valuable marine resources (Tan and Ransangan, 2016a). The demand for such seafood is expected to increase in the near future as the tourism industry in Sabah becomes popular to both international and local tourists (Said, 2011). In addition to biodiversity, seascape, landscape and cultural diversity, the abundance of seafood is also one of the factors that attract tourists to visit Sabah (Tan and Ransangan, 2016bc).

Increasing seafood demand will pose threat to the natural populations of many seafood resources in coastal areas of Sabah. This is because the fishing activity for molluscs will be intensified in order to satisfy market demand. This condition will become worse in the absence of good fishery management plan for the resources. However, in order to develop such a management plan, information on biology, reproduction and distribution of the species must first be well understood. Unfortunately, very little is known about the abundance, reproductive cycle (maturation, spawning season) and distribution of bivalve species in the coastal areas of Sabah. Such information gap is a hindrance to developing a good fishery management plan for bivalve in Sabah. If this situation is not tackled prudently, these remarkable yet highly demanded seafood resources will soon be depleted to a state beyond recovery.

Despite vast information gap, in this study, we will only be focusing on gathering information that lead to understanding of abundance and distribution of *M. meritrix* in the sandy shoreline at the mouth of Marudu Bay. The finding of current study is very crucial in providing directions for future studies.

2.0 MATERIALS AND METHODS

2.1 Study Area

Marudu Bay (6°35’ to 7° N and 116°45’ to 117° E) is situated within the Tun Mustapha Marine Park, the largest marine protected area in South East Asia, and part of the Malaysian region the Coral Triangle Initiative (Tan and Ransangan, 2015 and 2017). Marudu bay has a total area of 800,000 hectares and rich in biodiversity. It has a tropical climate with uniform temperature, high humidity and abundant rainfall due to its proximity to the equator. Ten sampling stations were positioned as shown in Figure 1. The selected sampling stations are the common fishing ground for local fishermen to harvest bivalves. Southwest coast of Marudu Bay is covered by 9,550 ha of mangrove forest (Zakaria and Rajpar, 2015). East coast of Marudu Bay is relatively more developed compared to west coast, where many light and small medium industries can be found along the coastal area (Tan and Ransangan, 2016a).

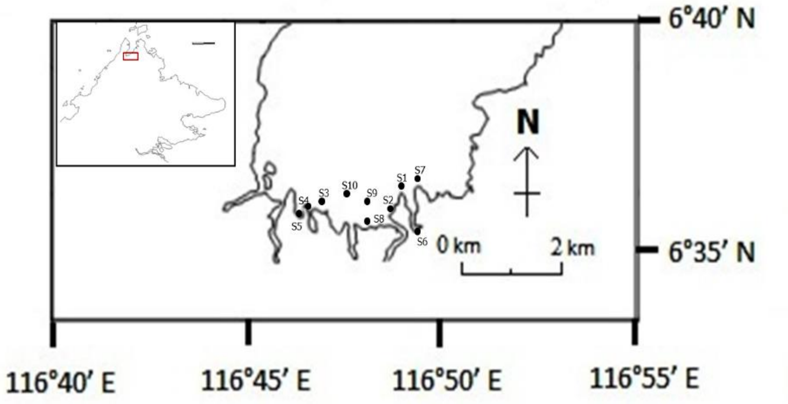

Figure 1: Sampling stations within the mouth of Marudu Bay.

2.2 Sampling

Systematic surveys were carried out from 8th to 14th May 2017 during low tide according to Gaza et al. (2014). Bivalves were collected at sandy shorelines which covered an area of 500 m^2 (50 m x 10 m) per site. Clam fishing gear locally known as "*kerek*" with blade measurement of 25 cm x 5 cm and a penetration below sand surface of about 15 cm was used to obtain the buried clams (Figure 2). The clam specimens were then placed in labelled plastic bags and stored at 4˚C, and then transported to the laboratory for analysis within 24h. In the laboratory, the samples were sorted and washed to remove all adhering organisms and other debris

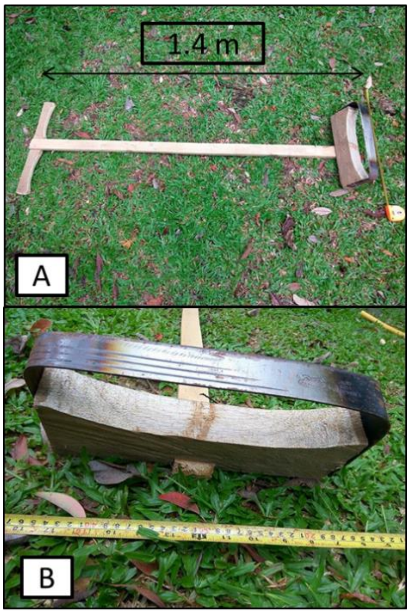

Figure 2: (A) Top view of "*kerek*"; **(B)** The Iron blade of "*kerek*"

2.3 Bivalve Identification and Measurement

All clam specimens were identified and counted. Individual specimens were measured for shell length, shell width and shell height with vernier caliper to the nearest 0.1 mm. The maximum dimension of the anterior–posterior axis was recorded as shell length, the maximum lateral axis as shell width and the maximum distance between the valves when they are closed was considered as height. Few representative individuals were preserved in 70% alcohol for further identification in the UMS laboratory according to Morris (1966), Keen (1971) and Skoglund (1992).

2.4 Sediment sampling

Surface sediment of 100 g was collected and stored at 4˚C. In laboratory, sediment subsample of about 50 g was air dried at room temperature, grinded and mixed thoroughly. The sediment particle size and clay-silt percentage were measured by a laser diffraction particle size analyzer (Sequola, Canada) according to Agrawal and Pottsmith, (2000).

2.5 Statistical Analyses

Statistical analyses were performed using the SPSS Windows Statistical Package (version 21). Tests were considered significant at $p<0.05$. Prior to analyses, all variables were tested for normality and homogeneity of variances. One-way ANOVA was used to test for significant differences among sites for sediment clay-silk composition and shell length. The shell length distribution of *M. meretrix* in each station was illustrated in a histogram, skewness and kurosis were calculated according to Groenveld and Meeden (1984).

3.0 RESULTS

3.1 Sediment grain size

The silt-clay composition of the sediment of the sandy shoreline at the bay pocket of Marudu Bay ranged from 5.50 to 61.31% (Figure 3). The silt-clay composition at stations 5, 6 and 10 (5.50 to 14.10%) were significantly lower ($p<0.05$) than that in other stations (45.98 to 61.31%).

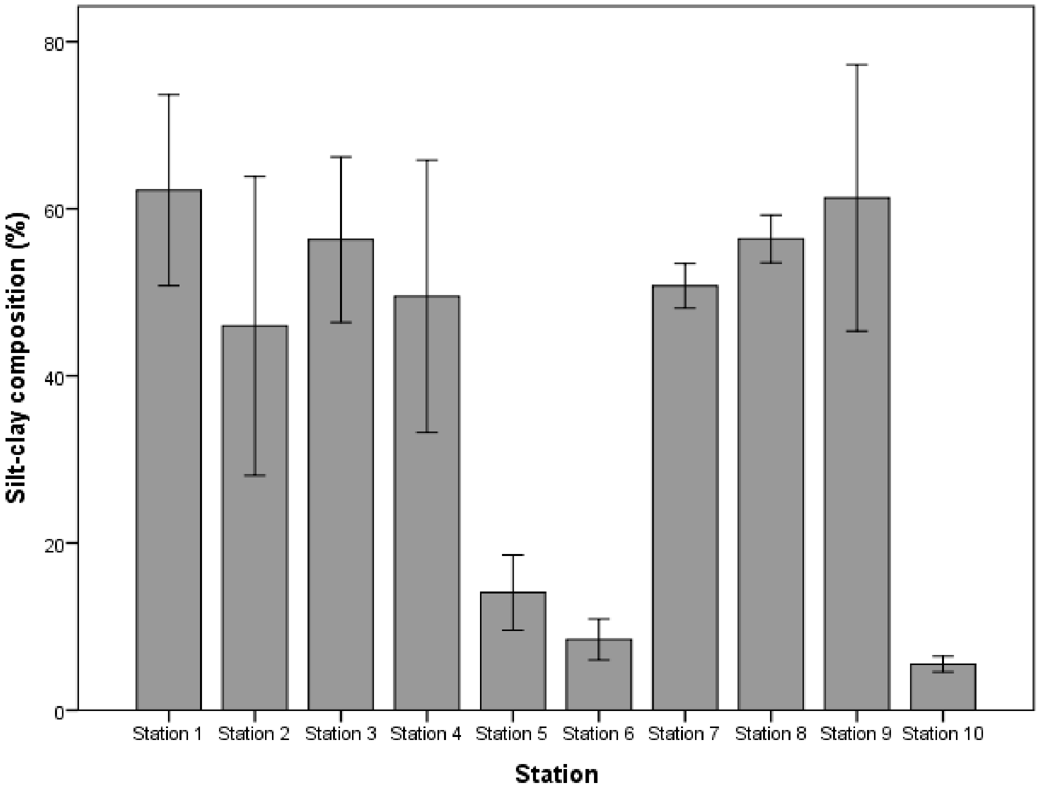

Figure 3: Silt-clay composition in the sediment of sandy shoreline at the mouth of Marudu Bay

3.2 Occurrence of bivalves at sandy shoreline

Occurrence and abundance of bivalves in the sandy shoreline at the bay pocket of Marudu Bay is illustrated in Figure 4. *Meretrix* sp. was found to be the most abundance bivalve species followed by *Artica* sp. and *Anadara* sp. In general, *Meretrix* sp. is widely distributed and occurred throughout the sandy shoreline at the bay pocket of Marudu Bay. However, the occurrence frequency for *Artica* sp. and *Anadara* sp. was only 60% and 20%, respectively. The density of bivalves in stations 2, 4 and 8 (20 to 25 ind/ 500 m^2) were significantly lower ($p<0.05$) than that in other stations (36 to 69 ind/ 500 m^2).

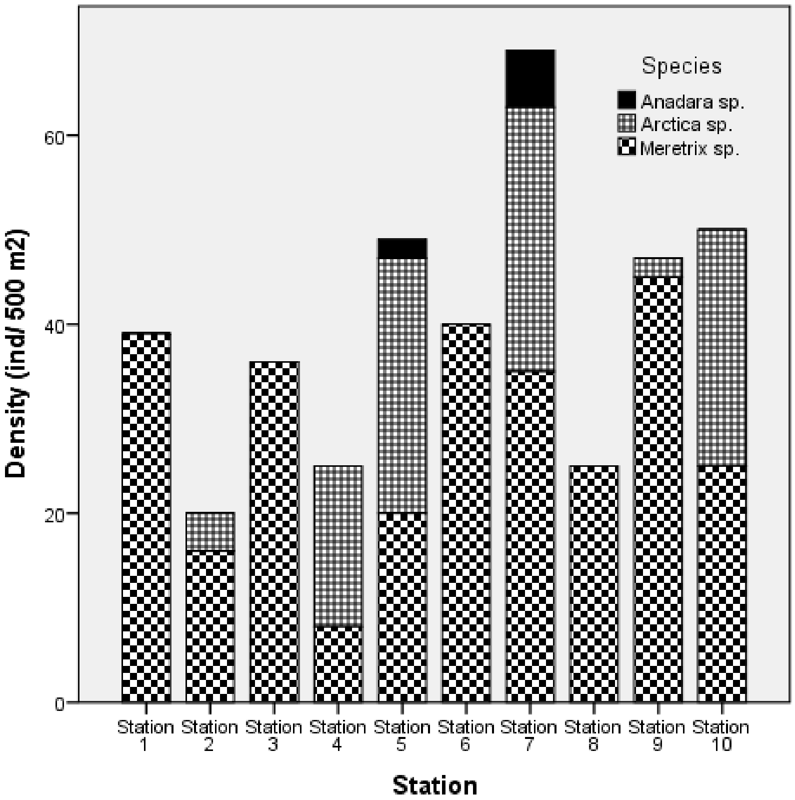

Figure 4: Density of bivalves at the mouth of Marudu Bay

3.3 Morphometric measurement analysis

Meretrix sp. in stations 8 and 10 were found to have significantly higher ($p<0.05$) and lower ($p<0.05$) length/ width ratio (1.57 to 1.63 vs 1.10 to 1.17, respectively) and length/ depth ratio (1.09 to 1.22 vs 1.62 to 1.86, respectively), respectively than that in other stations (Figure 5). *Arctica* sp. in station 10 recorded significantly higher ($p<0.05$) and lower ($p<0.05$) length/ width ratio (1.43 vs 0.94 to 1.01, respectively) and length/ depth ratio (1.01 vs 1.31 to 1.42, respectively), respectively compared to other stations. Whereas, no significant different ($p>0.05$) was recorded in length/ width or length/ depth ratio of *Anadara* sp. among stations.

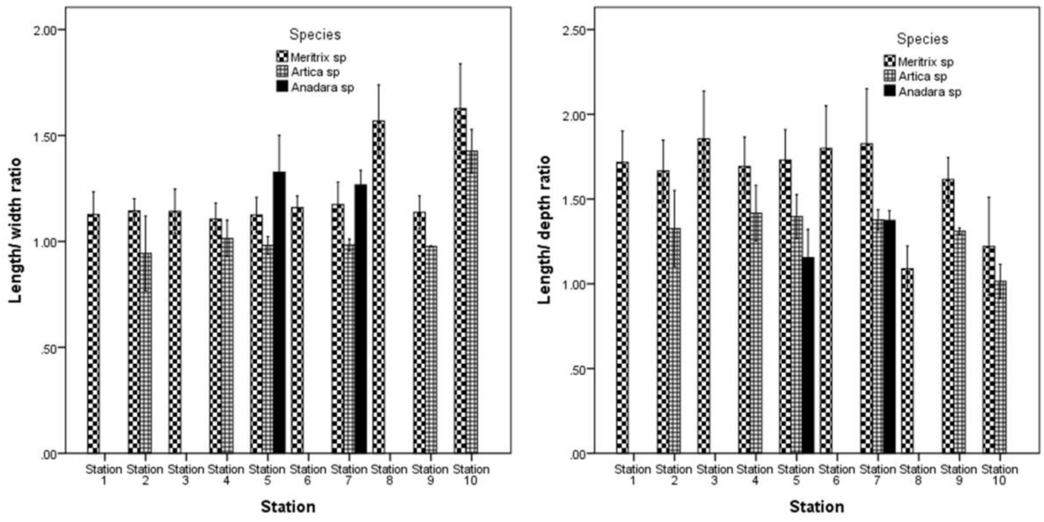

Figure 5: Morphometric ratio of bivalves at the mouth of Marudu Bay

3.4 Size distribution of *M. meretrix*

Size distribution of *M. meretrix* in the sandy shoreline of Marudu Bay is illustrated in Figure 6. The size distribution for *M. meretrix* in all stations generally showed a bell shape with various degrees of skewness and kurtosis. It is interesting to note that the shell length of *M. meretrix* in stations 2, 3, 6 and 8 were generally less than 5 cm, and the graphs showed a clear left skewed distribution. Moreover, size distribution of *M. meretrix* in station 9 was highly leptokurtic. On the other hand, the size distribution of other species was not included in current study due to the fact that low occurrence and abundance of the species may produce a misleading result.

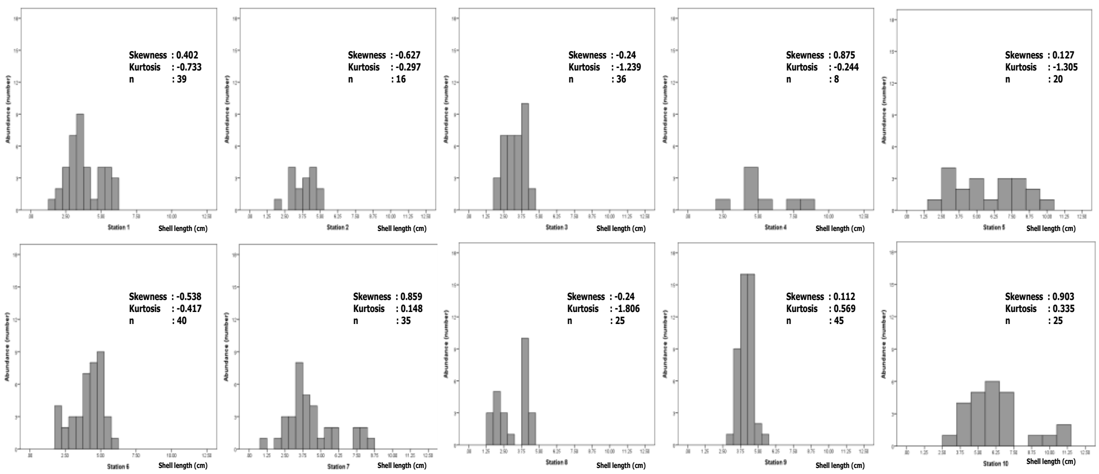

Figure 6: Size distribution of *M. meretrix* at the shoreline of Marudu Bay

4.0 DISCUSSION

4.1 Sediment grain size

Stations 5, 6 and 10 are located nearby river mouth. Grain size distribution is affected by distance from river, where the sediment grain size getting smaller with increasing distance from the source (river) (Harsha et al., 2010). Therefore, this could explain the lower silt-clay composition in the sediment of stations 5, 6 and 10 compared to other stations.

4.2 Bivalves in sandy shoreline at the bay pocket of Marudu Bay

Sandy shoreline is a tide and wave dominated habitat (Dugan and Hubbard, 2006). During floods tide, seawater penetrates sandy sediments, filling the spaces with seawater and dissolved oxygen. During ebb tide, water expelled from the sediment leaving the sediment exposed to hot air and depleted in oxygen (McLachlan and Brown, 2006). Many bivalve species are not able to live in a dry environment (Armonies and Reise, 2000). Therefore, only those species with relatively higher shell mass can tolerate this harsh environment. This could explain the observation that bivalve occurred (*Anadara* sp., *Arctica* sp., and *Meretrix* sp.) in sandy shoreline has thick and heavy shell which helps in reduce the temperature change within the shell cavity.

High energy condition caused by wave and current is another factor that influences the distribution of benthos in sandy shoreline (Defeo nd Gomez, 2005). Smooth and flattened shell burrowing bivalves have an advantage on the high-energy sandy beaches. This is because the bivalve with smooth and flattened shell will not be easily swept away by incoming waves and swash compared to those has rougher surface and bulbous shell (McLachlan and Brown, 2006). This could explain the higher abundance of *Meretrix* sp. in current study compared to *Anadara* sp., *Arctica* sp. which has relatively rougher surface and bulbous shell.

4.3 Morphometric measurement analysis

Morphometric changes of shells are intrinsically driven by genotype (Milly et al., 2012). However, morphometrical shifts can also be modulated by local environmental conditions (Costa et al., 2008). In current study, the length-width and length-height ratio of *M. meretrix* in stations 8 and 10 were significantly higher and lower, respectively compared to other stations. This means that the increase in shell length is superior to increase in shell width and height. In practice, this means that during ontogeny bivalve shells become progressively longer in order to smoother movement in sediment and increase burying speed (McLachlan and Brown, 2006). The observation was in agreement with current study where stations 8 and 10 were located at right in front of the river mouths. These characteristics would be very helpful to counter involuntary dislodgement and strong currents generated by tidal effects.

4.4 Size distribution of *M. meretrix*

Current study discovered that the *M. meretrix* in stations 2, 3, 6 and 8 not only had a negative skewed distribution, but also lack of larger *M. meretrix* broodstock. This observation indicated that the *M. meretrix* in stations 2, 3, 6 and 8 were heavily exploited. The *M. meretrix* fishing intensity in these areas must be reduced before the *M. meretrix* is depleted beyond recovery., Despite the male and female *M. meretrix* are known to attain first sexual maturity at 21-26 mm length (Jayabal and Kalyani, 1986), the larvae produced by smaller bivalves are generally experiencing low hatching rate and survival rate compared to those produced by larger parents (Sangsaangchote et al., 2010).

It is important to highlight that the fishing gear used by the local fisherman is potentially destructive. Despite the blunt iron blade and harmless to large *M. meretrix* (> 5cm in shell length), current study observed that it can easily cause permanence lethal damage to smaller *M. meretrix* (less than 3 cm in shell length) and other bivalve species that share the same habitat (Figure 6). Similar observation has also been reported in *Chamelea gallina* fishery in the northen Asriatic Sea which is captured by hydraulic dredging methodexperienced significant proportion of damaged shells. The fishing method was later found to be responsible for the indirect fishing mortality of the species (Moschino et al., 2003).

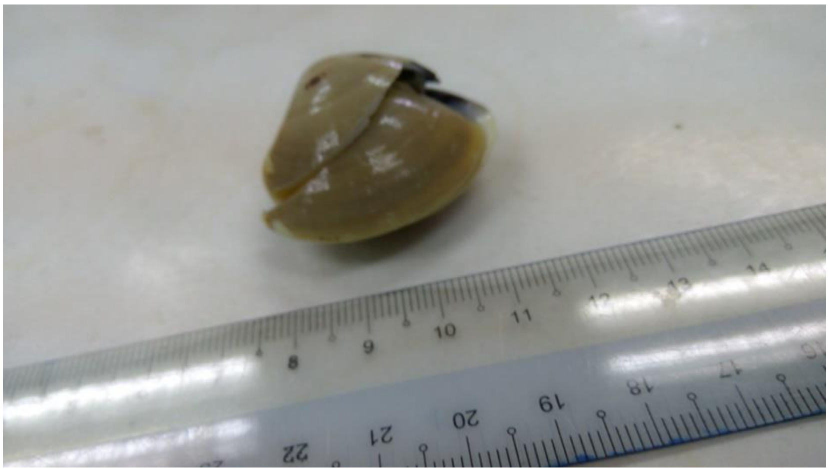

Figure 6: Damaged shell caused by "*kerek*"

For larger *M. meretrix*, the damage caused by the "*kerek*" might not lethal but it can affect market value of the clam. Although bivalves have the ability to repair their shells (Schejter and Bremec, 2007), but the energetic costs of this repair mechanism could considerably reduce the energy available for growth and reproduction (Palmer, 1992). This is an important and urgent issue that needs to be addressed before it causes permanent impact to the *M. meretrix* population in Marudu Bay.

5.0 CONCLUSION

In conclusion, *M. meretrix* is the most dominant species in sandy shoreline of Marudu Bay. However, its resource in some parts of the bay could already experiencing overexploitation. Therefore, the *M. meretrix* fisherman are highly recommended to temporary move their fishing ground to further north east part in order to allow the *M. meretrix* population nearby their village to recover. Moreover, the used of destructive fishing gear such as *kerek* to catch the clam might leave a remarkable negative impact on the biodiversity of the habitat.

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