POPULATION DISTRIBUTION OF MOLLUSKS IN MANGROVE FORESTS, PAKISTAN.

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Abstract

The present study was aimed to assess the population distribution of molluscs in mangroves forests of Pakistan using multivariate analysis. Five different locations of Pakistan coast were selected and 28 stands were sampled by using 1x1 m^2 quadrats. During study, 31 species of mollusks were recorded (18 gastropods and 13 bivalves). The highest number of Gastropod and bivalve species were found at Sandspit mangrove forests. On the basis of composition of Molluscan habitats the results disclosed four main groups of mollusks by cluster techniques which readily be superimposed on the ordination plane. *Telescopium telescopium* and *Cerithedia cingulatus,* members of family Potamididae, were the dominant molluscs in the mangroves.

Introduction

Mangrove habitats support a large group of animals belonging to a range of taxonomic groups. Individually, each group is diverse and occupies considerable position among mangrove taxa. Many of these animals live in association with the roots of the trees or may be found on the benthos of the mangrove lagoon. Mangrove forests bind sediments and recycle organic matter and nutrients to support a very large biomass of flora and fauna (Pawar, 2012).

Molluscs are the commonly found invertebrates in mangrove ecosystem. They account for a good portion of biomass and key components of trophic level and create a link between phytoplankton communities. Gastropods and bivalves are the important members of mollusca associated with mangrove forests. They constitute 98% of the total population of molluscs and they inhabit land, freshwater and marine environments (Shanmugam and Rajagopal, 2006). They are commonly found in or on the mud flats and attached with the parts of the tree roots, or forage in the canopy and also show a zonation on neighboring muddy substrates from the seaward fringes of the mangrove swamps to its landward positions (Cantera *et al*., 1983). Despite their significant ecological role in mangrove ecosystems they have been exploited worldwide for food, ornamentation, furniture and pearls throughout human history.

Most of the molluscan species are not the permanent residents of these forests. However, they are commonly associated with mangroves forests. Gastropods are the most conspicuous soft bottom fauna; predominantly they inhabit sheltered muddy sediments in mangrove forests. Slim *et al*., (1997) reported that most of the molluscan are deposit feeders that scrap organic particles from the surfaces. Thus their detritivorous habit aid nutrient release and flow in the mangal by processing mangrove litter. The group bivalves are also important for commercial production and are also collected as a food source. The calcium rich bivalve shells are mainly used for lime making and poultry feeds. Marine borers belonging to the families Pholadidae and Teredinidae of Bivalvia cause substantial damage to underwater wooden construction, wooden sailing craft and floating timber, particularly in the tropics. The fishing industry depends mainly on wooden boats, reported to suffer heavy losses as a result of borer damage. Recently Nazim (2011) conducted detailed ecological investigation in mangrove forest distributed along the coastal areas of Sindh.

Little is known of mangrove bivalves, especially those few species which appear to be endemic components of the mangrove forests. The studies on the faunal assemblage and ecology of the molluscan fauna of the extensive mangrove forests in Sindh and Baluchistan coasts of Pakistan are scanty. Thereore, present study is undertaken which will provide the knowledge regarding molluscan fauna of mangroves forest.

Materials and Methods

The specimens were collected during ebb tide from five different localities i.e. Sandspit, Port Qasim, Kemari, Ketti Bunder of Sindh coast and Sonmiani of Lasbella coast. Water samples were collected in pre-acidic washed bottles and transferred to the laboratory to measure the salinity, pH, total dissolved solids, conductivity and temperature by Sension multiparameter meter (model Tm^{105}). Most of the unbroken and

colorful shells were obtained by collecting living molluscs in their natural habitats. The specimen were brought to the laboratory, sorted out, narcotized, in 4% formalin or 90% alcohol or rectified spirit and were selected for detailed study. The snails were removed with the help of safety pin.

For qualitative analysis twenty eight stands were selected from the above mentioned sites, ten quadrats $1x1m^2$ in each stand were set up to detect the spatial pattern of molluscan fauna in mangrove forests. Total numbers of mollusca were counted and unidentified species were collected and preserved for later identification. The shells were identified mainly based on the shell morphology following Bernard, (1896); Thomas, (1975).

A group structure was exposed by agglomerative cluster analysis developed by Ward, (1963) while the trends (or gradients) were disclosed using Non-parametric multidimensional scaling (NMS) ordination (Orloci and Kenkel, 1985).

Results

The Dendrogram resulting from agglomerative cluster analysis by Ward's method is shown in Fig. 1. The Dendrogram disclosed four groups at level of 81% which are described separately in the succeeding paragraphs. Fig. 2. Showing non-parametric multi dimensional scaling ordination of mulluscan species from different mangroves forest stands while Fig. 3 is a few dominant mollusks of study area.

Group I (Nerita *albicilla* - *Cerithedium edule*): Group I is a group of purely Gastropod species consisting of six families and six genera. These six species include *Onchidium sp., Bulla sp., Cerithidea decollata, Nerita albicilla, Pupa sp. and Cerithedium edule.* Among these six species *N. albicilla* ranked first with its high abundance in two sites Sandspit and Port Qasim. Higher numbers of individuals were recorded from Sandspit whereas species was collected from Kemari, Ketti Bunder and Sonmiani. *Pupa* sp. was recorded from Sandspit area only.

Group II (*Clypeomorus subbrevicula* - *Terebralia bonelli*): This group includes three species i.e. *Clypeomorus subbrevicula, Nerita* sp. and *Terebralia bonelli* belonging to three families and three genera. The gastropod species *C. subbrevicula* holds first position whereas *T. bonelli* stands at second position and *Nerita sp.* is ranked third. The first two species *C. subbrevicula* and *T.* bonelli belonging to family Potamididae were recorded from two heavily polluted areas Sandspit and Port Qasim respectively whereas *Nerita sp*. a member of the family Naticidae was recorded from Port Qasim and Ketti Bunder that are relatively less polluted.

Group III (*Lyrodus pedicellatue* - *Mercenaria stimpsoni*): It is evident from the dendrogram that group III is the largest bivalve dominating group of all and consists of nineteen species. Twelve bivalve species showing the association between gastropods and bivalves with seven species of gastropods. *Lyrodus pedicellatue, Mercenaria stimpsoni, Anadra sp., Martesia striata, Dosinella penicillata, Terebralia semistriata, Tellina alternata, Diodora italica, Pyrene flava, Acropagia diaphora, Thais carnifera, Laternula sp, Mactra chinensis, Tellina donacina, Tellina philipii, Thais hippocampus, Littorina angulifera, Solen truncatus, Cymia carnifera*. The species *Lyrodus pedicellatue* was the dominant while *Mercenaria stimpsonica* be ranked as an associated species. The dominant species was found at all locations except Ketti Bunder whereas the associated species was recorded from three sites Sandspit, Port Qasim and Sonmiani while no Bivalvia species were collected from Ketti Bunder and Kemari.

Group IV (*Telescopium telescopium* - *Cerithedia cingulatus*): In comparison to the previous groups this is a less diverse group represents two important species, *Telescopium telescopium* and *Cerithedia cingulatus*. The species *cingulatus* is a small member of gastropods with light to dark brown shell colour ranked first whereas *Telescopium telescopium* ranked second. Both species belong to family Potamididae and commonly predominate in all sites with muddy substatum mud. Even sometimes a huge area is covered by them.

The distribution pattern of the molluscan species in two-dimensional Non-Parametric Multidimensional Scaling (NMS) ordination plane is shown in Figure 2. The ordination essentially repeats the grouping of species depicted by the cluster analysis. Group I occurs in the central right part in the ordination plane at axis1 and 2 whereas Group II as a small group located at the upper right portion in the ordination space. The third group (group III) is the largest group and can be seen in the upper left portion to the lower right part being separated out in the ordination configuration. Group IV is found at the upper right portion of the ordination being separated out as the smallest group in the ordination plane. The groups showed more or less continuous pattern based on the pollution gradients.

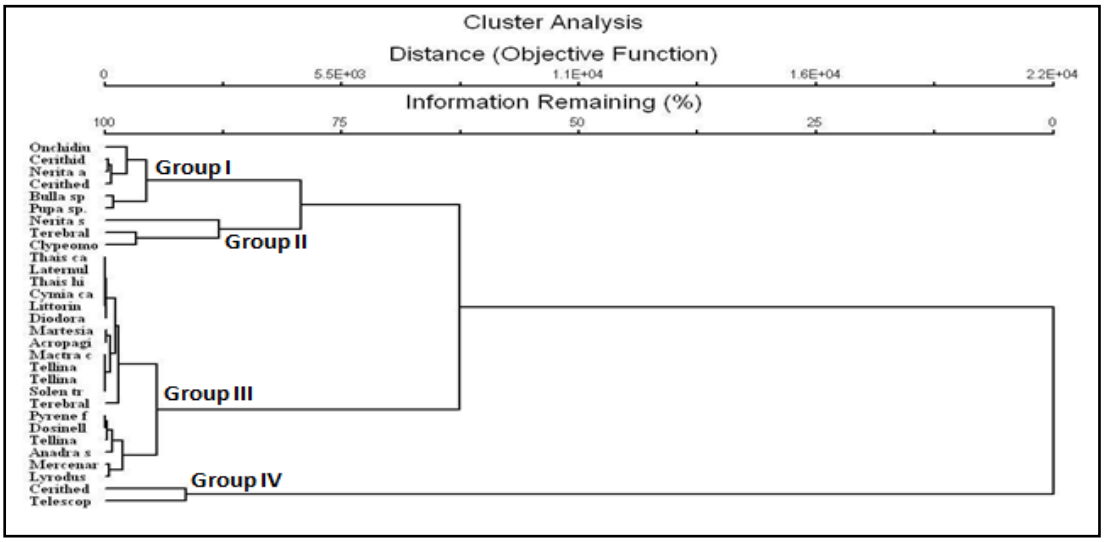

Fig. 1. Cluster Analysis of molluscan species at different areas of mangroves forests.

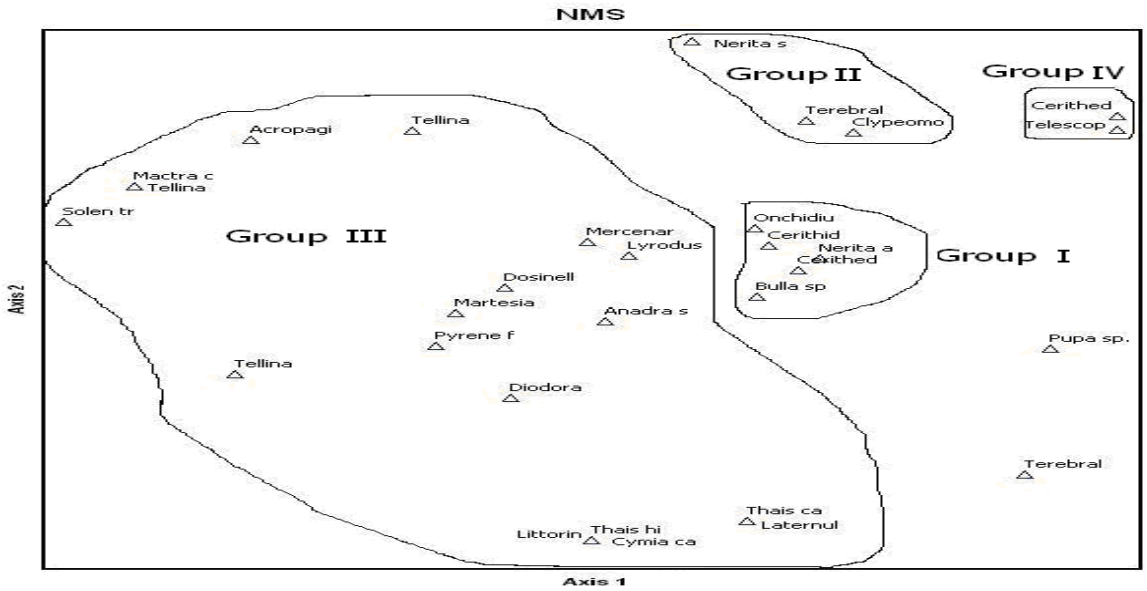

Fig. 2. Non-Parametric Multi dimensional scaling ordination of molluscan species from different mangroves forest stands.

Correlation of Ordination Axis with Environmental Variables: The correlation of Ordination axes with environmental variables is given in Table 1. Ordination axis 1 was found positively correlated with salinity (P<0.01), conductivity (P<0.01), and total dissolved solids (TDS) (P<0.05), while soil pH show no significant correlation with axis conductivity and temperature at (P<0.01). On the other hand total dissolved solids exhibited no significant correlation with axis 2.

Table 1. Correlation of ordination axes with physical parameters of water.

Environmental Variables	Axis 1	Axis 2
pH	Ns	0.77 P>0.001
Salinity	0.50 P<0.01	0.34 p<0.05
Conductivity	0.65 P>0.001	0.42 P< 0.01
Total Dissolved Solids	0.35P<0.05	Ns
Temperature	0.41 P<0.01	0.75 P>0.01

Terebralia bonelli *Clypeomorus subbrevicula* *Nerita albicilla* *Telescopium telescopium* *Cerithedia cingulatus*

Fig. 3 A few dominant mollusks of study area.

Discussion

Cluster analysis aims to organize data in such a way to expose the underlying group structure or to impose a group structure according to some a priori specifications. The species of Group A were observed less from Sandspit and Port Qasim which are considered as polluted and highly polluted areas respectively. *Onchidium* species is normally found with twigs and trunk of the mangrove trees. It was usually collected during mid tidal throughout the year at Sandspit and Port Qasim. Morphologically this species described as small sized shell-less gastropod with dark brown. The cluster analysis showed that *Telescopium telescopium* and *Cerithedia cingulatus* were found throughout the study area with a high number of individuals compared to other species because *Telescopium telescopium* can stay out of water for a long period of time. This important species consumes epiphytic algae growing on mangrove roots and pneumatophores. It sucks up detritus from the floor of the mangrove forests during low tide by using its proboscis. The bivalve species associated with the mangroves are primarily those that inhabit the mangrove roots. They often dominate the upper zones of the roots. The wood borer *Martesia striata* which is an important member of this group showing limited distribution. It is often ignored due to its occurrence in the substrate. This species occurred in a relatively open canopy, sandy bottom of shallow water in mangrove forests. The gastropods associated with this species are usually found in the mud of the mangrove lagoon. *M.striata* was only recorded from Port Qasim, Sandspit and Kemari areas as an empty shell. Morphologically *it* shows whitish rather thin and delicate characteristics. Shell is medium- to large-sized and ovate triangular.

Ordination is an important multivariate technique for taxonomic /ecological data. NMS actually refers to an entire related family of ordination techniques which use rank order information to identify similarity in a data set. NMS is a truly nonparametric ordination method which seeks to best reduce space portrayal of relationships (McCune and Grace. 2002). The groups obtained from Wards Cluster analysis were superimposed on the ordination plane of axes 1 and 2.Results explained that among the molluscan species the gastropods are the commonest epifauna species whereas bivalves are selectively found in the mangrove forest. One of the main reasons is that gastropods are suitably adapted to various macro habitats due to the elimination of the gills and conversion of the mantle cavity into a lung (Hutching and Saenger, 1987) or it may perhaps, by their voracious character which helps them to occupy a vital position in maintaining the productivity of mangroves. The large mud creeper *T.pulustris* was also present within or in the vicinity the forest areas, on soggy organic rich mud and in the channels among them (Feulner and Richard, 2006). Sometimes it has been suggested that *Littoraria* spp. feed on the hairs of *Avicennia* leaves, it is generally acknowledged that they graze the surface layers of trunks and roots where they feed on micro epiphytes (Reid, 1986; Blanco and Cantera, 1999). In contrast bivalves entail soft mud to grow well but the mangroves are highly zoned, typically occupying the upper half of the eulittoral and dominating the supra littoral fringe. These two features partly explain the lack of the bivalves in mangrove forests. The mangrove fauna also faces problems of general body desiccation but most of the gastropods recorded from the sites possess thickened shell which reduces water loss by evaporation. The thickened skeleton presumably affords some protection from predation. The gastropods and bivalves mostly depend on the productivity of the forests, presence or absence of organic matter and heavy growth of mangrove species. In the detritus based food chain, the plant material produced by the wetlands in the form of fallen leaves and so on, is broken down into fine particulate matter by a series of steps and most of the molluscs subsequently utilize the organic matter. The substrate having high organic contents and low oxygen levels may modify burrowing activity (Hutching and Saenger, 1987). The study showed that the majority of the gastropods are

tolerant to extreme environment and appear to grow progressively. The results also revealed that these three members of the families Cerithiidae, Naticidae and Potamididae are highly adopted species for polluted habitat and stress tolerant that could survive in better ways although Neritids are typically associated with marine environment. *Nerita albicilla* and *Nerita polita* are generally found on rocky shores and breakwaters directly facing surf (Tan and Reuben. 2008).

This may be concluded that mangrove forests of Pakistan provide a diverse habitat for molluscan fauna. This study also provides the understanding about the role and value of molluscs in mangrove areas and enables us to conserve such neglected, nevertheless ecologically and economically important populations for our marine as well as terrestrial environment. An important contribution of the present investigation is the observation on the occurance of wood borers which deserves special attention as these are potentially destructive not only to the mangrove trees but also for the under water wooden installations.

Acknowledgements

The authors are highly grateful to Port Qasim Authority (PQA), Geolink (Pvt) Ltd. and World Wildlife Fund (WWF) for providing facilities during the field survey conducted in this study.

References

Bernard, F. (1896). Deuxie`me note sur le de´veloppement et la morphologie de la coquille chez les lamellibranches (Taxodontes). Bulletin de la Socie´te´ Ge´ologique de France, troisie`me se´rie; 24:54–82.

Blanco, J.F and Cantera, J.R. (1999). The vertical distribution of mangrove gastropods and environmental factors relative to tide level at Buenaventura Bay, Pacific coast of Colombia. *Bull Mar Sci*, 65 (3) :617–630.

Cantera, J. Patrick, M.A and Bernard, A.T. (1983). Biogeographic and Ecological remarks on molluscan distribution in mangrove biotopes. *Gastropods. J. Mol. Std*, 49: 10-26.

Feulner, G.R and Richard, J.H. (2006). *Intertidal Molluscs in UAE Lagoons*. Tribulus 16.2 Autumn/Winter, 2006.

Hutchings, P and Saenger, P. (1987). *Ecology of Mangroves*. University of Queensland Press, Brisbane, Aust: 388.

McCune, B and Grace, J.B. (2002). Analysis of ecological communities. MjM Software Design, Gleneden Beach. Oregon. 300.

Nazim, K. (2011). Population dynamics of mangrove forest from the coastal areas of Sindh. Ph.D Thesis, Botany Dept. Fed. Urdu University, Karachi, Pakistan.

Orloci, L and Kenkel N.C. (1985). Introduction to data analysis in ecology and systematic Springer-Verlog. Berlin.

Pawar, P.R. (2012). Molluscan Diversity in Mangrove Ecosystem of Uran (Raigad), Navi Mumbai, Maharashtra, West coast of India. *Bull. Environ. Pharmacol. Life Sci*. 1(6): 55-59.

Reid, D.G. (1986). *The littorinid mollusks of mangrove forests in the Indo-Pacific region. The genus Littoraria. British Museum*, London. pp. 227.

Shanmugam, A and Rajagopal, S. (2006). Molluscs. In: UNU-INWEH-UNESCO International Training Course on Biodiversity in Mangrove Ecosystem-Course Manual, Kathiresan, K. and S.A. Khan (Eds.). Annamalai University, Parangipettai, India, 239-244.

Slim, F.J., Hemminga, M.A., Ochieng, C., Jannink, N.T., Moriniere, C.E and Velde, G.V. (1997). Leaf litter removal by the snail Telebralia palustris (Linnaeus) and sesarmid crabs in an East African mangrove forest (Gazi Bay, Kenya). *J ExperMar Bio & Eco*, 215: 35–48.

Tan, S.K and Reuben, C. (2008). Taxonomy and Distribution of the Neritidae (Mollusca: Gastropoda) in Singapore. *Zool Stud*, 47(4): 481-494.

Thomas, R.D.K. (1975). Functional morphology, ecology and evolutionary conservatism in the Glycymerididae (Bivalvia). *Palaeo*, 18(2): 217–258.

Ward, J. H. (1963). Hierarchical grouping to optimize an objective function. *Journal of the American Statistical Association.* Vol. 58(301): 236-244.