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Diversity and biomass distribution of intertidal fauna in sonmiani bay (Miani Hor), balochistan (pakistan)

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ABSTRACT

A year long study of seasonal variations in community structure and biomass of sandy intertidal zone was carried out in Sonmiani Bay (Miani Hor), Balochistan. The samples were collected, by using a small beach seine and experimentally designed small beam trawl to collect the pelagic, demersal and benthic intertidal organisms. The sampling was carried out from January 2002 to December 2002 during the low tides duration. A total of 84 species were recorded mainly comprised of three major faunal groups e.g. fishes, crustaceans and mollusca. The mollusca were the most diverse and abundant group of animals that formed 39.37% of total faunal assemblage, where as crustaceans and fishes contributed 32.2% and 27.6% ,respectively. Of these, Mugilidae and Sillaginidae were dominating families from fishes. Portunidae, Penaeidae, Diogenidae, Nassariidae and Dentaliidae families also showed their presence obviously as the prominent community groups. The beam trawl collected more number (58.71%) of benthic individuals from the benthic area than beach seine that sampled the pelagic and free swimming fauna (41.28%). A significant seasonal variation (P=0.047) in the biomass distribution indicated the utilization of shallow intertidal zone adjacent to mangroves, as nursery and refuge of many juveniles of resident and visiting fauna

Keywords: Diversity, Seasonal abundance, biomass distribution, Sonmiani Bay, Intertidal fauna.

INTRODUCTION

Shallow coastal marine waters are generally considered as highly productive due to high insulation to the bottom and high temperatures in enclosed areas and favoured as nursery and feeding grounds for fish and other faunal species (Pihl and Rosenberg, 1982, Kundo *et al*., 2010). The production, abundance, biomass, and horizontal dispersion of the macrofauna have been the core interest for many years in different coastal habitats (Ashton *et al*., 2003; Shou *et al*., 2011a).

Variations in biotic and abiotic characteristics promote various types of niches and habitats for macrofauna within the intertidal zone. Mangrove vegetation also contributes to habitat complexity and the diversity of the associated fauna of the mangrove ecosystem (Hutchings & Saenger, 1987; Lee, 2008a). The macro organisms are able to inhabit in both sandy and sandy-loamy substrates with or without vegetation. The macrofauna form an important link between mangrove detritus at the base of the mangrove food web and consumers at higher trophic levels, which include

birds and commercial fish species (Macintosh, 1984). Morton (1990) stated that mangrove lined intertidal areas are of greater importance as providing a habitat for commercially important aquatic animals. Therefore, two groups of animals e.g. fishes and shrimps that utilize nearshore intertidal zones, remain in the focus of research.

The muddy or sandy intertidal zones serve for variety of micro ecosystems for epibenthic, infauna and meiofaunal invertebrates. Composition of macrofauna distribution changes according to different tidal levels and varying micro habitats within an ecosystem (Chapman, 2006; Vazirezadeh *et al*., 2011), thus, distribution of macrofauna is affected by the environmental properties too (Lee, 2008b). It is also of great interest that mangroves and mud flats are utilized during flood tides by many periodic foragers from the inshore waters. Many of the inshore fish and shrimp species are commonly found species in mangrove and mudflat habitats. Chong *et al.*, (1990), discussed the species richness in Malaysian mangroves and found that intertidal mudflats and adjacent inshore water communities as transient both from mangrove and sub-tidal habitats. The benthic communities vary in structure and function regularly in a definite pattern because they continuously interacting with environmental factors such as temperature or salinity (Day *et al*., 1989; Veloso *et al*., 1997).

Many gears (e.g. portable pot net, small beam trawl, small beach seine, stake net, etc.) have been used to study the different distribution patterns and to estimate the abundance, biomass and production of macrofauna (Pierce *et al*., 1990; Turnbull and Watson, 1992; Gibson *et al*., 1993; Clark *et al*., 1996; Kurkilahti, 1999; Fransozo *et al*., 1998; Finstad *et al*., 2000; Selleslagh & Amara, 2007).

Several fishery workers reported the distribution and diversity of marine organisms found in Sonmiani Bay area (Ahmed *et al*., 1982a, Van Zalinge *et al*., 1987a) but these were reported from outside of the lagoon area in the open Arabain Sea. The dominance of *Metapenaeus monoceros* and *Penaeus monodon* in the bay was reported by Van Zalinge *et al*., (1987b). The only report that discussed the presence of mudskippers, fiddler crabs, other ocypodid crabs, snails, seaweeds, mangroves and birds by Ahmed *et al*. (1982b). Ahmed and Ayub (1996a) gave the first report on the Penaeid shrimp's population from Miani Hor. Recently Jahangir *et al*., (2012) and Afsar *et al*., (2012), updated the records of bivalve families Tellinidae, Veneridae and Arcidae and selected prosobranchs (gastropods) species from Phitti creek (Karachi) and Sonmiani (Balochistan) along the coast of Pakistan respectively.

The present study was aimed to document the qualitative seasonal diversity and community structure of the intertidal fauna in Sonmiani Bay. The environmental factors such as physical and chemical characteristics of the water masses and their seasonal changes were also investigated.

MATERIALS AND METHODS

Study site

The entire coastline of Pakistan, which is about 990 km long, consists of Sindh province (320 km) and Balochistan province (670 km) approximately, lays in the subtropics of the northern Arabian Sea. The coast of Balochistan has many characteristic bays (locally known as Hor). The Sonmiani Bay or Miani Hor is a lagoon, which is situated some 90 km away from Karachi on the eastern most part of Balochistan coast (Fig.1). The bay is a 60 km long and 7 km wide tortuous and contorted body of water, which is connected to the sea on southeastern end by a 4 km wide mouth. (Saifullah and Rasool, 1995). The sources of fresh water for Miani Hor

are the seasonal run-off of the Porali and Windor rivers (Rasool *et al*., 2002; Saifullah *et al*., 2004).

Miani Hor mangroves represent 42% (3000 ha) of the total cover of mangroves forest in the Balochistan. This area is also of extreme importance because three species of mangroves, *Avicennia marina, Rhizophora mucronata,* and *Ceriops tagal* are found growing naturally which plays an important role in the productivity of the lagoon. Two sampling stations were selected at a distance of 200 meters from each other. The sampling stations were located in between longitude 66° 33' 75" E and 66 ° 33' 78" E and latitude 25° 27' 43" N and 25° 27' 54" N.

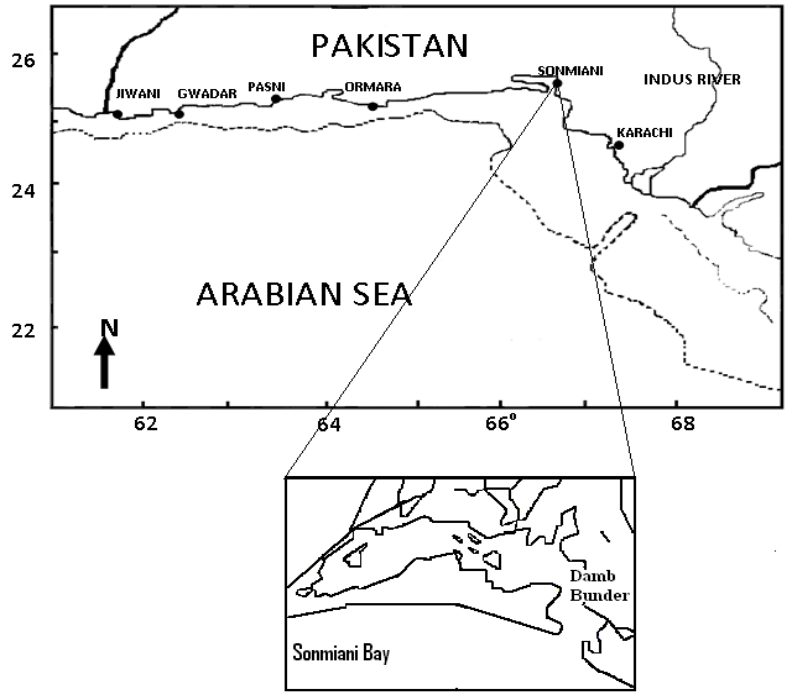

Fig. 1: Coastline map showing Sonmiani bay (Miani Hor/lagoon), the study site.

Sampling and Data Analysis

The samples of benthic and pelagic fauna were collected from January 2002 to December 2002 on monthly basis from two selected stations during low tide. Two different types of fishing gears; beach seine and beam trawl were used to collect the faunal samples. The pelagic fauna like small sized fishes and other pelagic nektons were collected by beach seine, whereas beam trawl was operated to collect the smaller intertidal benthic organisms. The net of 0.5 cm of mesh size made up of polyester + cotton was used in both beach seine and beam trawl. A beach seine of 10m x 2.5m was used to collect the mobile fauna. The beam trawl was a modified form of crab scrape used for blue crab fishing (Miller *et al.,* 1980). The sample was collected as a whole fraction for most of the faunal groups from both beach seine net and beam trawl net except for fishes. The sub-sampling was done by taking it approximately one tenth (by weight and number) representing the entire fish sample. In few instances, the sampled fishes were few in number, so the whole sample was made the part of collection. The samples were kept in the ice initially and brought back to laboratory for later investigations.

The physio-chemical parameters such as seawater salinity, air temperature, water temperature, pH and conductivity values were also recorded, using refractometer, pH meter and conductivity meter during the sampling.

In the laboratory, initially all faunal groups were sorted, preserved (5-10% formalin), and identified up to the lowest taxonomic level. The fish, shrimps, hermit crabs, crabs and molluscan shells samples were identified with the help of identification keys provided by Tirmizi and Siddiqui (1981); Eisenberg (1981); Tirmizi and Zehra (1982); Oliver (1984); Bianchi (1985) and Abbot (1991). The estimates for percent occurance and relative numerical abundance of each species were carried out. Species diversity for each month was calculated by Shanon-Weaver index (H´) (Shannon- Weaver, 1963), species richness of each sample calculated by Margalef, (1967) and Similarity index was also calculated to compare the two sets of data collected from two types of nets (beach seine and beam trawl) by using Jaccard's similarity index (Jaccard, 1908).

RESULTS

Hydrographical Parameters:

The salinity was observed high than the usual value (35 $^{o}/_{oo}$) of the normal seawater and was ranged in between 38 $^{o}/_{oo}$ to 40$^{o}/_{oo}$. The minimum salinity was recorded in the month of July; where as maximum value was observed in September (Table 1). The air temperature was ranged between 20^{o}C to 32^{o}C throughout the sampling period. The water temperature was also associated with air temperature, so there were limited seasonal fluctuations were observed in water temperature (Jan. 16.5^{o}C-Jun. 31.5^{o}C). The pH was ranged from 6.0 to 10.8, the minimum value was observed in September and maximum value was observed in November (Table1).

Table 1: Descriptive statistics of physicochemical parameters collected from Sonmiani Bay (Miani Hor) during Jan 2002-Dec 2002.

Season	Salinity (ppt.) (min-max)	Air Temp.(^{o}C) (min-max)	Water Temp.(^{o}C) (min-max)	pH (min-max)	Conductivity(µM) (min-max)
NE Monsoon	38±2.050 (35.7-39.7)	23±3.28 (20-26.5)	19.3 ±2.47 (16.5-21)	7.6±0.189 (7.5-7.8)	65.13±7.62 (56.8-71.75)
Pre Monsoon	36.9±0.520 (36.5-37.5)	30.16±1.155 (29.5-31.5)	27.9±2.17 (26-30.3)	8.0±0.0257 (7.9-8.0)	70.55±2.41 (68.6-73.25)
SW Monsoon	38.4±1.010 (37.5-38.2)	29.3±2.78 (29-32.2)	28.1±3.10 (25-31.25)	7.8±0.302 (7.5-8.1)	69.78±0.982 (68.65-70.4)
Post Monsoon	39.4±0.629 (38.75-40)	26.9±0.629 (26.3-28)	25.6±1.039 (25-26.8)	8.0±2.46 (6.0.-10.8)	70.4±2.56 (68.3-73.25)

Macrofauna Distribution

Mostly intertidal bentho-pelagic fauna consisted of smaller size individuals including juveniles and sub-adults of fishes, crabs (*Portunus spp*.), and shrimps that formed a bulk of samples. Monthly variations were observed in the distribution of macrofaunal species in the beach seine and beam trawl samples (Fig. 2).

The representatives of mollusca group showed abundance during Post monsoon season and North-east monsoon season where fish species were abundant during Pre and South-west monsoon season (Fig. 2). The total numbers of 84 species were identified in the collected samples from which 38 macrofaunal species were common and identified in both beach seine and beam trawl samples (Table 2). Species of three taxonomic groups included Mollusca (39.37%); Crustacea (32.9%) and Fishes (27.6%) were identified through out the year. The beam trawl collected more number (58.71%) of individuals from the benthic area than beach seine (41.28%) that sampled the pelagic and nektons (Table 2).

The mollusca were the leading, most varied and abundant group of organisms that represented 28 families with 34 species in total occurrence of intertidal fauna (Table 2) and mostly collected in beam trawl. There were 1346 individuals in the samples that represented the different classes mainly scaphopoda, gastropda and bivalvia (Table 2). The *Nassarius spp*. was found most abundant (13.58%) of total faunal assemblage in beam trawl. The hermit crabs (19.98%) were second in abundance among the bentho-pelagic intertidal fauna as associated with gastropod shells. The other taxa e.g. crabs, shrimps and few demersal fishes were also identified in the beam trawl samples (Table 2).

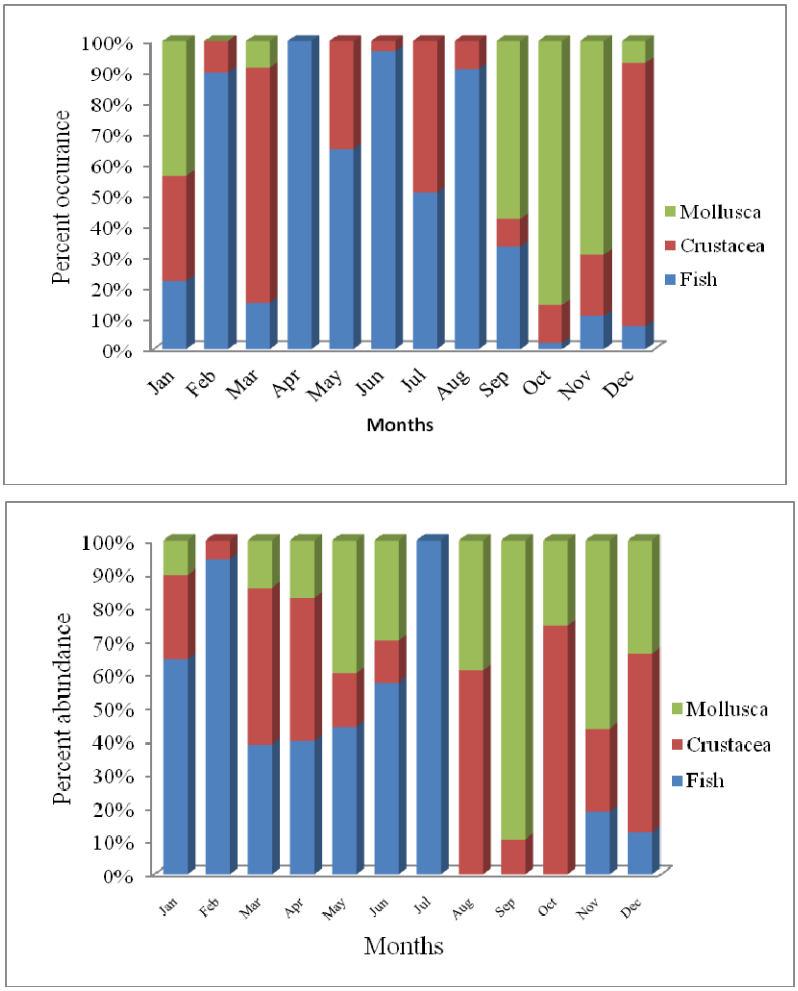

Fig. 2: Monthly percent occurance of three distinct intertidal faunal groups collected by A. beach seine (BS) and B. beam trawl (BT) during Jan 2002-Dec 2002.

The crabs also showed variation in abundance in the sandy benthic region of intertidal zone of Miani Hor. Among 7 families of crabs, family Calapidae showed its presence throughout the sampling period with two species *Ashtoret lunaris* and *Matuta planipes*. The juveniles and sub-adults of commercially important *Portunus pelagicus* and *Portunus sanguinolentus* were also found in the samples (Table 2). Representatives of family Penaeidae contributed (17.36%) to total beach seine sample as well as of total samples. A total of eight shrimp species were identified and juveniles of *Metapenaenus spp*. were abundantly found species (Table 2).

A total of 22 species of fish expressed their assemblage by 14 families as were mostly collected in beach seine samples. The fishes contributed 58.22% of total

sample by numbers collected through beach seine (Table 2). The representatives of two families Mugilidae (*Liza subviridis, L. carinata* and *L. vaigiensis*) and Leiognathidae (*Leiognathus fasciatus, L. splensens* and *Secutor insidiator*) were observed throughout the sampling period where as family Sillaginidae was present with only (*Sillago sihama*) permanent species (Table 2). The diversity among fish species was not much varied and maximum numbers of species were found in the month of May.

Table 2: Percentage occurance, percent biomass and abundance of macrofaunal species collected sample through beach seine (BS) and beam trawl (BT) from Sonmiani Bay (Miani Hor), during Jan 2002 – Dec 2002.

S. No.	Group (s)	N	Occurance (%)	BS	BT	BS %	BT %	Biomass (g)	Biomass (%)
	Fishes								
	Mugilidae								
1	*Liza subviridis*	354	9.97	348	6	9.8	0.16	356.04	2.35
2	*L. carinata*	118	3.32	88	30	2.48	0.84	59.34	0.39
3	*L. vaigiensis*	23	0.64	23	0	0.64	0	40.4	0.266
	Albulidae								
4	*Albula vulpes*	44	1.24	38	6	1.07	0.16	37.59	0.24
	Sillaginidae								
5	*Sillago sihama*	146	4.11	135	11	3.8	0.31	210.52	1.39
	Soleidae								
6	*Solea elongata*	38	1.07	25	13	0.7	0.36	34.53	0.22
7	*Zabrius quaga*	1	0.028	0	1	0	0.028	0.68	0.004
	Clupeidae								
8	*Illisha* Juveniles	19	0.53	19	0	0.53	0	2.7	0.017
9	*Sardinella gibbosa*	6	0.16	6	0	0.16	0	2.75	0.018
	Gobiidae								
	Bolephthalmus spp.								
10	**Leiognathidae**	1	0.028	1	0	0.028	0	8.28	0.054
	Leiognathus fasciatus								
11	*L.splendens*	2	0.056	2	0	0.056	0	4.51	0.029
	Secutor insidiator								
12	**Gerridae**	1	0.028	1	0	0.028	0	0.43	0.002
13	*Gerres filamentosus*	4	0.11	2	2	0.056	0.056	4.03	0.026
	Hemiramphidae								
14	*Hyporamphus dussumieri*	6	0.16	5	1	0.14	0.028	41.02	0.27
	Platycephalidae								
15	*Cociella crocodile*	23	0.64	23	0	0.64	0	28.92	0.19
	Engraulidae								
	Thryssa vitrirostris								
16	*T. hamiltonii*	1	0.028	1	0	0.028	0	14.31	0.094
	Carangidae								
17	*Carangoides spp.*	129	3.63	129	0	3.63	0	34.41	0.22
	Alepes melanoptera								
18		18	0.5	18	0	0.5	0	29.28	0.19
19		1	0.028	1	0	0.028	0	16.39	0.10
20		1	0.028	0	1	0	0.028	6.05	0.03

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S. No.	Group (s)	T.N. (Total number)	Occurance (%)	BS (N)	BT (N)	BS %	BT %	Biomass (g)	Biomass (%)
	Bothidea								
21	*Pseudorhombus elevates*	1	0.028	1	0	0.028	0	65.41	0.43
	Teraponidae								
22	*Terapon jerboa*	1	0.028	0	1	0	0.028	0.3	0.001
	Crabs								
	Portunidae								
23	*Portunus pelagicus*	109	3.07	72	37	2.02	1.04	925.24	6.10
24	*P.sanguinolentus*	14	0.39	10	4	0.28	0.11	21.28	0.14
25	*Charybdis annulata*	5	0.14	0	5	0	0.14	11.14	0.07
	Calapidae								
26	*Ashtoret lunaris*	54	1.52	47	7	1.32	0.19	377.47	2.49
27	*Matuta planipes*	28	0.78	20	8	0.56	0.22	22.78	0.15
	Xanthidea								
28	*Actea savignyi*	2	0.056	1	1	0.028	0.028	0.29	0.001
	Leucosiidae								
29	*Philyra globosa*	47	1.32	0	47	0	1.32	2.16	0.01
	Grapsidae								
30	*Grapsid spp.*	49	1.38	0	49	0	1.38	0.24	0.001
	Porcellanidae								
31	*Petrolisthes spp.*	9	0.25	1	8	0.028	0.22	1.59	0.01
	Ocypodidae								
32	*Uca spp.*	2	0.056	2	0	0.056	0	3.74	0.024
	Shrimps								
	Penaeidae								
33	*Metapenaeus affinis*	96	2.7	66	30	1.86	0.84	48.41	0.31
34	*M. monoceros*	48	1.35	0	48	0	1.35	25.98	0.17
35	*M. stebbingyi*	208	5.86	142	66	4	1.86	147.75	0.97
36	*M. brevicornis*	35	0.98	10	25	0.28	0.7	12.56	0.08
37	*Penaeus indicus*	2	0.056	2	2	0.056	0	0.55	0.003
38	*P. marguiensis*	6	0.16	0	0	0	0.16	1.22	0.008
39	*Parapenaeopsis hardwickii*	29	0.81	22	22	0.65	0.19	32.05	0.21
40	*P. scluptilis*	33	0.93	16	16	0.45	0.47	17.42	0.11
	Hermit crabs								
	Diogenidae								
41	*Diogenes bicristimanus*	51	1.43	1	1	0.028	1.4	63.24	0.41
42	*D. planimanus*	13	0.36	3	3	0.084	0.28	230.8	1.52
43	*D. diogenes*	33	0.93	1	1	0.028	0.9	29.08	0.19

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S. No.	Group(s)	T.N	Occurance (%)	BS(N)	BT(N)	BS %	BT %	Biomass (g)	Biomass (%)
44	*D. custos*	5	0.14	1	4	0.028	0.11	5.72	0.037
45	*D. avarus*	335	9.44	33	302	0.93	8.51	262.77	1.73
46	*D. guttatus*	2	0.056	0	2	0	0.056	5.12	0.033
47	*D. costatus*	1	0.028	0	1	0	0.028	0.91	0.006
48	*Clibanarius signatus*	1	0.028	0	1	0	0.028	51.2	0.33
	C. padavensis								
49	*C. infraspinatus*	5	0.14	0	5	0	0.14	105	0.69
50	**Mollusca**	5	0.14	0	5	0	0.14	354.8	2.34
	Naticidae								
	Natica spp.								
51	**Mitridae**	41	1.15	24	17	0.67	0.47	470.2	3.10
	Mitra spp.								
52	**Muricidae**	71	2	2	69	0.056	1.94	1019.8	6.73
	Cymia carinifera								
53	**Cerithiopsidae**	26	0.73	10	16	0.28	0.45	1577.2	10.41
	Seila spp.								
54	*Cerithiopsis spp*.	96	2.7	26	70	0.73	1.97	40.37	0.26
55	**Arcidae**	27	0.76	0	27	0	0.76	580.3	3.83
	Anadara antiquta								
56	**Nassaridae**	6	0.16	1	5	0.028	0.14	50.8	0.33
	Nassarius spp.								
57	*Bullia spp.*	554	15.16	72	482	2.02	13.58	302.18	1.99
58	**Thaididae**	30	0.84	0	30	0	0.84	299.3	1.97
	Morula granulate								
59	**Turridae**	1	0.028	0	1	0	0.028	0.6	0.003
	Turricula javana								
60	*Turris spp.*	79	2.22	0	79	0	2.22	1500.2	9.90
61	*Clavatula spp.*	27	0.76	4	23	0.11	0.64	281.3	1.85
62	*Turritella spp.*	21	0.56	9	12	0.25	0.33	99.7	0.65
63	**Janthinidae**	16	0.45	2	14	0.056	0.39	323	
	Janthina spp.								
64	**Veneridae**	2	0.056	0	2	0	0.056	20.5	0.13
	Leioconcha picta								
65	**Olividae**	1	0.028	0	1	0	0.028	18.2	0.12
	Oliva spp.								
66	**Strombidae**	33	0.93	1	32	0.028	0.9	375.9	2.48
	Tibia spp.								
67	**Littorinidae**	11	0.31	2	9	0.056	0.25	179.6	1.18
	Littorina spp.								
68	**Dentallidae**	16	0.45	0	16	0	0.45	832.4	5.49
	Dentallium spp.								
69	**Buccinidae**	107	3.01	4	103	0.11	2.9	151	0.99
	Babylonia								
70	*spirata*	3	0.08	1	2	0.028	0.056	7.4	0.048
	Terebridae								
	Terebra spp.								
71	**Volutidae**	55	1.55	9	46	0.25	1.29	1045.3	6.90
	Lyria spp.								
72	**Thaididae**	2	0.056	2	0	0.56	0	7.2	0.04
73	*Thais cranifera*	19	0.53	0	19	0	0.53	682.2	4.50
74	*Mancinella spp.*	1	0.028	0	1	0	0.028	31.2	0.20
75	**Veneridae**								
	Dosinia spp.	3	0.08	0	3	0	0.084	682.2	4.50
76	**Mitridae**								
	Vaxillum spp.	12	0.33	0	12	0	0.33	143	0.94
77	**Solenidae**								
	Solen spp.	3	0.08	0	3	0	0.084	19	0.12
78	**Columbellidae**								
	Strombina spp.	15	0.42	0	15	0	0.42	13.5	0.08
79	**Acteonidae**								
	Pupa solidula	2	0.056	0	2	0	0.056	2.5	0.01
80	**Potamididae**								
	Potamides spp.	34	0.95	0	34	0	0.95	108.8	0.71
81	**Cerithidae**								
	Cerithium spp.	39	1.09	1	38	0.28	1.07	135.9	0.89
82	**Planaxidae**								
	Planaxis spp.	13	0.36	0	13	0	0.36	24.7	0.16
83	**Veneroidae**								
	Circenita callipyga	9	0.25	0	9	0	0.25	189	1.24
84	**Mactridae**								
	Mactra spp.	8	0.22	0	8	0	0.22	171	1.12
	TOTAL	**3548**		**1486**	**2062**			**15143.85**	

Biomass Distribution

Monthly variations were observed in the biomass distribution in beach seine and beam trawl samples (Fig. 3). Significant seasonal variations ($F_{3, 47}$= 2.89, P=0.047) were found in the biomass distribution and the highest biomass (463.2±450.1) was observed in the north east monsoon season and was lowest (151.6 ±138.7) in pre monsoon (Table 3). As the mollusca contributed major share in the species composition of the intertidal zone thus the biomass of the zone was also affected. The biomass composed of molluscan individuals was 76.8% for the sample. The whole fraction was constituted of various species; however *Cymia cranifera* (14.68%), *Turricula javana* (14.185), *Terebra spp.* (9.88%) and *Mitra spp.* (9.64%) were other leading species to make the mollusca as dominant group of organisms of the area.

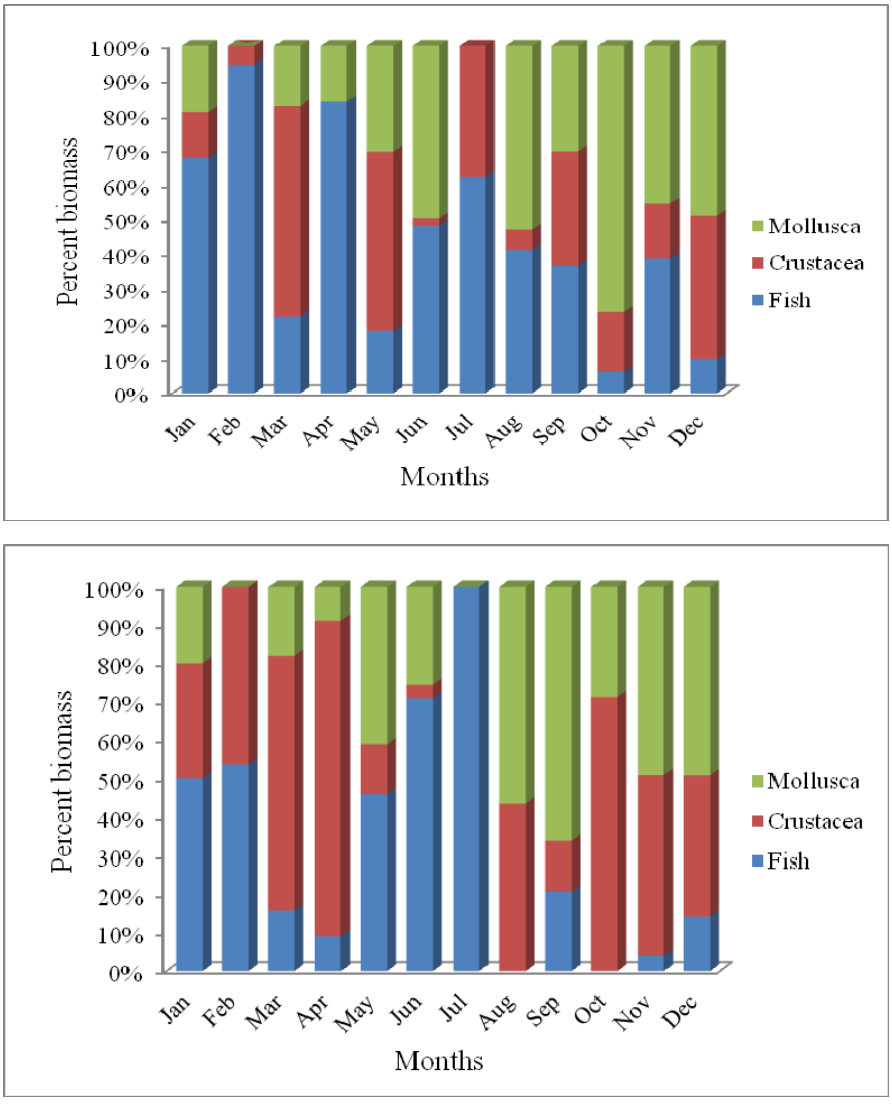

Fig. 3: Monthly distribution of biomass of three distinct intertidal faunal groups collected by A. beach seine (BS) and B. beam trawl (BT) during Jan 2002-Dec 2002.

Table 3: Descriptive statistics for seasonal differences in diversity indices (Diversity, Equitibility, Spp. Richness) and biomass in intertidal fauna of Sonmiani Bay (Miani Hor) during Jan. 2002 to Dec. 2002.

Season	Net Type	Div.(±SD) (min-max)	Equit. (±SD) (min-max)	Sp. Rich. (±SD) (min-max)	Biomass (g) (±SD) (min-max)
NE Monsoon	BS	1.60(±0.40) (1.14-1.87)	0.62(±0.10) 0.52-0.72)	11.39(±2.0) (9.8-13.6)	239(±216) (39-469)
Pre Monsoon		1.97(±1.48) (0.30-3.16)	0.56(±0.37) (0.15-0.88)	12.0(±2.38) (9.33-13.89)	737(±494) (234-1221)
SW Monsoon		2.05(±0.14) (1.89-2.17)	0.72(±0.09) (0.62-0.81)	9.73(±2.68) (6.64-11.40)	299(±225) (54-499)
Post Monsoon		2.85(±0.64) (2.33-3.57)	0.75(±0.04) (0.71-0.80)	9.60(±1.97) (8.0-11.80)	355.8(±170.3) (246.2-552)
NE Monsoon	BT	2.70(±1.56) (1.11-4.24)	0.77(±0.06) (0.70-0.83)	12.50(±9.61) (5.65-23.49)	758(±1124) (83-2055)
Pre Monsoon		3.48(±0.31) (3.28-3.84)	0.84(±0.02) (0.81-0.87)	9.62(±4.66) (6.24-14.93)	786(±749) (235-1639)
SW Monsoon		2.34(±0.93) (1.29-3.11)	0.80(±0.01) (0.78-0.81)	8.81(±7.07) (2.82-16.61)	452(±474) (48-973)
Post Monsoon		2.43(±0.63) (1.72-2.97)	0.64(±0.11) (0.52-0.74)	14.05(±7.78) (9.48-23.04)	993(±995) (343-2139)

Among crustaceans, crabs (Anumuran and Portunid) formed the total biomass of 9.27%. However, *Portunus pelagicus* contributed 68.59% of total crab biomass in the sample. The *Metapenaeus stebbingi* (50.7%) and *Clibanarius infraspinatus* (32%) were among the major contributor. The other crustaceans that represented the secondary production of the zone were shrimps and hermit crabs. Both shrimps and hermit crabs represented 1.96% and 7.62% contribution in the living biomass of the zone.

Fishes were the only vertebrates that presented 7.28% living biomass in the samples. Although, there were range of species (22) in the samples but only *L. subviridis* (33.58%) was the leading species among the fish fauna.

Ecological indices:

Variations were observed in the diversity, equitibility and species richness in faunal assemblage collected by beach seine and beam trawl (Table 3). The faunal diversity was not significant among seasons ($F_{3, 47}$ = 0.72 P=0.55) nor in between the net ($F_{3, 47}$ = 2.41 P=0.14). However, two faunal groups i.e. fishes (in beach seine samples) and mollusca (in beam trawl samples) exhibited seasonal variation in both diversity and abundance throughout the study period. The overall diversity among species was more pronounced than abundance. The significant highest diversity (3.48 ± 0.31) in beam trawl and (2.85 + 0.64) in beach seine was observed during Pre-monsoon and Post-monsoon respectively (Table 3).

The Jaccard similarity measure indicated that there was 82.6% species shared the same habitat. The intertidal fauna sampled by using both beach seine and beam trawl showed a significant value (0.45) of Jaccard co-efficient.

DISCUSSION

This study showed high variability and complexity in macrofaunal community of Miani Hor. Samples which are usually collected from the same habitat using two different methods can be different found during the present study. The beach seine was found more effective to sample the nektons in shallow intertidal zone composed of sandy substratum in Miani Hor. There were more fishes and some crab species caught in the beach seine as compared to beam trawl. Where as the beam trawl was

found a reliable gear for the benthic faunal species like crustaceans and mollusca when hauled repeatedly on sandy intertidal zone of Miani Hor. There are many studies in which utility of shallow zones have been examined by using small sized hand or boat hauled beach seines, beam trawls and push nets. Sasekumar *et al*., (1992), utilized different types of nets (gill nets of different mesh sizes, enclosure nets, and trawl nets) for varying types of habitats (mud flats and mangrove creek inlets). Lonergan *et al.*, (1995) reported that beam trawl provides efficient estimates for benthic individuals as the beach seine does not prove to be a good method for estimating the pre-dominantly benthic fauna mainly Mollusca. In contrast, Connolly (1994) suggested that seine net is very useful in shallow embayments that work faster and it is the cheapest method to collect the small fishes and other nektons beside other species associated with sea bed. Some times seine net data become more informative and reliable when the efficiency of net is estimated and compared with any other net (Parsely *et. al.,* 1989). The benthic faunal assemblage of sandy shore was encountered by beam trawl in which the mollusca were also the leading taxa. The abundance of Molluscan taxa during Post-monsoon and North-east monsoon was associated with low temperatures (16^oC-25^oC) and high salinities ranging from $38^o/_{oo}$ to $40^o/_{oo.}$ Ahmed and Hameed (1999) observed that distribution and abundance of animals were influenced by a number of factors such as salinity, pH, and dissolved oxygen, air and water temperatures. There were 28 families that represented 34 species throughout the sampling. The *Nassarius spp.* dominated the mollusca group that also found most of the year, followed by *Seila spp*. and *Dentallium spp*. Ourives *et al.,* (2011) observed the richness of macrobenthic fauna especially microgastropods due to the availability of high salinity, low temperatures, rich organic content in sediment. Sonmiani is an arid zone, which receives less than 200mm rainfall annually. The two seasonal rivers Winder and Porali add very little amount of fresh water in the Hor, that results in the high salinity throughout the year. Shou *et al.*, (2009b) also described the complicated relationship of macrofaunal abundance with temperature and our observation showed the similar trends as most of the animals found during the Post- monsoon and North-east monsoon seasons that are of high salinity and low temperatures.

The beach seine was found more effective to sample the nektons in shallow intertidal zone composed of sandy substratum in Miani Hor. There were more fishes and some crab species caught in the beach seine as compared to beam trawl. The efficiency of seine nets varies with changes in temperature for capturing the fish (Allen *et. al*., 1992). Shallow marine coastal zones are considered as important habitats in the life history of many marine organisms. The fish and epibenthic crustaceans utilize the mangrove intertidal zone as nursery ground as well as place of refuge. The fishes were the second most abundant and diverse group of animals found during the sampling period. A total of 22 species of fishes representing 14 families were identified in the sample and were less than previous reported (27 species) by Ahmed and Abbas (1999) from the Miani Hor. The representatives of Mugilidae, Sillaginidae and Engraulidae were abundantly found in lagoon area. Ikejima (2003), stated that juveniles of Engraulids, Leiognathids and Gerrids were dominating in mangrove estuaries while juveniles of Mugilids, Lutjanids, and Carangids were utilizing the habitat for feeding during their juvenile stages in mangrove estuary. Many species of family Engraulidae, Scienidae and Mugilidae were found common and transient along the coast that moved to inshore areas for feeding or to spawn (Jalal *et al.,* 2012). *Liza subviridis* (Family: Mugilidae) was the most abundant specie (9.97%) followed by *Sillago sihama* (4.11%) that represented its dominance during the sampling (Table 2). The fishes used the mudflats and coastal inshore shallow

waters when the mangrove forests were drained during low tide. The ichthyofauna utilized the same habitat as refuge during low tide because the turbidity increased and the risk of predation become reduced (Laroche *et.al.,* 1997). Amara and Paul (2003) concluded through studies that the risk of predation in shallow waters was likely to be diminished with both decreasing water depth and with increasing individual size. The intertidal shallow zones serve for feeding for diversity of organisms only when they are immersed. The smaller sized *S. sihama, L. subviridis,* and *S. elongata* were caught by beach seine. The demersal fishes e.g. *S. elongata, C. crocodila,* and *Z. quaga* (1.07%, 0.028%, 0.028%) were dominating the demersal ichthyofaunal assemblages. The juveniles of three fishes indicated the rich organic content in the sediment and availability of food, so the juveniles used the adjacent shallow waters of mangrove forests. These were using shallow intertidal zones adjacent to mangrove forests, so may be designated as resident species of the shallow intertidal sandy zone of Miani Hor. The representatives of crustaceans mainly the crabs (Family: Portunidae and Family: Anumouranidae) and shrimps (Penaeidae) were also observed as an important groups of animals that showed their contribution in the samples. The members of family Portunidae e.g. *Portunus pelagicus* and *P. sanguinolentus* were characteristic species. These two species were considered as commercially important and local fishery was also depending on it beside the conventional fin fisheries. The other member families e.g. Calapidae, Xanthidae, Leucosiidae, Ocypodidae showed their presence occasionally. There were 8 species of shrimps that representing a single family Penaeidae. The shrimps were more in beach seine as compared to beam trawl. Hassan (1989) reported the abundance and distribution of penaeid juveniles (*Metapenaeus stebbingyi*) but recommended the dominant species as *Penaeus marguien*sis and *P. penicillatus*. Ahmed and Ayub (1996b), ranked *P. merguiensis* as the most abundant species followed by *P. stylifera*. The shrimps used the mangrove and adjacent intertidal areas successfully and subjected to colonization (Ronnback *et. al*., 1999). The juveniles and post larvae of shrimps also utilized the mangroves and unvegetated intertidal zones as shelters (Meager, *et.al.* 2003). The occurance of hermit crabs was associated with abundance of gastropods.

Biodiversity is widely regarded to be important to maintain genetic richness, ecological functioning and the resilience of the ecosystem. The study is a preliminary investigation on the abundance and diversity of intertidal faunal assemblage. The Balochistan coast could get very little attention for such type of studies, though habitats like lagoons, rocky coasts and mangrove forests are an open invitation for scientific studies. More scientific and organized initiatives are required to explore the marine resources of Pakistan in general and Balochistan coast for particular.

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