QUANTITATIVE DESCRIPTION AND MULTIVARIATE ANALYSIS OF FLORA AND FAUNA OF BULEJI AREA OF KARACHI COAST

KANWAL NAZIM[1], MOINUDDIN AHMED[2], ALIA ABBAS[2] AND MUHAMMAD UZAIR KHAN[1]

[1]Marine Reference Collection and Resource Centre, University of Karachi, Karachi
[2]Laboratory of Dendrochronology and Plant Ecology, Department of Botany,
Federal Urdu University of Arts, Science & Technology, Karachi

Abstract

Karachi coast is rich in flora and fauna like any other coast of the world. The present study deals with the quantitative and multivariate analysis of the biota found at Buleji area, Karachi coast. Three different habitats i.e. intertidal rocky shore, pools and sandy beach were selected for quantitative sampling. Macro flora and fauna were counted and collected while the fresh weight of seaweeds found on sandy beach was also obtained. The species diversity and multivariate analysis (cluster analysis and ordination) were applied on data. The results report twenty species on sandy beach, nineteen species in rocky pools and thirty three species on rocky area. The highest species diversity was recorded from sandy beach (3.623) while least (2.186) was found in pools. The results of the cluster analysis indicated two large groups on the basis of pure seaweeds on the sandy beach and the mixed flora and fauna from rocky shore and rocky pools. Two main groups were clearly separated out on ordination plane (axis 1 and 2). Some recommendations are proposed for the improvement and future research in this connection.

Introduction

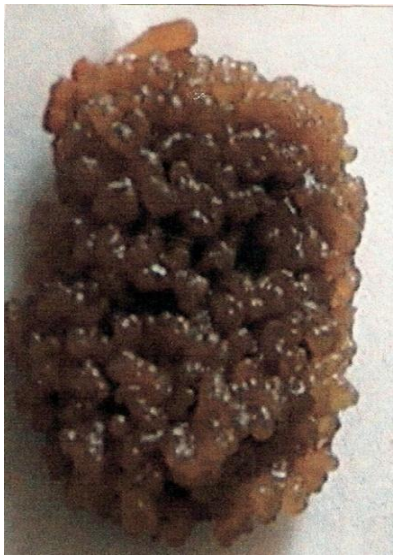
Karachi coast is one of the most diversified areas in the world. However, due to anthropogenic disturbances and higher amount of pollution, this is rapidly degrading; hence biodiversity of this coast is under a great threat. Only a few ecological attempts have been made to study the flora and fauna of this area (Anand 1940, Shameel and Tanaka 1992). Saifullah (1973) and Saifullah *et al*. (1984) carried out quantitative investigation on seaweeds of Karachi coast. Ahmed *et al*. (1982) investigated the distribution and abundance of intertidal species from Makran coast while seasonal changes in seaweeds of Manora and Buleji were studied by Qari and Qasim (1988). Barkati and Burney (1991, 1995) and Burney and Barkati (1995) presented species composition and biomass of littoral rocky shore of Karachi coast. Seasonal variations in biomass of intertidal flora and fauna of Buleji rocky shore as well as rocky bench of Pacha and abundance of marine animals on sandy beach of Clifton were studied by Ahmed and Hameed (1999 a,b) and Hameed and Ahmed (2002). A comparative ecological studies of molluscan fauna of intertidal rocky shores of Karachi were carried out by Rehman (2002). Recently Nazim *et al*. (2010a,b, Nazim 2011) extensively studied flora and fauna of mangrove ecosystem of Arabian coast from Sonmiani to Ketti Bunder.

Many factors i.e. anthropogenic, pollution, habitat, substratum, biological, physical, hydrological, climatical etc. are responsible for distribution and abundance of intertidal flora and fauna in coastal areas. These organisms play an important role in marine ecosystem and investigation of their composition, abundance, diversity and richness would increase our knowledge to understand energy/food chain of the rocky intertidal coastal ecosystem. Therefore, an attempt was made to study the mega organisms of intertidal rocks, pools and sandy beach of Buleji area of Karachi.

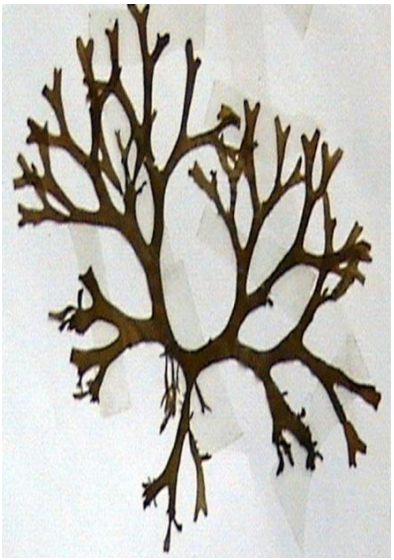
Materials and Methods

Quantitative sampling was carried out in intertidal rocky shore, pools and sandy beach. Five randomly selected stands were sampled in each area. Quadrat method (1x1 m) (Bray and Curtis 1957) was applied in sites. Macroflora and fauna were counted in each quadrat. Fresh weight of seaweeds found in coastal beach was also obtained. It was anticipated that higher amount of scattered algae on sandy beach, represents the dominance of submerged seaweeds closed to the coast. Species diversity was measured following Shannon and Weiner (1963) method. Species richness was measured using the index proposed by Menhinick (1964). The equitability index was estimated by the Pielou (1969) method while dominance was determined on the basis of density following Ahmed and Shaukat (2012). Water analysis i.e. pH, conductivity, total dissolved solid, dissolved oxygen and temperature were recorded using Hach multiparameter (model Sension TM^{105}).

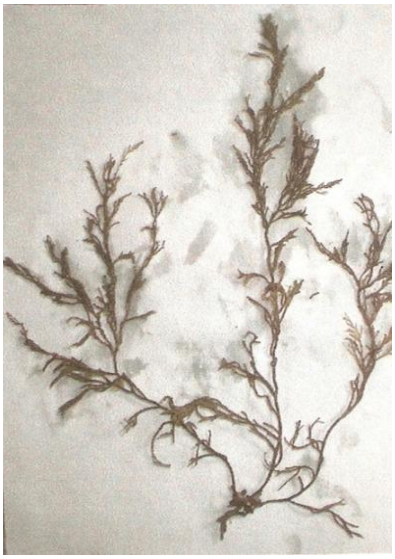
Among multivariate techniques, cluster analysis for classification of Gauch (1982) and Greig-Smith (1983) was applied to establish natural grouping in a hierarchical structure. Similar analysis was performed to define species assemblages. Ordination technique (McCune and Grace, 2002) was used to arrange all stands in relation to two coordinate axes to explain the dissimilarities in community structure.



Lyengaria stellata



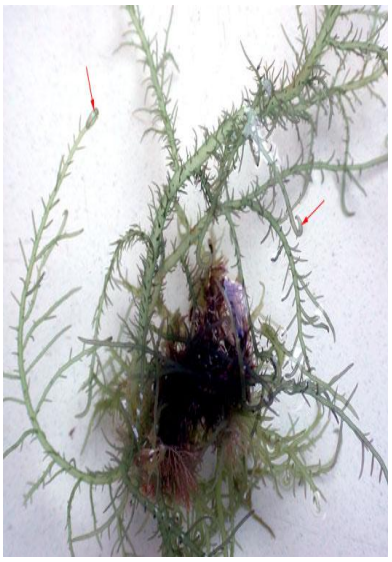
Glacilaria corticata



Cystoseira indica

Codium iyengarri

Caulerpa manorensis



Hypnea musciformis

Padina afaghusainii

Sptoglossum asperum

Stypopodium zonnale

Plate 1. Some widely distributed flora

Terebralia bonelli

Clypeomorus bifasciata

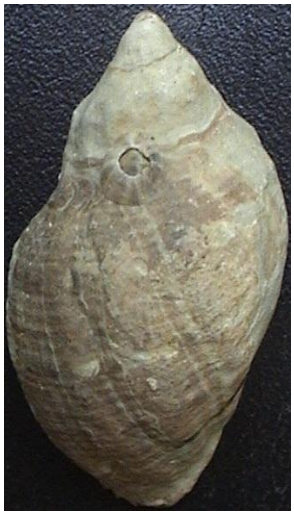
Turbo intercostalis

Turbo hippocampus

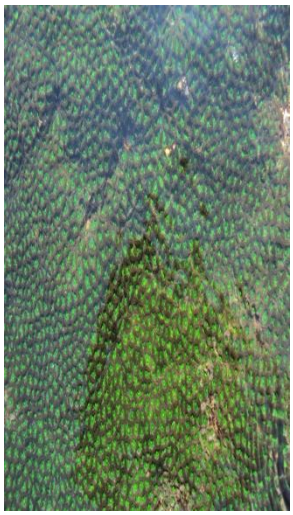
Nerita albicilla

Cypraea sp.

Clypeomorus subbrevicula



Pyrene flava



Madracis pharensis

Chiton sp.

Circenita callipyga

Siderastrea siderea

Plate 2. Some widely distributed fauna of study area.

Results and Discussions

Plates 1 and 2 indicated some of the dominant flora and fauna of study area. Overall 58 species were recorded excluding fishes, crabs and fast moving organisms (nekton).

1. **Rocky area:** Thirty three species of fauna and flora were recorded on rocky area of Buleji in which *Iyengaria stellata, Colpomenia sinuosa* and *Sargassum* sp. were found in 100 % stands. These species showed 30 (*Sargassum* sp.) to 78 (*Iyengaria stellata)* individuals, however, *Cerithedia cingulatus* was distributed with highest (103) individuals. *Terebra palustris* and *Padina pavonica* represented by 63 and 70 individuals respectively with *Siderastrea siderea, Madracis pharensis* and *Balanus* sp. colonies. Ten species were confined to only 10 % of the sampling stands of rocky shore area. Sampling was possible on exposed rocks during the low tide period only while several species of flora and fauna were abundantly distributed on submerged rocks. Therefore, to explore a wider picture of these species distribution, more detailed investigation is suggested. Physical characteristics of water collected from rocky area, during the low tide are shown in Table 1.

2. **Pool site:** Rocky pools are situated on slightly higher elevation than rocky area and sandy beach. Some larger pools are connected continuously by seawater through holes and cracks, underneath the rock show higher number of flora and fauna. Pools feed during high tide only supported few number of species and are subjected to higher rate of evaporation. Nineteen species of fauna and flora were distributed in rocky area pools. Widely distributed species were *Hypnea musciformis* found in 80 % of pools. *Balanus* sp. and *Sabella* sp. were recorded in 60 % pools while *Sargassum* sp., *Morulla granulata, Caulerpa taxifolia* and *Terebra palustris* were found in 40 % of the pools. With the exception of *Caulerpa taxifolia* other species found on rocky shore like *Spatoglossum asperm, Bulla* sp., bivalves, *Dictyota dichotoma* and *Trochus stellatus* were also associated with pool species. *Hypnea musciformis, Caulerpa taxifolia* and *Sargassum* sp. attained 171,130 and 107 individuals respectively. Other species in pool found with very low density (1 to 38). Analysis of pool water is presented in Table 1. Except dissolved oxygen, values of all parameters were higher than values of rocky shore and sandy beach.

3. **Sandy beach:** On sandy beach twenty species of fauna and flora were recorded. These organisms were uprooted or broken by tides or wave action and accumulated on sandy beach. The amount of seaweeds gave some ideas about presence, growth and abundance of different types of submerged weeds near the coast. *Padina pavonica, Padina* sp., *Iyengaria stellata, Dictyota dichotoma, Hypnea musciformis, Codium* sp., *Caulerpa recemosa, Caulerpa* sp. and *Cystoseira indica* were widely distributed individuals found in 100 % stands. Species like *Spatoglossum asperum, Sargassum* sp., *Botryocladia leptopoda, Stoechospermum polypodioides* and *Plocamium telfairiae* were recorded in 80 % of stands.

   Among seaweeds *Padina* sp. (276 g), *Padina pavonica* (218 g) and *Iyengaria stellata* (270 g) were the most abundant species on the basis of biomass. *Cystoseira indica* (199 g), *Hypnea musciformis* (193 g) and *Dictyota dichotoma (159 g)* were the next. *Plocamium telfairiae* (145 g), *Sargassum* sp. (135 g), *Caulerpa recemosa* (131 g), *Codium* sp. (130 g) and *Halymenia porphyraeformis* (114 g) occupied the third position on the basis of biomass. Three species *i.e*. *Stoechospermum polypodioides*, *Caulerpa* sp. and *Spatoglossum asperum* attained almost similar (111 g) average biomass. Other species were associated with low biomass on sandy beach.

   In this study area *Sargassum* sp. *and Hypnea musciformis* were the most abundant species found in 73 % of the overall stands. *Dictyota dichotoma* (60 %), *Terebra palustris (53* %) and *Spatoglossum variabile* (43 %) alongwith above two species were found in all three types of habitat; however few species were restricted to only one type of habitat. Low number (or biomass) of seaweeds recorded on sandy beach does not necessarily mean that these species are also less abundant in submerged condition. It is anticipated that species with larger thallus are more subjected to wave action than species with small and unfragmented thallus. However, more detailed studies are required in submerged condition to explore real distribution of seaweeds in this area.

   Table 2 shows the species diversity, species richness, evenness and concentration of dominance of fauna and flora of three areas at Buleji. The highest diversity (3.621), evenness (0.927), richness (3.846) and dominance (2.719) were calculated from sandy beach while least were recorded from pools. Rehman (2002) calculated the overall diversity of flora and fauna at Buleji. The present values are within the range of the previous findings.

   Water analysis of sandy beach showed considerable lower values if compared to pool water while no significant difference was found with water of rocky shore (Table 1). It is anticipated that higher amount of salinity, dissolved oxygen, conductivity and pH in pool water were due to the less amount of water and higher rate of transpiration. This may be the reason of lowest values of species diversity, evenness, richness and dominance in pool water (Table 2).

Table 1. Physical analysis of sandy beach, rock water and pool water at Buleji area.

Parameters	Sandy beach	Rock water	Pool water
Salinity	35.24	35.31	41.92
Total dissolved solids	33.60	33.42	40.96
Conductivity	51.44	51.52	62.58
Dissolved oxygen	1.19	1.15	1.31
pH	7.90	7.85	8.35
Temperature	23.22	23.56	24.3

Table 2. Species diversity, richness, equitability and dominance of species recorded from Buleji area.

Parameters		Sandy beach	Rock water	Pool water
Diversity	(H)	3.623	2.811	2.186
Evenness	(J)	0.927	0.818	0.707
Richness	(d1)	3.846	1.214	0.902
Dominance	(D)	2.719	0.190	0.170

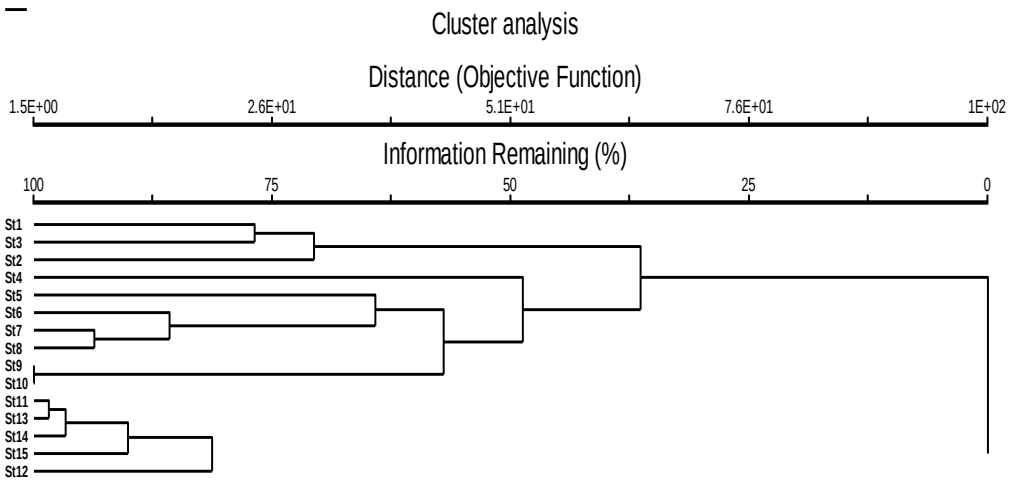


Fig. 1. Showing the cluster analysis of fifteen stands at Buleji area.

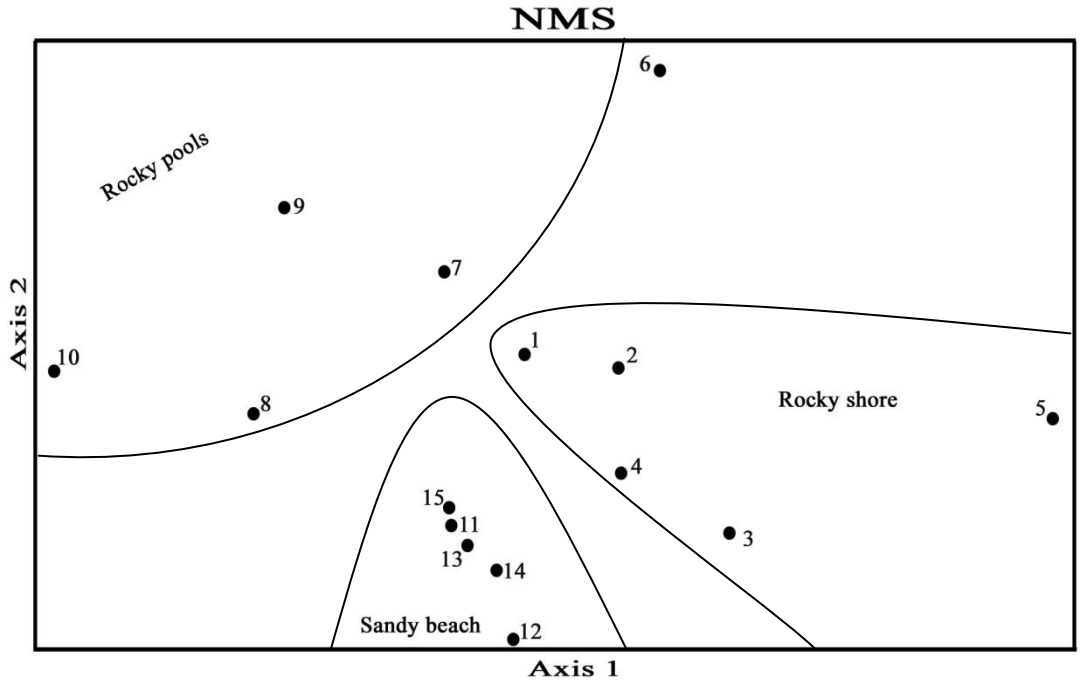


Fig. 2. Non-Parametric Multidimensional Scaling (NMS) ordination of fifteen sites at Buleji area.

Cluster analysis and ordination: Figure 1 showed the cluster analysis of fifteen study sites including rocky shore, rock pools and beach area of Buleji. Results indicated two large groups on the basis of pure seaweeds (without any animal) on the sandy beach and the mixed flora and fauna from rock shore and rocky pools. Group 2 is divided in two groups again. Stand 1, 2 and 3 were dominated by *Iyengaria stellata* and *Padina pavonica* while stands 4 and 5 were occupied by *Chiton* sp. and *Spatoglossum asperum* respectively. These belonged to the rocky shore area. Stands 6 to 10 representing the pools, in which *Hypnea musciformis, Balanus* sp. and *Sabella* sp. are the widely distributed fauna and flora. Stands 11 to 15 were from the sandy beach which were dominated by *Padina* sp., *Iyengaria stellata* and *Codium* sp.

Distribution of stands are also shown on two axes of Non-Parametric Two Dimensional Scaling Ordination (Figure 2). On axis 1 stand 5 of rocky shore, extreme right hand side and stand 10 of rocky pool, extreme left hand side were two most dissimilar stands. Stand 5 was dominated by *Cerithadia cingulata, Turbo coronatus* and *Colpomenia sinuosa*, while stand 10 was dominated by *Caulerpa taxifolia and Hybnea musciformis*. Similarly on axis 2 stand 12 of sandy beach and stand 6 of rocky shore were extremely separated stands. These were occupied by *Hypraea prophyraeformis, Iyengaria stellata, Padina pavonica* and *Bulla* sp., *Bivalvia* sp. respectively. Ordination also indicated the three same groups or habitats. Beach stands (11 to 15) occupied the lower middle position of the two axes. Rocky shore stands are distributed from middle to lower right side of the ordination diagram while pool stands may be seen on upper left side of the ordination.

Sandy beach stands occupied smallest area of axis 1 and 2, indicating highest similarity among stands. Stands of rocky beach disturbed on wider area of diagram followed by rocky pools. It is anticipated that wider distribution of rocky pools on the ordination space are due to their different sizes, depts, distances from sea and connection of sea water which may be the controlling factors of salinity and presence of flora and fauna in these pools.

This area shows less anthropogenic disturbance compared to other nearby coastal areas and located away from pollution. Therefore present study would provide basic information about the distribution of flora and fauna of these three habitats.

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