# DIVERSITY OF TURRET SHELLS (GASTROPODA: TURRITELLIDAE) IN MON COASTAL AREAS

Naung Naung Oo[1]

## Abstract

Studies on diversity of turret shells were conducted at Kawdut (Lat. 15° 49′ N, Long. 97° 23' E), Sitaw (Lat. 15° 11' N, Long. 97° 48' E) and Kyungyi Island (Lat. 15° 04' N, Long. 97° 45' E) in Mon coastal areas from June 2016 to May 2017. A total of 135 individuals were collected from three different stations. Duplicate turret, *Turritella duplicata* and Screw turret, *Turritella terebra* were dominance. Higher density of turret shells were recorded in station 1 with 0.027 ind/$m^2$ and station 2 was recorded lower density with 0.004 ind/$m^2$ at Kawdut. Univariate analysis at Kawdut subtidal population recorded higher values for diversity and richness indices compared to Sitaw sandy bottom and Kyungyi Island but the value of evenness index was quite similar between the three stations. Fifty eight individuals of turret shell were collected from study areas for taxonomy identification. Seven groups of turret shell were identified base on the external shell characteristics. Seven species were clearly identified which *Turritella* and *Haustator* were dominant from the intertidal water of Mon coastal shoreline.

**Keywords**: Gastropoda, Turritellidae, Turret shells, Diversity, Mon coastal areas.

## Introduction

The Turritellidae or Turret shells are widely distributed in the Indo-Pacific from East Africa, including Red Sea to Melanesia and New Zealand, north to Taiwan Province of China and south to central Queensland. Turret shells are also found in Southeast Asia and Indian Ocean Region (Abbott, 1991). *Haustator* and *Turritella* species exist as metapopulations, composed of small groups or patches of individuals.

Turret shells are generally elongate gastropods (13-18 cm long), sharply conical in shape, thick, with numerous whorls and a small, square to rounded aperture. Umbilicus is usually absent. Whorls are strongly sculptured

[1] Dr., Assistant Lecturer, Department of Marine Science, Myeik University.

with spiral ribs or keels. Growth lines arched to sinuous. Outer lip of the aperture is thin, often concave. Inner lip is smooth. Anterior siphonal canal is absent. Operculum is corneous and rounded, with many spiral coils and a central nucleus; border of the operculum very thin, often with flexible bristles. Head is large and prominent, with a short snout and long, tapering tentacles bearing eyes on slight swellings at their outer bases. Foot is rather short, truncate anteriorly, obtusely attenuated posteriorly and grooved beneath. Shells are light to dark brown externally and internally in color. Turret shells live on soft bottoms, from shallow sublittoral zones to a depth of about 30 m (Poutiers, 1998). Turret shells are relatively common at the sandy or muddy substrate of the soft bottoms.

According to Subba Rao (2003), *Turritella* and *Haustator* species exhibit internal fertilization and the chances of successful fertilization are deturretdent on the proximity of other spawning individuals as well as other factors, including water movement. Turret shells reach sexual maturity at a shell length of not less than 15 cm. The reproductive cycle of turret shells appeared to be an annual event. Little is known of turret shells population in Mon coastal areas. Turret shells are also one of the important fisheries resources and it can easily be established as important shellcraft industries to make decorative items. This study was started from June 2016 to May 2017. The line quadrat transect method is a popular method used to estimate the distribution and abundance of benthic organisms present in particular area (English *et al*. 1994). The emphasis was given to identification of turret shell species at first. The aim of the study is to generate some information on the ecological habitat, taxonomy, distribution and abundance of the turret shells in Mon coastal areas.

## Materials and Methods

**Study areas:** Studies on distribution and diversity of turret shells were conducted at Kawdut (Lat. 15° 49′ N, Long. 97° 23' E), Sitaw (Lat. 15° 11' N,

Long. 97° 48' E) and Kyungyi Island (Lat. 15° 04' N, Long. 97° 45' E) in Mon coastal areas from June 2016 to May 2017 (Figure. 1).


**Figure 1.** Map showing the sampling sites of Turret shells in Mon coastal areas

**Quadrat transect technique:** A quadrat of 1 $m^2$ size that was sub-divided to 16 sectors was used. Five replicates of line quadrate were used during the sampling time. The quadrates were set at every 5 m along the transect line set perpendicular to the shoreline. The turret shell assemblage in each quadrat was recorded. After the number of turret shells has been completely counted and recorded, the associated flora in the surround same quadrate were recorded in percentage cover. Estimates of coverage of can be made using a technique developed by Saito and Atobe (1970). This technique uses classes of dominance, which are converted to frequency and percentage cover. Identification was made from the specimen and photographs according to WoRMS (World Register of Marine Species, 2018).

**Species identification:** A total of 58 individuals were collected from the study areas during low tide and were transferred to the laboratory for species identification, labeled specimens were stored and images were taken and recorded. Shells were measured using digital vernier caliper for total length and other shell morphometric characteristics. Measurement was emphasize the following parameters: length of shell (1), number of whorl (2), type of operculum (3), sculpture of shell (4), suture (5) and aperture (6). For the identification of the different morphological structure on turret shell species, the works of Marwick (1957), Garrard (1972), Abbott (1991), and Oliver (2004) were followed.

## Data analysis

**Species diversity:** Diversity indices were calculated using PRIMER (Plymouth Routines In Multivariate Ecological Research) v5 statistical program. The three diversity indices of the univariate analysis were Shannon's diversity index, Margalef's richness index and Pielou's evenness index.

**Multidimensional scaling (MDS) analysis:** The multidimensional scaling (MDS) were used to find the distribution of species according to the different stations. The goodness of fit of MDS was measured by the stress value.

Generally, a stress below 0.05 represents an excellent fit while a figure below 0.1 indicates good relationship and below 0.2 is considered useful (Clark, 1993).

## Results and Discussion

**Characteristics of turret shells**: Shell is small to large, up to 100 mm long and attenuate with numerous whorls. Aperture is proportionately small, rounded or angled at the top. Outer lip is thin with a convex outer margin. There is no umbilicus. Sculpture consists of spiral striations or ridges. Operculum is chitinous, circular, thin and rnultispiral with a central nucleus.

Head is large and bears long tentacles having eyes at their outer bases. Foot is short, truncate anteriorly and narrow posteriorly, with a groove on the ventral side. It possesses a pedal gland at the posterior end. Mantle margin is fringed and has a siphonal fold on the right side. Mantle cavity consists of a monopectinate ctenidiunl and a string-like osphradium. Radula is taenioglossate, 3-1-1-1-3. Digestive system contains small salivary glands, long and narrow oesophagus and a large two-chambered stomach. Sexes are separate. Male is without a penis. Some deposit eggs in stalked capsules, while some brood the young within the oviduct. Veliger larva may be of short duration.

Majority of the species prefer muddy sands of tropical waters. These are detritus feeders and occur from intertidal to offshore, mostly beyond the low tide line. It is a large family consisting of five subfamilies embracing 18 genera and an estimated 150 species. In Myanmar four genera, *Turritella*, *Torcula*, *Haustator* and *Neohaustator*, belonging to the subfamily Turritellinae are reported by Soe Thu (1980). These are mainly distributed along the continental shores. The family Turritellidae has two genera, *Turritella* with five species and *Haustator* with two species in Mon coastal areas (Table 1).

**Distribution of turret shells**: It was observed that, the turret shells of Kawdut, Sitaw and Kyungyi Island were patchy in existence, composed of small clusters or sometime existed as patches of individuals. Turret shells live associated with the marine algae (*Gracilaria* sp., *Catenella* sp., *Padina* sp. and *Acanthophora* sp.) at Kawdut and Sitaw. Most of the turret shell live associated with rock oyster bed and barnacles at the rocky shore area in Kyungyi Island.

**Table 1.** Classification of family Turritellidae in Mon coastal areas

| | | |
|---|---|---|
| **Phylum** | **:** | Mollusca Linnaeus, 1758 |
| **Class** | **:** | Gastropoda Cuvier, 1795 |
| **Order** | **:** | Mesogastropoda Thiele 1925 |
| **Family** | **:** | Turritellidae Lovén, 1847 |
| **Genus** | **1** | *Turritella* Lamarck, 1799 |
| **Species** | 1 | *Turritella attenuata* Reeve, 1849 |
| | 2 | *Turritella carinifera* Lamarck, 1822 |
| | 3 | *Turritella duplicata* (Linnaeus, 1758) |
| | 4 | *Turritella fastigiata* Adams and Reeve, 1849 |
| | 5 | *Turritella terebra* (Linnaeus, 1758) |
| **Genus** | **2** | *Haustator* Montfort, 1810 |
| **Species** | 1 | *Haustator trisulcata* (Lamarck, 1822) |
| | 2 | *Haustator variegata* (Linnaeus, 1758) |

From the 50 meter line transect it was found that one to three individuals in each quadrat. A total of 135 individuals of turret shells were recorded from three stations. Among them, 78 individuals from Kawdut, 35 individuals from Sitaw and 22 individuals from Kyungyi Island (Table 2), (Fig. 2) and (Fig. 3A). In the present study, the density was low. Density of turret shells recorded in St. 1 was 0.027 ind/$m^2$ and St. 2 was 0.004 ind/$m^2$ at Kawdut. Sitaw recorded 0.014 ind/$m^2$ at St. 3. In addition, Kyungyi Island recorded 0.009 ind/$m^2$ at St. 4. The higher densities were recorded at St. 1 and the lower densities were recorded at St. 2. Connell and Orias (1964) reported the densities of turret shell in Indian coastal water was up to 14 individuals per $m^{-2}$. *Turritella attenuata* were presents all the stations. *T. carinifera* only

found at Kawdut and Kyungyi Island. But *T. terebra* was present at Kawdut and Sitaw. The abundance of *T. duplicata* and *T. fastigiata* were at Kawdut and Kyungyi Island. *Haustator variegata* was found at Kawdut and Sitaw but *H. trisulcata* were present at Kawdut. Most of the turret shells were found in the range of 10 cm to 30 cm long. The growth of turret shells is relatively slow (3-4 cm/year), based on annular growth rings in specimens and may live up to 18 years Garrard (1972).

**Table 2.** Occurrence of turret shells species in the study areas

| Species | Kawdut | | Sitaw | Kyungyi Island |
|---|---|---|---|---|
| | St. 1 | St. 2 | St. 3 | St. 4 |
| *Turritella attenuata* | 25 | 3 | 20 | 5 |
| *Turritella carinifera* | 4 | 1 | 0 | 3 |
| *Turritella duplicata* | 8 | 3 | 2 | 6 |
| *Turritella fastigiata* | 18 | 2 | 9 | 8 |
| *Turritella terebra* | 2 | 0 | 1 | 0 |
| *Haustator trisulcata* | 3 | 0 | 0 | 0 |
| *Haustator variegata* | 8 | 1 | 3 | 0 |
| Total | 68 | 10 | 35 | 22 |

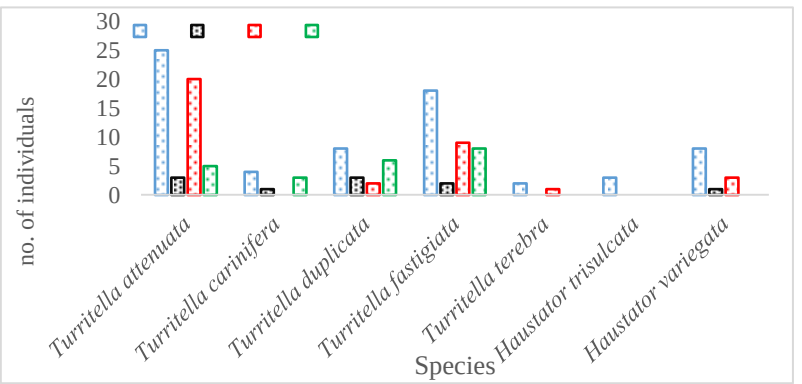


**Figure 2.** Number of individual present for every study sites

According to Connell and Orias (1964), there was no obvious strong relationship between density of *Turritella attenuata* and various physical and

biological variables in Indian coastal water. However, in Kawdut, Sitaw and Kyungyi Island, turret shells are patchy in their distribution and it is proved by the quadrate line transect result. Only one to three individuals found in each meter square of quadrate. Turret shells from these areas were constantly been sought after by the villagers who frequently visited to the sandy mudflat during low tide period. The low abundance might be largely attributed to this activity.

**Table 3.** Univariate analysis of the turret shells at study areas

| Stations | | No. of individuals recorded (N) | Densities ($N/m^2$) | Taxa (S) | Diversity index (*H'*) | Richness index (*R'*) | Evenness index (*J'*) |
|---|---|---|---|---|---|---|---|
| Kawdut | St. 1 | 68 | 0.027 | 7 | 1.631 | 1.422 | 0.838 |
| | St. 2 | 10 | 0.004 | 5 | 1.505 | 1.737 | 0.935 |
| Sitaw | St. 3 | 35 | 0.014 | 5 | 1.145 | 1.125 | 0.711 |
| Kyungyi Island | St. 4 | 22 | 0.009 | 4 | 1.331 | 0.959 | 0.959 |

**Species Diversity**: From the univariate analysis of turret shells (Table 3), the diversity index recorded higher value at Kawdut St. 1 (1.631) and the lowest value at Sitaw St. 3 (1.145) (Fig. 3B). Highest richness indices values was recorded at Kawdut St. 2 (1.737) and the lowest value at Kyungyi Island St. 4 (0.959) (Fig. 3C). Similarly, the highest evenness indices was recorded at Kyungyi Island St. 4 (0.959) and the lowest value recorded at Sitaw St. 3 (0.711) (Fig. 3D). From the results it is showed that the relatively higher abundance of turret shells at Kawdut as compared to Sitaw and Kyungyi Island. This is further supported by the univariate diversity analysis done for the result gathered in the study area. This study can also confirm that the turret shells are patchy in their distribution.

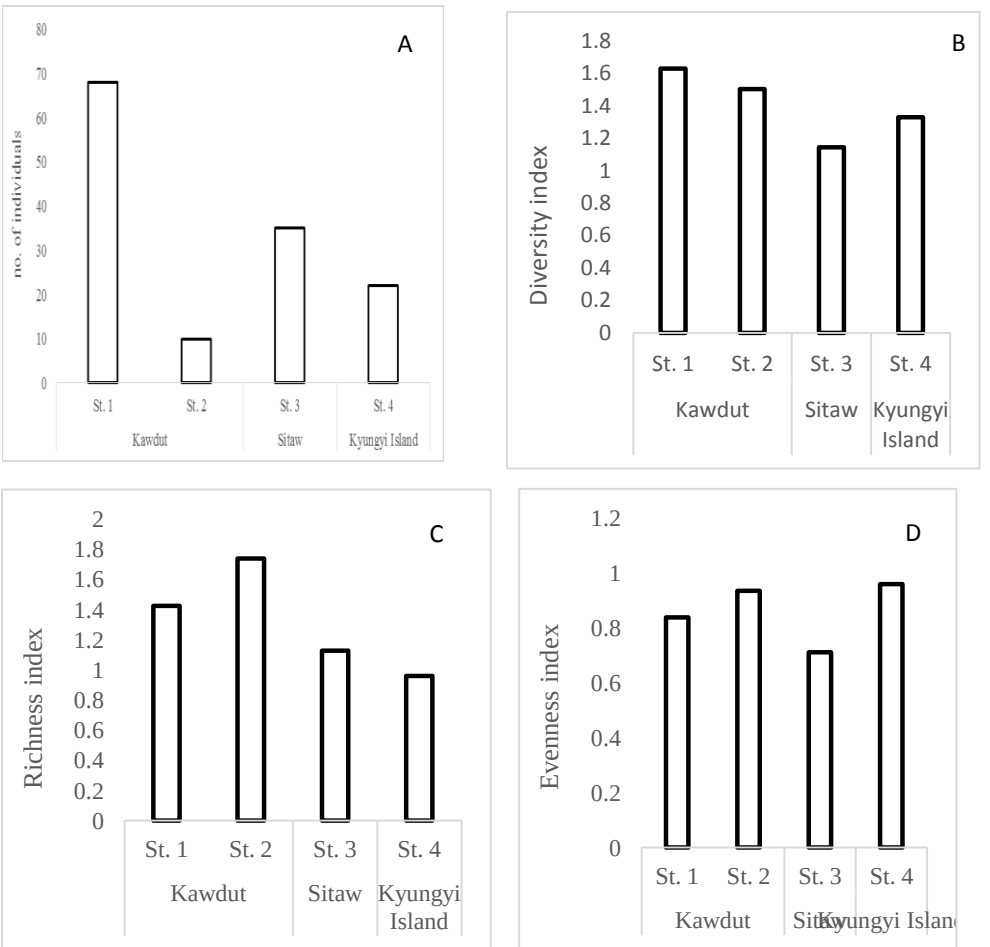


**Figure 3. (A-D):** Graph of univariate analysis three indices for every study areas. Total number of individuals (A), Diversity index (B), Richness index (C) and Evenness index (D).

As earlier been mentioned, turret shells are distributed as a metapopulations species, where the populations are patchy, composed of small groups or patches of individual (Carpenter and De Angelis, 2016). Boettger (1987) also mentioned that the spatial patchiness of *Turritella*

*attenuata* must be considered before interpreting the situation. In many areas, *Turritella attenuata* can occur in patches only a few meters to a few tens of meters in diameter separated by gaps of similar size.

**Multidimensional Scaling (MDS):** Figure 4 and 6 show the MDS ordinations of the clustering communities of turret shell respectively at Kawdut (KD), Sitaw (ST) and Kyungyi Island (KGI). MDS analysis showed a clear separation between the four sites. The stress value quoted together with the ordination showed in zero values and it is indicated that an excellent fit and this showed each sites were clearly different with one other (Fig. 4).

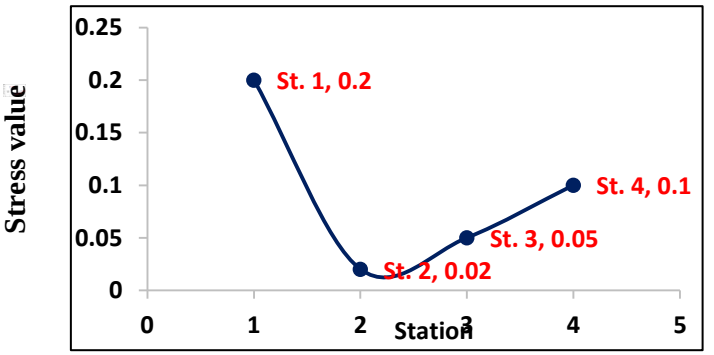


**Figure 4.** MDS ordinations plot for turret shells at Kawdut, Sitaw and Kyungyi Island

**Species Identification:** A total of seven species of turret shells were recorded from the sandy mudflat and rocky shore at Kawdut, Sitaw and Kyungyi Island (Table 2). The identification of the species was based on the six characteristics of internal and external of the shells (Fig. 5). Among these seven species, five species belongs to the genus *Turritella* was recorded and two species belongs to genus *Haustator*. *Turritella attenuata* and *Turritella fastigiata* were the dominant species in these study areas.

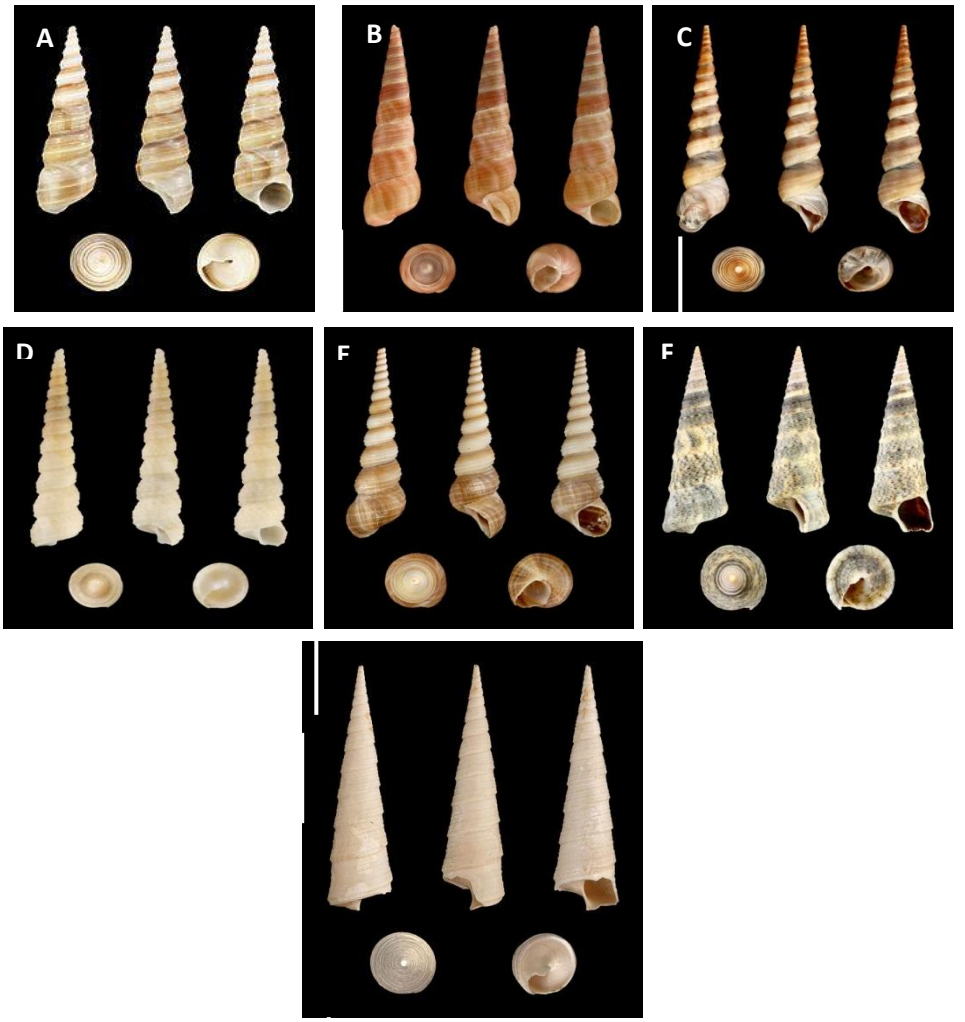


**Figure 5. (A-G):** Turret shells of Kawdut, Sitaw and Kyungyi Island at Mon coastal areas. A) *Turritella attenuata* Reeve, 1849; B) *Turritella carinifera* Lamarck, 1822; C) *Turritella duplicata* (Linnaeus, 1758); D) *Turritella fastigiata* Adams and Reeve, 1849; E) *Turritella terebra* (Linnaeus, 1758); F) *Haustator trisulcata* (Lamarck, 1822); G) *Haustator variegata* (Linnaeus, 1758). Scale bars = 10 cm.

In term of similarity amongst populations, dendrogram plots show from the study areas there are two areas group together (KD St. 1 and ST St. 3) and (KD St. 2 and KGI St. 4). Result showed KD St. 1 is correlated to ST St. 3 and they can be grouped together at 71% similarity (Fig. 6) and KD St. 2 is correlated to KGI St. 4 which, can be grouped together at 68% similarity. These two groups are correlated by the total number of turret shells existing in each area. KD St. 1 and ST St. 3 recorded higher number of individuals compared to KD St. 2 and KGI St. 4.

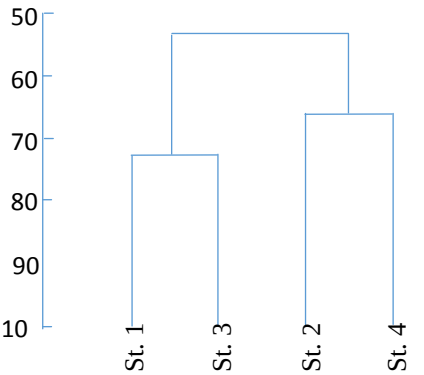


**Figure 6.** Dendrogram plot for turret shells at Kawdut (KD), Sitaw (ST) and Kyungyi Island (KGI)

In the sandy mudflat and rocky shore areas of Mon coastal areas, *T. duplicata* (Linnaeus, 1758) was recorded at Kawdut, Sitaw and Kyungyi Island and *T. terebra* (Linnaeus, 1758) was recorded at Kawdut and Sitaw. These two species of turret shells was a new distribution recorded in the sandy mudflat and rocky shore areas of southern part of Mon coastal areas. The previous study by Soe Thu (1980) only mention and recorded the existing of turret shell in Myanmar. The statements given are not specific to an exact area. Also Thaw Zin Naing Tun *et.al* (2012), reported the existing of turret shells only at Kampani coastal area, northern part of Taninthayi Coastal Region.

The local fishing communities collect these molluscs for their livelihood and especially gastropods are used for human consumption. They are good source of proteins, mineral and glycogen, and easily digestible compared to other animal foods. The non-edible molluscs were deposited into heaps on the platforms for sun drying and then utilized for domestic and commercial purposes. In the present study 7 species of turret shells were recorded on mud flats, sandy areas, near swamps and mangroves of Ye River Estuary in southern Mon coastal areas. Gastropods were observed to be predominant in this area. The study provides the base line information on malacofauna and it would assist the researchers for further studies on molluscs and manage the resources for sustainability.

## Conclusion

From this study it could be concluded that the sandy mudflat and rocky substrate of Kawdut and Sitaw provided rich habitat for turret shells where, *Gracilaria* sp., *Catenella* sp., *Padina* sp. and *Acanthophora* sp. were among the dominant species. However, turret shells also can be found at the rocky shore area in Kyungyi Island. A total of 135 individuals of turret shell were found at four studies areas and they were patchy in distribution. Higher density of turret shells were recorded at St. 1 with 0.027 ind/$m^2$ and St. 2 recorded lower density with 0.004 ind/$m^2$ at Kawdut. Seven species of turret shells were recorded from the sandy mudflat and rocky shore at Kawdut, Sitaw and Kyungyi Island. *Turritella attenuata* and *Turritella fastigiata* were found to be dominant in these three study areas. Univariate analysis at Kawdut population recorded higher values for diversity and richness indices compared to the Sitaw and Kyungyi Island but the value of evenness index was quite similar between Kawdut, Sitaw and Kyungyi Island. Multidimensional scaling (MDS) and dendrogram plots found the stress value were zero and it indicated that excellent fit. Two groups were found from MDS and dendrogram plots which Kawdut (St. 1) is correlated to Sitaw (St. 3) and Kawdut (St. 2)

correlated to Kyungyi Island (St. 4). In addition, *Turritella duplicata* (Linnaeus, 1758) and *Turritella terebra* (Linnaeus, 1758) was new distribution records from southern part of Mon coastal areas.

## Acknowledgements

I would like to express my gratitude to Dr. Aung Myat Kyaw Sein, Rector of Mawlamyine University; Dr Mie Mie Sein and Dr San San Aye, Pro-rectors of Mawlamyine University for their permission to undertake this research work. I would like to express my sincere thanks to Dr. San Tha Tun, Professor and Head of Department of Marine Science in Mawlamyine University for his advices and needful assistance. My final thank goes to local people from my study areas in Mon coast, for their assistance in the sample collections and Daw Lwin Lwin who has put in back breaking hours studying seashells but more importantly has kept me focused.

## References

Abbott, R. T. (1991) *Seashells of Southeast Asia*. Graham Brash, Singapore.

Boettger, A. J. (1987) Ecology of Turritellidae (Mollusca: Gastropoda) in Gulf St. Vincent, South Australia: density, reproductive cycle, recruitment, growth and mortality at three sites. *Australian Journal of Marine and Freshwater Research*, vol. 38, pp. 743-769.

Carpenter, K. E. and De Angelis, N. (2016) The living marine resources of the Eastern Central Atlantic. Volume 2: Bivalves, gastropods, hagfishes, sharks, batoid fishes, and chimaeras. *FAO Species Identification Guide for Fishery Purposes, Rome, FAO*, pp. 665–1509.

Clark, K. E. (1993) Non-parametric multivariate analysis of changes in community structure. *Australian Journal of Ecology*. vol. 18, pp. 117-143.

Connell, J. H. and Orias, E. (1964) The ecological regulation of species diversity. *Amer. Natur*. Vol. 98, pp. 399-414.

English, S., Wilkinson, C. and Baker, V. (1994) *Survey Manual For Tropical Marine Resources*. Australia Institute Of Marine Science. Townsville.

Garrard, T. A. (1972) A revision of Australian recent and tertiary Turritellidae. *J. Malac. Soc. Aust*., vol. 2, pp. 267-337.

Marwick, J. (1957) Generic revision of the Turritellidae. *Proc. Malac. Soc. Lond*., vol. 32, pp. 144-166.

Oliver, A. P. H. (2004) *Guide to sea shells of the world*. Philip's a division of Octopus Publishing Group Ltd, London.

Poutiers, J. M. (1998) Gastropods. *In*: Carpenter, K. E. and Niem, V. H. (Eds.), FAO Species Identification Guide for Fishery Purposes. The Living Marine Resources of the Western Central Pacific. Volume 1. Seaweeds, Corals, Bivalves and Gastropods. Food and Agriculture Organization, Rome: pp. 363-649.

Saito, Y. and Atobe, S. (1970) Phytosociological study of intertidal marine algae. I. Usujiri Benten- Jima, Hokkaido. *Bulletin of the Faculty of Fisheries*, Hokkaido University, vol. 21, pp. 37-69.

Soe Thu. (1980) *Taxonomy and distribution of Burmese marine gastropods*. MSc Thesis, Department of Zoology, Art and Science University, Rangoon (Unpublished).

Subba Rao, N. V. (2003) Indian Seashells (Part-I): *Polyplacophora and Gastropoda*, *Rec. zool. Surv. India*, Occ. Paper No. 192: i-x, 1-416. (Published: Director, *Zool. Surv.* Kolkata, India)

Thaw Zin Naing Tun, Aung Myint Kyaw, Phyo Wai Aung, Sai San Myint and Thu Yain Tun. (2012) *Preliminary survey of gastropods and pelecypods around Kanpani Village, Longlone Township, Taninthayi Region*. BSc Term Paper, Department of Marine Science, Mawlamyine University (Unpublished).

WoRMS. (2018) Available Source: http://www.marinespecies.org.