

The Assessment on the Diversity of Gastropods and Pelecypods along Chaungtha Coastal Area

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Abstract

The species diversity of gastropods and pelecypods were recorded in three study sites; sandy site, rocky site and trawled shelves situated in Chaungtha Coastal Area by three indices of species richness, Shannon and Simpson. Similar species collected in three study sites were evaluated with the index value of Jaccard method. Field surveys were conducted twice in each season for a period of two years starting from March, 2006 to February, 2008. A total of 117 gastropod species of 58 genera belonging to 34 families of four orders and a total of 43 pelecypod species of 22 genera belonging to 15 families of four orders were recorded during the study period. In gastropods, according to species richness index the highest value (19460.242580) was in rocky site while the lowest value (3494.072886) in sandy site. According to Shannon index, the highest value (3.363804) was in sandy site while the lowest value (3.091343) in rocky site. According to Sampson index the highest value (0.94958) was in sandy site while the lowest value (0.936485) in rocky site. In pelecypods, according to species richness index, the highest value (3621.136296) was in sandy site while the lowest value (291.844804) in rocky site. According to Shannon index, the highest value (2.952227) was in sandy site while the lowest value (0.856679) in trawled shelf site. According to Sampson index, the highest value (0.929658) was in sandy site while the lowest value (0.442403) in trawled shelves site.

Key words: diversity, pelecypods, gastropods, Chaungtha Coastal Area

Introduction

The phylum Mollusca is divided into seven classes: Of these the Gastropoda and the Bivalvia account for the great majority of living mollusks (Abbott and Dance, 2000). Class Gastropoda is by far the largest and most diverse, containing about 40,000 living and 15,000 fossil species. They include snails, limpets, slugs, whelks, conchs, periwinkles, sea slugs, sea hares. (Hickman, Larry and Allan, 1993). It is estimated that there are about 20,000 living species of marine gastropods. There may be 10,000 living species of bivalves in the world's sea. (Abbott and Dance, 2000). Myanmar includes in Indo Pacific province. It has a costal line of 2229 km. running north and

south, link with Bay of Bengal and Indian Ocean (Wye, 2003). Chaungtha beach near Chaungtha village of Patheingyi Township is a part of the Rakhine Coast on the Bay of Bengal. It is situated approximately at 17 degree 50 minutes North and 94 degree 30 minutes East. The beach is mostly sandy with occasionally rocky outcrops. Chaungtha beach is gently sloped and its intertidal zone has an average length of 75 meters. The parameters which define it are its composition: the species present and their relative abundances; the nature and form of the relationships between those species (the direction, relative strength and impact of those relationships) and its dynamics; its flux in both space and time (Putman,1994). Myanmar supports many natural habitats and species communities in Indo-pacific Province ,including many globally threatened species .

Mollusks play an important role in the marine ecosystem .They are also essential and valuable species in the world's sea .Myanmar researchers have studied about some mollusks concerning taxonomy and distribution along some coastal areas in Myanmar. However, the study of mollusks has been still much less than that of any other invertebrates .The present research tends to record the species richness and diversity of gastropods and pelecypods along Chaungtha coastal area. The diversity of those species is expected to be high since the area is composed of different habitat types. Therefore, the present work is conducted with the following objective.

1. To assess the diversity of gastropods and pelecypods along Chaungtha Coastal area.

Materials and Methods

Study area and Study period

Chaungtha coastal area with the coordinates of 17° 50' N and 94° 30' E), at Patheingyi Township, Ayeyarwady Division was chosen as study area. The study period lasted from March 2006 to February 2008 (Fig. 1).

Collection sites

Three study sites such as sandy site, rocky site, and trawled shelves site along Chaungtha coastal region were designated to collect the specimen. The first one is sandy site where the shells carried by tidal waves deposited. The second study site is their habitat in which the alive mollusks are found by cling on the rocks in the intertidal zone. The third collection site is the trawled

shelves on the beach. Trawled shelves are the racks on which small aquatic organisms including mollusk shells accidentally caught in the trawls were dried.

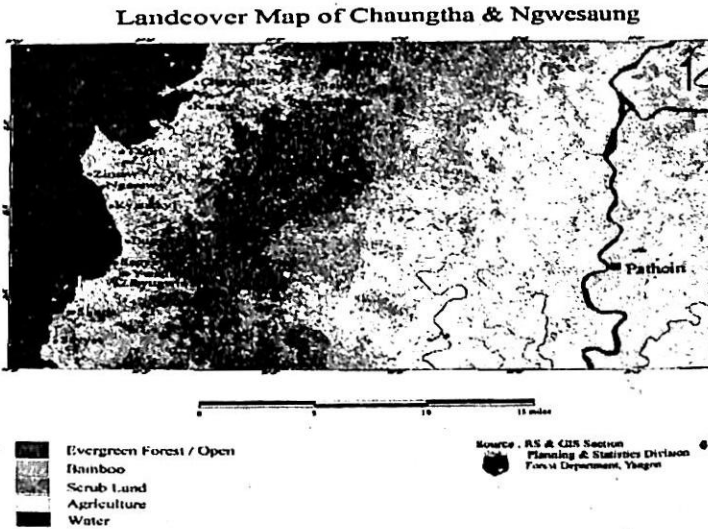


Fig. 1. Land cover map of Chaungtha coastal region (RS and GIS section, Planning and Statistics Division, Forest Department)

Specimen collection

Collection was done seasonally, twice in each season and it took a week in each trip. Shells were collected along the shore line. A vast assemblage of different forms lives on rocky shores, clinging to or hiding under the rocks while the tide is out. Other prefers sandy flats where they burrow into the sand during ebb tide. A large majority of shells were wave-worn, eroded, broken or otherwise imperfect. These shells were also collected to study some distinctive characters which still remain. Low tide is the most favorable time for collecting.

Data collecting

All the shells were recorded immediately after collecting. This was done by label tips. This label included number, date of finding, locality. Field notes were also taken on the tide conditions, and the weather conditions of the collected specimens and its relative abundance at the site of collection.

Cleaning of the shells

After collecting, the shells were cleaned properly so that shell beauty is enhanced and not destroyed, and promptly so that decomposition of animal parts and resultant unpleasant odours do not set in. Boiling for a few minutes is the most satisfactory method of removing the fleshy or soft parts. Then they were put to be cool enough to permit handling and remove the fleshy parts by using pin or other sharp instrument. Minute specimens were placed to dry without removing the soft parts. Then the shells were dried in shady place. After that the shells were lightly rubbed with a small amount of mineral oil applied with a tuft of cotton. The shells were ready to identified and take the photos.

Identification

Recorded species were identified by distinctive characters and texture, colouration, dentition, and photo key followed after Habe (1964), Kira (1972), Carpenter and Volker, (1998), Abott (2000) and Wye (2003).

Estimates of species diversity

Five indices of species diversity were used, such as Dominant index, Richness index, Shannon index, Simpson index and its evenness and Jaccard index to assess species diversity of mollusks. Each index values of gastropod and pelecypod species collected from different collection sites and seasons were compared (Krebs, 2001 and Stiling, 1999).

The formula of Dominant index is as:

$$\text{Dominant index} = n/N * 100$$

where n is the number of individuals in each species and N is the total population number.

The formula of Richness index is as:

$$\text{Richness index} = n * (n-1) / n$$

where n is the number of individuals in each species.

The formula of the Simpson index of species diversity is as:

$$D_{si} = \sum_{i=1}^s \frac{(n_i(n_i-1))}{(N(N-1))}$$

where n_i is the number of individuals in the i^{th} species and N is the total population number. Since D_s and species diversity are negatively related, Simpson's index is expressed as $1-D_s$. So that increasing values mean increasing diversity (Stiling, 1999).

The formula of the Shannon index of species diversity is as:

$$H' = -\sum P_i \ln P_i$$

where P_i is the proportion of individuals found in the i^{th} species and \ln is the natural logarithm. A high number of species and a more even distribution both increase diversity as measured by the Shannon index (Stiling, 1999). Shannon index formula was developed by Shannon and Weiner in 1949. Where P_i is the proportion of individuals found in the i^{th} species and \ln is the natural logarithm. The Shannon index has a minus sign in the calculation so the index actually becomes positive. Higher number of species and a more even distribution both increase diversity as measured by the Shannon index. The actual diversity value and the maximum possible diversity can be compared by a measurement called the evenness value. The formula is

$$\text{Evenness} = H' / \ln S$$

where S is total number of species. Evenness is usually ranges between 0 and 1.0.

Similarity indices for indices of the qualitative similarity or Jaccard index determined by Jaccard (1912). Jaccard index is as:

$$J = 100 c / a + b - c$$

where 'a' is the number of species occurred in 1st community or area, 'b' is the number of species occurred only in 2nd community, 'c' is the number of species occurred in both communities.

Result

Species Diversity

Species diversity at all study sites represented by different indices was found to vary. A total of 160 species including 117 gastropod species of 58 genera belonging to 34 families of 4 orders and 43 pelecypod species of 22 genera of nine families under four orders of the class Pelecypoda were

recorded. Changes of species number are also associated with the habitat they inhabit.

Population abundance and dominant index

In sandy site, a total of 62 species and 3439 individuals of gastropods were recorded. The highest values of abundance 467 individuals and dominant index (13.579529), were recorded for the species *Turritella terebra* which was successively followed by *Turricula tornata* with abundance 311 individuals and dominant index (9.043327) and *Gemmula congener cosmoi* with abundance 305 individuals and dominant index (8.868857) respectively.

In rocky site, a total of 56 species and 19,411 individuals of gastropods were recorded. The highest values of abundance 2,621 individuals and dominant index, (13.502653), were recorded for the species *Siphonaria pectinata* which was successively followed by *Thais tissoti* with abundance 2,436 individuals and dominant index (12.549585) and the third highest value of abundance and dominant index was 1,547 individuals and (7.969708) for the species *Notosinister granulata*.

In trawled- shelves area, a total of 56 species and 7,381 individuals of gastropods and dominant index (14.997968) was the highest values for the species *Conus ximenes* which was successively followed by the species *Bursa rana* with abundance value 751 and dominant index (10.174773) and *Nassarius olivaceus* which had abundance value 555 and dominant index (7.519306) respectively.

Species richness, Shannon and Simpson indices

Sandy area

In Sandy area, the highest values of species richness index (467.997859), Shannon index (-0.271130), Simpson's index (0.018406), were observed for the gastropod species, *Turritella terebra*, Screw Turritella of family Turritellidae. The second highest values of species richness index (311.996785), Shannon index (-0.217324), Simpson's index (0.008154), were observed for the species, *Turricula tornata*, Turned Turrid of family Turridae.

The third highest values of those indices (305.996721), (8.868857), (-0.214859), (0.007842) were recorded for the species *Gemmula congener cosmoi*, Mellvill's Turrids of Family Turridae. Two species, *Latirus polygonus* and *Vexillum regina* were observed to obtain only one shell with

species richness index (0.029078), Shannon index (-0.002368), Simpson's index (0.000000).

In Sandy area, the highest values of species richness index (516.998062), Shannon index (-0.278850), Simpson's index (0.020636), were observed for the pelecypod species *Cardia bicolor*. The second highest values of species richness index (397.997481), Shannon index (0.243542), Simpson's index (0.012208), was observed for the species *Sunetta meroe*. The third highest values of those indices (374.997326), (0.235652), (0.010833) were recorded for the species *Lunulicardia hemicardia*. Three species, *Trisidos semitorta*, *Argopecten circularis*, *Cardium multispinosum* were observed to obtain only one shell with species richness index (1.00000), Shannon index (0.0022863), Simpson's index (0.000000).

Rocky area

In rocky area, the highest values of species richness index (2621.999618), Shannon index (-0.270361), Simpson's index (0.018226), were observed for the gastropod species, *Siphonaria pectina* of family Siphonariidae. The second highest values of species richness index (2426.999589), Shannon index (-0.260464), Simpson's index (0.015744), were observed for the species, *Thais tissoti*, Tissot's rock shell of family Muricidae. The third highest values of those indices (1547.999354), (-0.201596), (0.006348) were recorded for the species *Notosinister granulata*. Four species which had the least value of such indices, (1.000000), (0.005152), (-0.000509), (0.00000) were observed for the species *Cypraea zonaria*, *C. gutternium*, *Gyrineum natator* and *Babylonia japonica*.

In rocky area, the highest values of species richness index (142.992958), Shannon index (-0.344907), Simpson's index (0.254474), were observed for the pelecypod species, *Lunulicardia hemicardia*. The second highest values of species richness index (27.962963), Shannon index (0.225082), Simpson's index (0.008922), were observed for the species *Paphia textile*. The third highest values of those indices (26.961538), (0.220237), (0.008261) were recorded for the species *Trachycardium flavum*. Two species which had the least value of such indices, (1.000000), (0.020065), (0.00000) were observed for *Crassatellites radiata* and *Plagiocardium pseudolium*.

Trawled shelves area

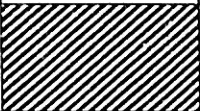
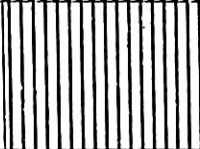

In trawled shelves area, the *Conus ximenes* of family Conidae has the highest index values in species richness (1107.999097), Shannon (-0.284550), Simpson (0.022477). The second highest index value of species richness was 751.998668, Shannon (-0.232520), Simpson (0.010340) which was observed for the species, *Bursa rana* of family Bursidae. The third highest values of those indices, (555.998198), (-0.194577), (0.005645) were recorded for the species *Nassarius olivaceus*. Ten species which had the least values of such indices, (1.000000), (0.013548), (-0.001207), (0.000000) were observed for the species *Territella duplicata*, *Tibia fusus fusus*, *Tectonatica janthostoma*, *Gyrineum natator*, *Murex termispina*, *Murexiella bojadorensis*, *Pleuroploca trapezium*, *Melo melo* and *Mitra taeniata*.


In trawled shelves area, the highest values of species richness index (419.9976134), Shannon index (0.231495), Simpson's index (0.528810), were observed for the pelecypod species *Trachycardium asiaticum*. The second highest values of species richness index (69.985507), Shannon index (0.254198) Simpson's index (0.014167) were observed for the species *Lithophaga plumula*. The third highest values of those indices (67.985074), (0.250251), (0.013351) were recorded for the species *Anadara transversa*. *Anadara granosa* had the least values of such indices (21.952380), (0.120735), (0.001268).


Jaccard index


The overlapped species among three study sites were assessed by using Jaccard similarity index. The gastropod communities between sandy and rocky area and rocky and trawled-shelves area and sandy and trawled shelves sites did not reveal any similar pattern. Hence, the gastropod species were not very similar at three study sites (Table 1).

Table 1. Jaccard index of gastropods among study sites

	Sandy	Rocky	Trawled Shelves
Sandy		100	56.8
Rocky			25
Trawled shelves			

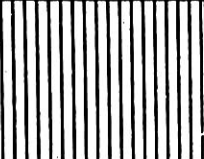

 1-35


 36-70


 71-105

Similarly, the species overlapping of pelecypod communities among study sites were assessed. No similar pattern was found between sandy and rocky sites, rocky and trawled –shelves sites and sandy and trawled shelves sites. Hence, the pelecypod species were not very similar at three study sites (Table 2).

Table 2. Jaccard index of pelecypods among study sites

	Sandy	Rocky	Trawled Shelves
Sandy		92.85	0
Rocky			7.14
Trawled shelves			

 1-50

 51-100

Comparison of species diversity in study sites

Diversity index values of gastropod and pelecypod species collected from three study sites were assessed to categorize three folds, the highest, second highest and the least by three parameters of species richness, Shannon and Simpson.

Gastropods

The species richness index showed that the highest value (19460.242580) was investigated in rocky area which was followed by trawled shelved area while the least value (3494.072886) was in sandy area in the gastropod species collected from three study sites (Table 4.12).

Both indices of Shannon and Simpson expressed that the highest values of (-3.363804) and (0.94958) in sandy area respectively while the least value of Shannon index, (-3.091343), was observed in rocky while that of Simpson index (0.936485), was observed in rocky area.

Pelecypods

The highest value of species richness index (3621.136296) was observed in sandy area and the least value (291.844804) in rocky area for the pelecypod species .

The highest value of Shannon index, (-2.952227), was observed for pelecypod species in sandy area while that of Simpson index, (0.929658), was observed in sandy area. The least value of Shannon index, (-1.829549), was observed in rocky while that of Simpson index (0.442403), was observed in trawled shelves area .

Discussion

Chaungtha Beach is part of the Rakhine Coast of Myanmar and its sandy and rocky beach supports good natural habitat for marine gastropod and pelecypod species. Sandy area is the deposited site of both gastropod and pelecypods which were swept by the tide of Bay of Bengal. Sandy, rocky and trawled shelves sites were designated as study sites along Chaungtha beach during the study period March 2006 to February 2008.

A total of 160 species including 117 gastropod species of 58 genera belonging to 34 families of 4 orders and 43 pelecypod species of 22 genera of nine families under four orders of the class Pelecypoda were recorded.

According to the different index values of species diversity, the Shannon index was weighed to rare species which collected the least number while the Simpson index was weighed to common species. The value assessed by Simpson index for the least number (collected number is only one individual) of a particular species assessed value could not mentioned at all. Hence the former index should be suitable for the rare species while the Simpson index for the common species.

The species representing the highest value of Shannon index (-0.271130), Simpson's index (0.018406), was the gastropod species, *Turritella terebra*, which was followed by *Turricula tornata* Shannon index (-0.217324), Simpson's index (0.008154) in sandy area. Two species, *Latirus polygonus* and *Vexillum regina* had the least value Shannon index (-0.002368), Simpson's index (0.000000). It agrees with Carpenter (1998) who stated that members of Family Turritellidae are filter feeding and mostly live in soft subtidal bottoms of sand and mud.

The species which has the highest value of Shannon index (-0.270361), Simpson's index (0.018226), was the gastropod species, *Siphonaria pectina* which was followed by *Thais tissoti* Shannon index (-0.260464), Simpson's index (0.015744) in rocky area. It agrees with Carpenter (1998) who stated that members of Family Siphonariidae are sedentary air-breathing animals, common on intertidal rocks where they clamp by means of their strong foot and graze on encrusting lichens and algae with a powerful radula.

The species possessing the highest index values in Shannon (-0.284550), Simpson (0.022477) was the gastropod species *Conus ximenes* which was followed by *Bursa rana* Shannon (-0.232520), Simpson (0.010340) in trawled shelves area. It also agrees with Carpenter (1998) who stated that members of Family Conidae (cones) and Bursidae (frog shells) are mostly reef-dwellers, living in clean or muddy-sand bottoms under rocks or corals, or silty crevices. In the present study, dead cones and frog shells were observed dirty with mud when cleaning them. Moreover, he described that cones are active predators, armed with sharp arrow-like teeth and a poisonous gland which secretes a powerful nerve toxin. Living cones must be handled with great care, as their bites may be painful or even occasionally fatal to death. Frog shells were locally collected for food and shell trade, either at low tide or with trawls Carpenter (1998).

The species of the highest value of Shannon index (-0.278850), Simpson's index (0.020636) was the pelecypod species *Cardita bicolor* which was followed by *Sunetta meroe* Shannon index (0.243542), Simpson's index (0.012208) in sandy area.

The species assessed as the highest value of Shannon index (-0.344907), Simpson's index (0.254474), was the pelecypod species, *Lunulicardia hemicardia* which was followed by *Paphia textile* Shannon index (0.225082), Simpson's index (0.008922) in rocky site.

The species evaluated as the highest value of Shannon index (0.231495), Simpson's index (0.528810), was the pelecypod species *Trachycardium asiaticum* which was followed by *Lithophaga plumula* Shannon index (0.254198), Simpson's index (0.014167) in trawled shelves area. *Anadara granosa* had the least value of such indices (0.120735) and (0.001268).

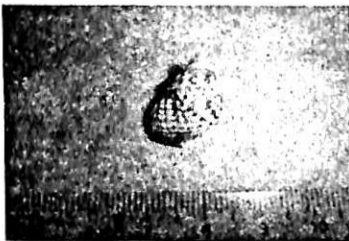
It may be assumed that the high value of species diversity may coincide with the breeding season of those species. The least value of species diversity may probably be due to the prebreeding season of those species or may be the scarcity of those species in the natural habitat.

The diversity of gastropods was found to be higher than that of pelecypods in the study area. It may be due to the fact that the study area could provide the favorable environment for gastropods. Gastropod species at rocky site were observed alive. It may be assumed that gastropods are more able to withstand the wave movement, tide condition and rough weather condition than pelecypods because rocky habitat could provide shelter and food and give protection. In the market of Chaungtha village, nerites species were sold very cheaply. According to shell sellers, those nerites were collected from rocky habitat near Chaungtha beach. Nonetheless, gastropod and pelecypod shells are very useful for shell shops and shell enthusiasts who like to enjoy the nature of the beach. On the other hand, living gastropod and pelecypod species in marine environment play a significant role to sustain the healthy marine ecosystem. Even empty shells scattered on the beach give pleasure for the beach visitors and are beneficial to the shell shops. Moreover, foreign currency is obtained by selling souvenirs made of mollusk shells to tourists. It is vitally important for the inhabitants along Chaungtha Coastal area to be aware of the importance of mollusks and not to exploit them unnecessarily but to have the thought of conserving them. Thus, educational

talks concerning conservation should be given to public residing at coastal areas so as to sustain the marine ecosystem.

Summary

1. Species diversity of some gastropods and pelecypods were conducted along the Chaungtha coastal area, Patheingyi Township, during the study period from March 2006 to February 2008 .
2. Three study sites sandy, rocky, and trawled shelves, were chosen along Chaungtha coastal area and species richness and abundance were recorded in each study site.
3. A total of 117 gastropods under the 34 families under four orders and a total of 43 species under 15 families under four orders of pelecypods were recorded.
4. The highest values of species richness index (19460.242580) were observed in rocky area and that of Shannon index, (-3.363804), Simpson index, (0.94958) was observed for gastropod species in sandy site.
5. The highest values of pelecypod species richness index (3621.136296) ,Shannon index, (-2.952227), Simpson index, (0.929658), were observed in sandy area. The least value of Shannon index, (-1.829549), was observed in rocky while that of Simpson index (0.442403), was observed in trawled shelves site.



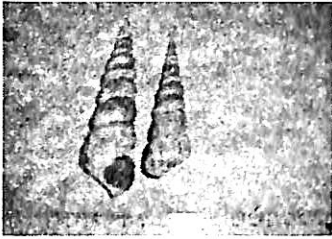
A. *Littorina pintado*
Exterior view



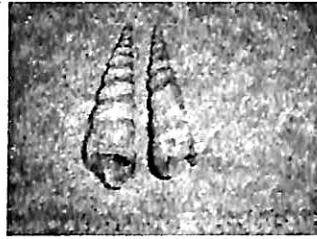
B. *Littorina scabra*
Interior view



C. *Turritella fastigiata*



D. *Turritella ligar*



E. *Turritella duplicata*



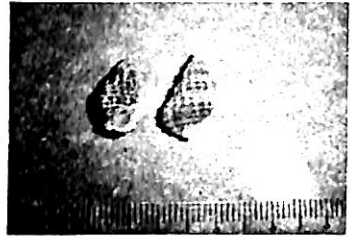
F. *Turritella terebra*



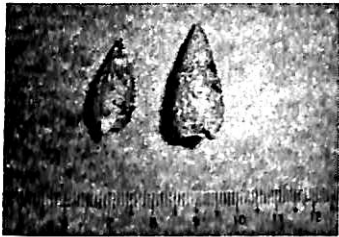
G. *Architectonica perspectiva*



H. *Telescopium telescopium* Exterior view



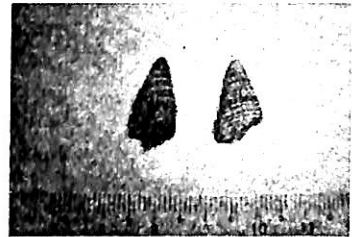
L. *Notosinister granulate*



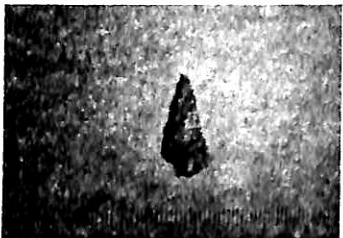
J. *Cerithium algicolum*



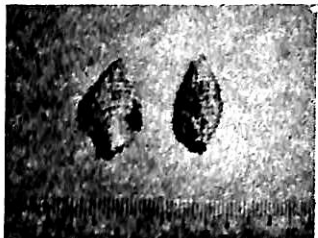
K. *Ochetoclava pilsbryi*



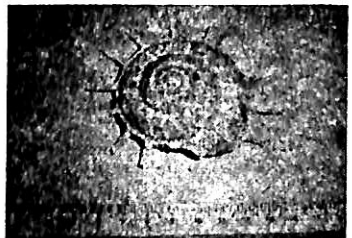
L. *Notosinister granulata*



M. *Proclaava pfefferi* Interior view

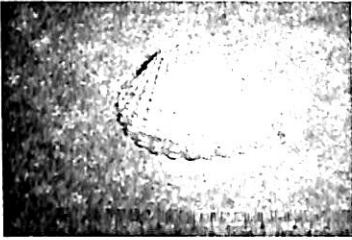


N. *Clypeomorus trailli*

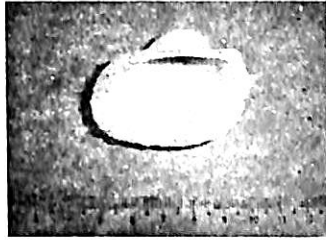


O. *Xerophoria solaris* Exterior view

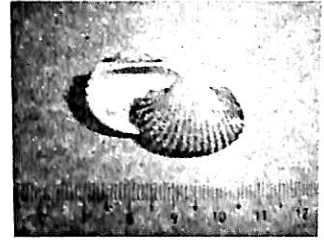
Plate 1. Some gastropods belonging to Order Mesogastropoda



A. *Anadara granosa*
Exterior view



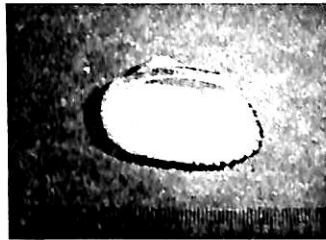
Anadara granosa
Interior view



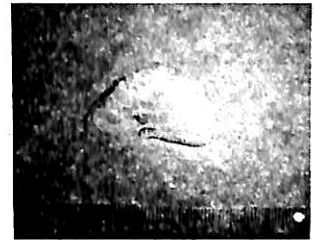
B. *Anadara ransversa*



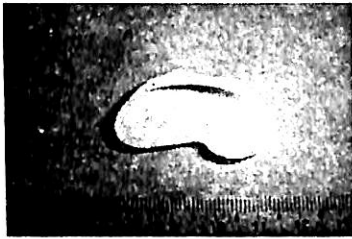
C. *Anadara scapha*
Exterior view



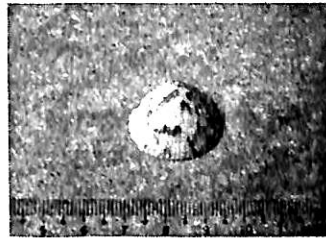
Anadara scapha Interior
view



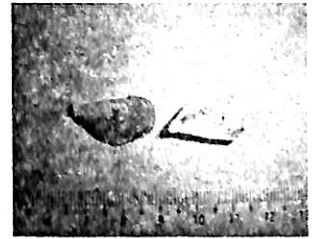
D. *Trisidos semitorta*
Exterior view



D. *Trisidos semitorta*
Interior view



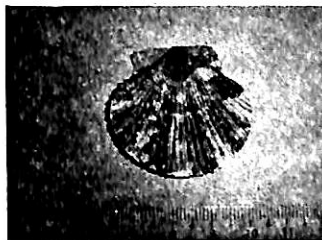
E. *Glycymeris decussata*
Exterior view



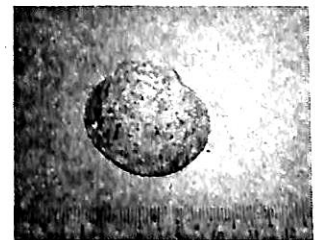
F. *Septife bilocularis*



G. *Lithophaga plumula*



H. *Argopecten circularis*
Exterior view



I. *Spondylus candidus*
Exterior view



J. Lima sowerbyi
Exterior view



K. Cardium
multispinosum
Exterior view

Plate 2. Some pelecypods belonging to Order Arcoida, Mytiloida, Pterioida and Veneroid

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