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COMMUNITY STRUCTURE AND SEASONAL DISTRIBUTION OF INTERTIDAL MACROFAUNA FROM TWO ROCKY SHORES OF KARACHI COAST

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ABSTRACT: Rocky shores are considered heterogeneous environments due to their composition and structure. Therefore, they support numerous habitats for flora and fauna. Organisms found on rocky shores are facing intense physicochemical conditions during tidal changes from upper to lower intertidal zones. Total (N=1888) specimens were collected on seasonal basis from intertidal zone during low tide from two rocky sites of Karachi coast, Buleji and Sunehri during January 2017 to December 2017. The highest number of individuals (N=1041), were recorded from Buleji than Sunehri (N= 847). The seasonal abundance in Mollusca were measured as (36.84%), (63.67%), (25.08) and (40.38%) from Buleji while from Sunehri (45.16 %), (46.01%), (48.65) and (42.79 %) during pre-monsoon, south-west monsoon, post monsoon and north-east monsoon season respectively. Group Arthropoda, Mollusca and Echinodermata were shows the highest abundance of the species at both sites as compare to other groups. The highest diversity index from Sunehri (H'=0.64) was measured in north-east monsoon season meanwhile, (H'=0.61) was measured in post monsoon season from Buleji coast. Evenness index (J'=0.25) in pre-monsoon season from Buleji and (J'=0.28) in south-west monsoon season from Sunehri coast . Season shows the great abundance of species as compare to other seasons. No significant correlation was observed in between seasons, water temperature and salinity with macrofauna groups at both sites.

KEYWORDS: seasonal distribution; macrofauna; Karachi coast; Buleji; Sunehri

INTRODUCTION

Rocky shores have the greatest biodiversity as compared to any other coastal habitats as they provide many ecological niches. These niches are created by the abundance and variety of food types in shallow coastal seas, the stability and complexity of the rocky substrate that creates numerous sheltered microhabitats for organisms to live in or on, and the widely varying abiotic conditions from the low shore to the upper shore that prevent any single species from dominating the entire shore.

Rocky shores are the most wide-ranging littoral habitats exposed to eroding waves and thus, are ecologically very important (Crowe *et al.*, 2000). Organisms of several phyla responsible for the maintenance of ecosystem functioning dwell in this important environment (Little & Kitching, 1996; Menge & Branch, 2001), and many species (e.g. algae, mussels, oysters and crabs) can be of considerable social and economic value. Among that invertebrate community of rocky shores function as integrators of ecological processes over time scale.(Kroenke *et al.*, 1998; Beuchel *et al.*, 2006) and also act as a bioindicator and may be monitored to assess ecological change due to anthropogenic actions (Ikomi *et al.*, 2005; Vaghela *et al.*, 2010. Rocky shores are susceptible to many impacts, and have increasingly been the focus of research and monitoring programs for biodiversity conservation (Thompson *et al.*, 2002).

The abundance and distribution of intertidal biota was reported from Karachi coast by Khan and Dastagir (1971, 1972); Haq, *et al.*, (1978); Tirmizi and Siddiqui, (1981); Ahmed, *et al.*, (1982), Barkati and Burney (1991, 1995); Burney and Barkati, (1995). Ahmed and Hameed (1999a & b), Niazi *et al.*, (2007), Siddiqui and Farooq, (2000), Takween and Qureshi, (2001), Hameed and Ahmed (2002), Gondal, *et al.*, (2012), Rahman and Barkati, (2012), Ahmed *et al.*, 2016 and Khanam and Saher, (2018).

Processes within ecosystem can depend on the diversity of the organisms which constitute them. Measuring species richness and diversity in various habitats is a useful tool for conservation action planning of the marine and coastal biodiversity (Pielou 1975; Magurran 1988; Gray 1997; Amaral & Jablonski, 2005). Therefore, the present study describes the species richness, species composition, species diversity and seasonal abundance of macro invertebrates and to compare in two intertidal rocky habitats i-e Buleji and Sunehri. In addition, a brief account of the taxa dominance and distribution of taxa with seasons have also provided.

MATERIALS AND METHOD

Sample Collection: The study was carried out in two rocky shores Buleji (24°50'20.41" N, 66°49'24.15" E) which is approximately eight hundred (800) meters long and one hundred fifty (150) meters wide and Sunehri (24°52'33.49" N, 66°40'40.20" E) is approximately twelve hundred (1200) meters long and two hundred (200) meters wide at 0.0 m low tide. Study area map was shown in (Fig. 1). Study sites were surveyed on monthly basis from January 2017 to December 2017. Total twelve (12) months surveys were conducted from intertidal area during low tide. Random sampling was done parallel to sea for sample collection. Specimens were collected from irregular boulders, gaps between boulders, crevices and under stones. The macro-invertebrates were collected by large size forceps and fishes by small hand net. Some animals such as sea cucumbers, *Chiton* species and *Cellana* species, etc., were collected by hammer and chisel. Specimens of all groups (Porifera, Nemertea, Cnidaria, Platyhelminthes, Annelida, Arthropoda, Mollusca, Echinodermata, Ascidiacea, and Pisces) were collected and transported live to the laboratory and shifted in well aerated aquariums.

Physicho-chemical parameters: The physicochemical parameters such as air temperature (^{o}C) and seawater temperature (^{o}C) were noted with the help of mercury glass thermometer, salinity (ppt) by hand refractometer and pH were recorded by pH meter at monthly interval throughout the study period of one year.

Sample Identification: Specimens were examined morphologically and studied under microscope with the help of field guides and monographs. (Hooper & Soest (2002), Day (1968), Clark and Rowe (1971), Psomadakis *et al.*, (2015), Worms- Marine Species Identification Portal, Kazmi, Q. B. (2018) Lieske and Myers (2004), Tirmizi and Zehra (1982), Tirmizi and Siddique (1981, 1982), Tirmizi and Kazmi (1973, 1984, 1988, 1996), Tirmizi and Ghani (1996), Tirmizi *et al.*, (1989)).

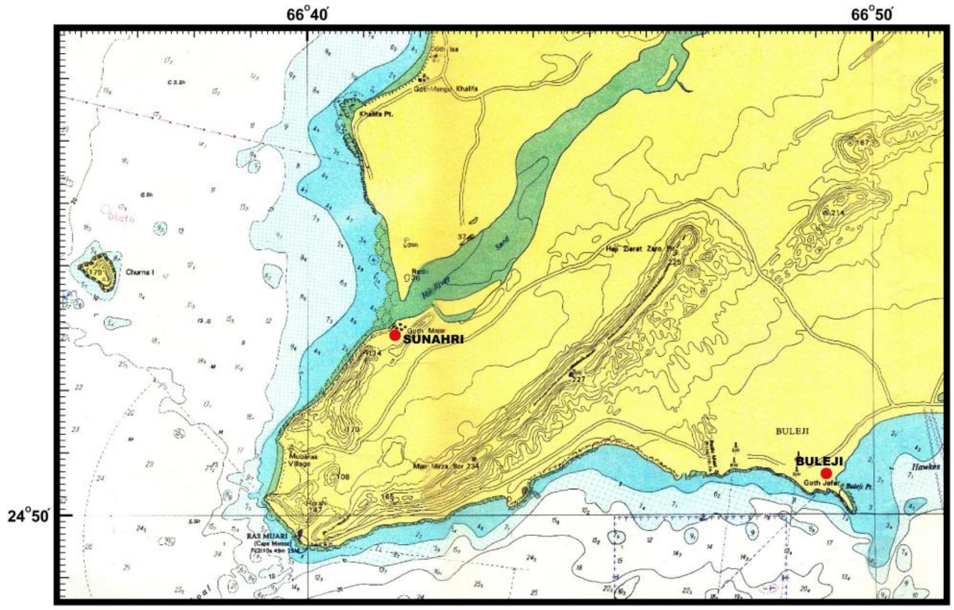

Fig. 1. Map of study area.

Statistical Analysis: Diversity of the macrofauna was determined using Shannon-Wiener index (H') (1963), and Pielou's index (1966)of evenness (J') and Margalef index (1958) of species richness (R1) and Menhinick index (1964) of species richness (R2) was applied to calculate the diversity as per Odum (1971). The Shannon Index (H') was calculated by the formula $H' = -\sum pi. Ln\ pi$, where $pi = ni / N$. Pielou's evenness (J') was calculated by the formula $J' = H' / In\ S$, where H' is the Shannon index as defined above and S is the number of species observed. Species richness (R1 and R2) is based on the number of species present in a community (S) and incorporates the total number of individuals in the community (N). The species richness was calculated by the formula

$$R1 = S-1 / Ln\ (N) \text{ and } R2= S' = S / \sqrt{N}.$$

For statistical analysis IBM SPSS (statistics 20 version) with a 5% significance level was used to determine the difference between groups, localities and seasons. Correlation coefficients analysis was also done to assess the influence of abiotic factors on the macrofaunal community structure.

To compare the data for seasonal variations, the months between March to May referred as pre-monsoon, June to September as southwest monsoon, October and November as post-monsoon and from December to February consider as northeast monsoon.

RESULTS AND DISCUSSION

Seasonal changes in various physicochemical parameters of seawater at two selected locations are shown in Table 1. Regarding measures taken for the environmental parameters, it was observed that amongst the abiotic factors, highest mean seawater temperature (28.75±1.26) and (28.75±1.71) was recorded during southwest monsoon at Buleji and Sunehri respectively. The highest pH values were observed in post monsoon season at Buleji (7.90±0.14) and at Sunehri (8.05±0.07) as well. The salinity was found high during northeast monsoon at Buleji (39.00±1.00) as well as at Sunehri (38.33±2.08) while low during the southwest monsoon at Buleji (36.75±0.50) and during pre-monsoon at Sunehri (36.33±1.53) (Table 1). Relatively, air temperature of both sites show similar trend, being highest during southwest monsoon and lowest during northeast monsoon (Table 1).

Table 1: Physico-chemical parameters collected from Buleji and Sunehri during January to December 2017.

Sites	Seasons	Air temperature (°C)	Seawater Temperature (° C)	Salinity (ppt)	pH
Buelji	Northeast monsoon	24.67 ± 5.69	21.67 ± 3.51	39.00 ± 1.00	7.47 ± 0.40
	Pre monsoon	30.00 ± 0.00	28.33 ±0.58	37.00 ± 1.73	7.80 ± 0.44
	Southwest monsoon	31.00 ±1.15	28.75 ± 1.26	36.75 ± 0.50	7.83 ± 0.17
	Post monsoon	30.50 ± 0.71	28.00 ± 0.00	37.50± 3.54	7.90 ± 0.14
Sunehri	Northeast monsoon	24.33±5.86	22.67±5.51	38.33±2.08	7.47±0.47
	Pre monsoon	30.67±1.15	27.67±1.53	36.33±1.53	7.67±0.42
	Southwest monsoon	31.25±0.96	28.75±1.71	37.75±1.50	7.95±0.17
	Post monsoon	28.00±4.24	28.00±1.41	37.50±-0.71	8.05±0.07

Table 2 shows the occurrence of species on both localities. Neritidae family (*Nerita albicilla*) was found at both study sites. According to Abbot (1991), Neritidae are classified as herbivore grazers and are the most common family to be found across wide ecological zones. Feeding groups of herbivores are a decisive factor in species spatial

Table 2. The distribution of species of macrofauna groups at Buleji and Sunehri.

Name of Specimens	Buleji	Sunehri
PORIFERA		
Tethya sp.	+	+
Callyspongia sp.	+	+
NEMERTEA		
Lineus ruber	+	-
Baseodiscus hemprichii	+	+
CNIDARIA		
Zoanthus sp.	+	+
Cerianthus membraneus	+	+
Gorgonia sp.	+	+
PLATYHELMINTHES		
Pseudoceros cf. susanae?	+	-
Pseudoceros sp.	+	+
Stylochus sp.	+	+
Notoplana sp.	+	+
ANNELIDA		
Sabella sp.*?*	+	+
Eurythoe sp.	+	+
ARTHROPODA		
Caridea		
Saron marmoratus	+	+
Athanus dimorphus	+	+
Alpheus splendidus	+	+
Alpheus lopidens	+	+
Stenopodidea		
Microprosthema validum	+	+
Stomatopoda		
Gonodactylus sp.	-	+
Anomura		
Petrolisthes lamarckii	+	-
Petrolisthes boscii	+	+
Pachycheles natalensis	+	+
Pachycheles tomentosus	+	+
Pisidia dehanii	+	+

Continued….

Brachyura		
Charybdis orientalis	+	+
Charybdis annulata	+	+
Thalamita crenata	+	+
Actaea jacquelinae	+	-
Atergatis floridus	+	+
Aterigatus roseus	+	+
Elamina sindensis	+	-
Eriphiasmithii	+	+
Halimede ochtodes	+	-
Heteropanope glabra	+	+
Leptodius exaratus	+	+
Medaeops granulosus	+	+
Micippa platipes	+	+
Pilumnus kempii	+	+
Pilumnus vespertilio	+	+
Plagusia tuberculata	+	-
Schizophrys aspera	+	+
Grapsus albolineatus	+	+
MOLLUSCA		
Polyplacophora		
Chiton sp.	+	+
Gastropoda		
Diodora sp.	-	+
Cellana sp.	+	+
Trochus depictus	+	+
Trochus scabrosus	+	+
Monondonta australis	+	+
Turbo intercostalis	+	+
Turbo chrysostomus	+	+
Turbo coronatus	+	+
Astraea semicostata	+	+
Nerita undata	+	+
Nerita albicilla	+	+
Nerita textilis	+	-
Cerithidea sp.	+	-
Planaxis sulcatus	+	+

Continued….

Cypomorus caeruleum	+	-
Cypomorus variegatum	+	-
Cerithium sp.	+	+
Rhinoclavis sp.	+	+
Cypraea lentiginosa	+	+
Cypraea ocellata	+	+
Cypraea turdus	+	+
Cypraea arabica	+	+
Cypraea grayana	+	+
Drupa sp.	+	+
Rapana sp.	+	+
Thais bufo	+	+
Thais persica	+	+
Thais hippocastanum	+	+
Thais rudolphi	+	+
Pyrene flava	+	+
Babylonia spirata	+	+
Cantharus undosus	+	+
Oliva elegans	+	+
Turbinella sp.	+	-
Mitra sp.	+	-
Onchidium sp.	+	-
Aplysia sp.	+	-
Aplysia oculifera	+	-
Aplysia cornigera	+	-
Berthellina citrine	+	-
Doris sp.	+	-
Sebadoris sp.	-	+
Dendrodoris sp.	+	-
Dendrodoris fumata	+	-
Bornella stellifer	+	-
Bivalvia		
Perna viridis	+	+
Donax sp.	-	+
Barbatia sp.	+	+
Pinna sp.	+	-
Pecten sp.	+	-

Continued….

Circenita sp.	+	+
Circe sp.	+	+
Cephalopoda		
Octopus defilippi	+	+
ECHINODERMATA		
Asteroidea		
Asterina sp.	+	+
Asterina burtoni	+	-
Asterina lorioli	+	+
Anthenia rudis	+	+
Ophiuroidea		
Macrophiothrix aspidota	+	-
Ophiothrix sp.	+	+
Ophionereis sp.	+	-
Ophioneries dubia	+	+
Ophiopeza fallax	+	+
Ophioplocus imbricatus	+	+
Holothuroidea		
Holothuria arenicola	+	+
Holothuria atra	+	-
Holothuria pardalis	+	+
Holothuria verrucosa	+	-
Holothuria lineata	+	-
Holothuria notabilis	-	+
Aslia forbesi	+	-
Ohshimella ehrenbergi	-	+
Echinoidea		
Echinometra mathaei	+	+
ASCIDIACEA		
Ascidian colony	+	+
PISCES		
Epinephelus sp.	+	-
Abudefduf saxatilis	+	-
Mud skipper	+	+
Scorpion fish	+	-
Eel fish	-	+

(+) Present, (-) Absent

distributions within tropical rocky shore ecosystems (Cruz-Motta 2007). At both sites, *Planaxis sulcatus* (Planaxidae) and *Cellana* sp. (Nacellidae) were also found. These species are also categorized as herbivore grazers. A study by Rao & Sundaram (1972) along the Indian coasts found that prosobranch gastropods such as Planaxidae (*Planaxis sulcatus*) and Nacellidae (*Cellana radiata*) feed on marine green algal species such as *Chaetomorpha sp*. and *Enteromorpha compressa* and organic detritus, there were so many studies that evidence that these green algae were found abundantly at Buleji (Ahmed and Hameed, 1999b; Rizvi and Shameel, 2003; Qari and Khan, 2018).

During studies total N=1888 specimens representing 10 phyla were collected from intertidal zone of both sites. 2 species belongs to phylum Porifera, 2 species to Nemertea, 3 species to Cnidaria, 4 species to Platyhelminthes, 2 species to Annelida, 28 species to Arthropoda, 50 species to Mollusca, 17 species to Echinodermata, 4 species to Class Pisces and an Ascidian colony from Buleji. While at Sunehri, 2 species belongs to phylum Porifera, 1 species to Nemertea, 3 species to Cnidaria, 3 species to Platyhelminthes, 2 species to Annelida, 24 species to Arthropoda, 36 species to Mollusca, 12 species to Echinodermata, 2 species to Class Pisces and an Ascidian group. Buleji (Table 2) (N=1041) shows highest number of specimens than Sunehri (N=847) (Table 3). The Mollusca shows the highest relative abundance among all groups at Buleji (41.88%) as well as at Sunehri (45.81%). While after Molluscs, Arthropods formed second highest phylum in percentage (25.76 and 25.61%) at Buleji and Sunehri respectively. Ascidians group were lowest (0.38%) at Buleji, however at Sunehri Nemertean possess lowest (0.47%) relative abundance (Table 3).

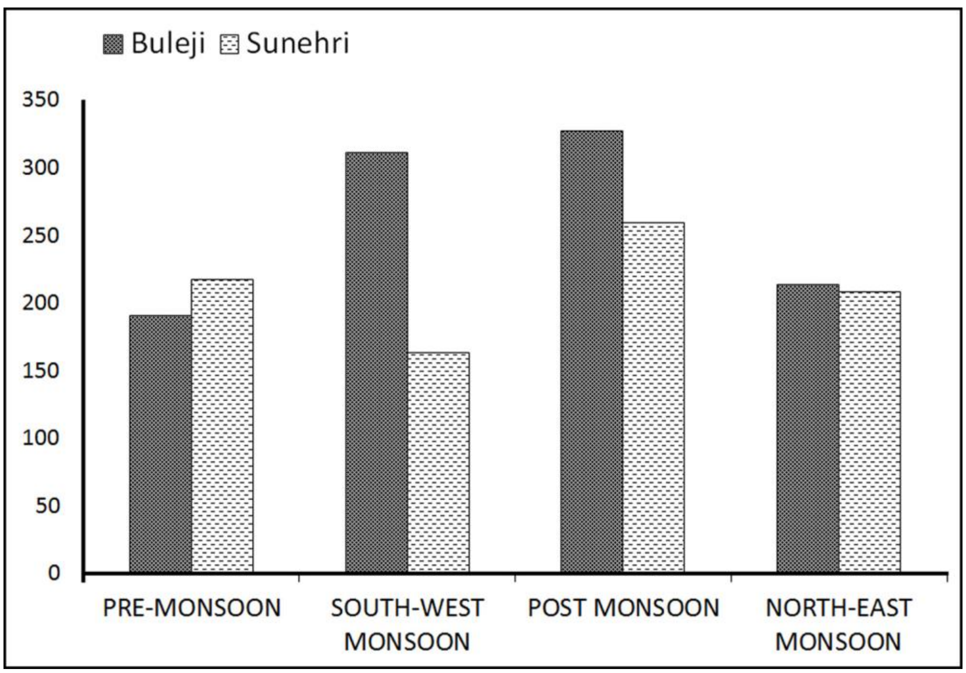

Fig. 2. Seasonal occurrence of total number of macrofauna found on Buleji and Sunehri from January 2017 to December 2017.

A significant seasonal trend in the variation of number of individuals was shows in macro fauna groups of both study sites (Fig. 2). Highest number of individuals were reported in post monsoon (October to November) season from Buleji (N=327) as well as at Sunehri (N=259) (Fig. 2).

Table 3. Relative abundance (%) of macrofauna groups at Buleji and Sunehri during January to December 2017.

Name of Groups	Total no. of samples	Relative abundance (%)	Total no. of samples	Relative abundance (%)
	BULEJI (N = 1044)		**SUNEHRI (N = 847)**	
PORIFERA	9	0.86	11	1.29
NEMERTEA	9	0.86	4	0.47
CNIDARIA	14	134	7	0.82
PLATYHELMINTHES	8	0.76	22	2.59
ANNELIDA	11	1.05	11	1.29
ARTHROPODA	269	25.76	217	25.61
MOLLUSCA	436	41.88	388	45.81
ECHINODERMATA	263	25.19	166	19.59
ASCIDIACEA	4	0.38	8	0.94
PISCES	18	1.73	13	1.53

At Buleji Mollusca shows highest seasonal abundance during all seasons except post monsoon, where Echinodermata (40.37%) found highest abundance (Table 4). However at Sunehri, Mollusca appears to be highest in percentage abundance in all seasons (Table 4).

Table 4. Seasonal abundance (%) of Macrofauna groups at Buleji and Sunehri during January 2017 to December 2017.

GROUPS	PRE-MONSOON (March to May)	ABUNDANCE %	SOUTH-WEST MONSOON (June to September)	ABUNDANCE %	POST MONSOON (October to November)	ABUNDANCE %	NORTH-EAST MONSOON (December to February)	ABUNDANCE %
BULEJI								
PORIFERA	02	1.05	03	0.96	01	0.31	03	1.41
NEMERTEA	0	0.0	03	0.96	05	1.53	01	0.47
CNIDARIA	03	1.58	03	0.96	07	2.14	01	0.47
PLATYHELMINTHES	0	0.0	03	0.96	03	0.92	02	0.94
ANNELIDA	04	2.11	02	0.64	02	0.61	03	1.41
ARTHROPODA	62	32.63	63	20.26	85	25.99	59	27.67
MOLLUSCA	70	36.84	198	63.67	82	25.08	86	40.38
ECHINODERMATA	46	24.21	29	9.32	132	40.37	56	26.29
ASCIDIACEA	0	0.0	01	0.32	02	0.61	01	0.47
PISCES	03	1.58	06	1.93	08	2.45	01	0.47
Total	190		311		327		213	
SUNEHRI								
PORIFERA	02	0.92	04	2.45	01	0.39	04	1.92
NEMERTEA	02	0.92	01	0.61	01	0.39	0	0.0
CNIDARIA	02	0.92	02	1.23	02	0.77	01	0.48
PLATYHELMINTHES	0	0.0	03	1.84	06	2.32	13	6.25
ANNELIDA	04	1.84	03	1.84	01	0.39	03	1.44
ARTHROPODA	64	29.49	34	20.86	62	23.94	57	27.40
MOLLUSCA	98	45.16	75	46.01	126	48.65	89	42.79
ECHINODERMATA	38	17.51	37	22.61	57	22.01	34	16.35
ASCIDIACEA	02	0.92	02	1.23	01	0.39	03	1.44
PISCES	05	2.30	02	1.23	02	0.77	04	1.92
Total	217		163		259		208	

The number of individuals were collected from Buleji following according to season as; Mollusca>Echinodermata > Artheropoda > Pisces > Cnidaria > Annelida > Porifera > Nemertea > Platyhelminthes > Ascidiacea.

Seasonally the number of individuals were collected from Sunehri following as; Mollusca > Arthropoda > Echinodermata > Platyhelminthes > Pisces > Porifera > Annelida > Ascidiacea > Cnidaria >> Nemertea.

Table 5: Seasonal analysis of diversity (Shannon-wiener diversity index (H'), species richness (R1), (Margalef index, 1958), species richness (R2), (Menhinick index, 1964) and Evenness index (J') (Pielou, 1966) were measured from Buleji and Sunehri.

	Pre-monsoon	**South-west monsoon**	**Post monsoon**	**North-east monsoon**
Buleji				
Shannon-wiener diversity index (H'	0.58	0.48	0.61	0.57
Species richness (R1) (Margalef index, 1958),	0.42	0.39	0.39	0.41
Species richness (R2) (Menhinick index, 1964)	0.07	0.06	0.06	0.07
Evenness index (J') (Pielou, 1966)	0.25	0.19	0.24	0.24
Sunehri				
Shannon-wiener diversity index (H'	0.58	0.62	0.54	0.64
Species richness (R1) (Margalef index, 1958),	0.41	0.42	0.40	0.41
Species richness (R2) (Menhinick index, 1964)	0.06	0.08	0.06	0.07
Evenness index (J') (Pielou, 1966)	0.25	0.28	0.22	0.27

At Buleji the highest diversity index (H'=0.61) was measured in post-monsoon, highest species richness (R1=0.42), (R2 =0.07) and highest Evenness (J'=0.25) were calculated in pre monsoon season, however from Sunehri the highest diversity index (H'=0.64), was found in North-east monsoon, while highest species richness (R1=0.42), (R2 =0.08) and Evenness (J'=0.28) were observed in south-west monsoon season. Possibly due to the fluctuations in the environmental conditions (Bhadja *et al.*, 2014) and differences in local, landscape and bio-geographical variables (Aggemyr *et al.*, 2018) at both study sites may explain the species richness and composition of marine organisms, although the diversity and evenness indices (H' and J') in both study sites were categorized as low, based on Odum & Barret (2004). To sort this index number more biological logic, we can convert it into the effective number of species (ENS), which is the actual biodiversity and permits us to compare the biodiversity with other communities. A community with Shannon index of H has an equivalent diversity as a community containing equally-common species of exp (H), the ENS. So if you got a Shannon index of 0.61 (Buleji) and 0.64 (Sunehri), this number can be converted into ENS that is exp (0.61) = 1.84 and exp (0.64) = 1.90. This means that a community with Shannon index of 0.61 and 0.64 has an equivalent diversity as a community with 1.84 and 1.90 equally-common species (Table 5).

Mollusca shows highest relative abundance at Buleji (41.88 %) as well as Sunehri (45.81%) coast, similar studies reported by (Gondal *et al.*, 2012) from Sonmiani Bay (Miani Hor) Balochistan, where Mollusca was the most abundant group among total occurrence of intertidal fauna. Molluscs showed different spatial arrangements throughout the rocky intertidal zone evaluated in this study, possibly due to a combination of morphological, physiological and behavioral factors. The predominance of species suggests that the environmental components available in these intertidal zones favor the formation of microhabitats that contribute to the establishment and survival of several species of marine invertebrates, such as Molluscs (Veras *et al.*, 2013).

Khanam and Saher, 2018 reported community composition at Manora ledge, Pakistan and found Mollusca as dominated by 75% (39 species) and Arthropoda by 20%, the second highest group which represents 16 species. Several authors have delivered the same conclusion for Molluscan population on rocky shores of Pakistan (Ahmed, 1977; Ahmed *et al.*, 1982; Ahmed and Hameed, 1999a,b; Hameed and Ahmed, 2000; Rahman and Barkati, 2012; Aijazuddin and Barkati, 2013).

Present study shows Molluscs were the most abundant contributor from both sites, according to few studies (Vaghela and Kundu, 2011; Khade and Mane, 2012) Molluscs are dominating animal group in the intertidal areas due to their ecological adaptations as they can survive in every habitat; from deepest ocean trenches to the intertidal zone, land and freshwater habitats. However according to Vaghela *et al.* (2010), George *et al.* (2010) and Bhadja and Kundu (2012) the composition, abundance, and distribution of invertebrate macrofauna in the rocky intertidal zones are generally influenced by water quality.

On rocky shores the abundance of macro invertebrates frequently diversifies with the seasons (Barkati and Burney, 1995; Fatima and Barkati, 1999; Nasreen *et al.*, 2000; Rahman and Barkati, 2012; Vaghela *et al.*, 2010; Zamprogno *et al.*, 2012). In present study abundance of intertidal fauna varied with season at both study sites, Regional and area specific conditions may prevail and uncertain any wide climatic outcomes (Rahman and Barkati, 2012). During the present study high abundance of macrofauna were noted during postmonsoon season (October to November) at both study sites. However Nasreen *et al.* (2000) observed high number of individuals at Manora rocky coast from May to August. While Fatima and Barkati (1999) mentioned low species abundance at Paradise point from April to August. We did not find any significant correlation in macrofaunal richness and physicochemical parameters at both sites ($P > 0.01$).

There is a need for further surveying and monitoring of intertidal taxa, such as Algae, Crustaceans, Molluscs, Echinoderms and Polychaetes in this valued ecosystem to derive a better understanding of its importance. This study contributes to a preliminary checklist on macroinvertebrates of Sunehri coast. Although it is preliminary, it could provide a baseline study on the intertidal fauna of this coast.

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