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Quantitative Analysis of Macrobenthic Molluscan Populations Inhabiting Bandri Area of Jiwani, South West Pakistan Coast

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Abstract

The present study is done by using quadrate sampling techniques to estimate macrobenthic molluscan population structure on three tidal levels at two selected stations along the Bandri beach of Jiwani coast, Balochistan for the first time during October 2014 to March 2015. Generally calculated values show a higher species composition, abundance and density at station two (ST-II) which has a predominately rocky bottom profile, while species frequency and diversity are found to be higher at station one (ST-I) which has a sandy muddy bottom composition. Calculating the species composition values reveals that only 4 species give more than 1 % mean cover (overall an average composition %) at ST-I which are *Umbonium vesterium* (94.34 %), *Mitrella blanda* (2. 37 %), *Branchiodontes variabilis* (1.79%) and *Nassarius (Plicalcularia) persicus* (1.17 %), whereas at ST-II only one sp. provides more than 1 % mean cover which is *Branchidontes variabilis* (98.46 %). Overall *Umbonium vesterium* and *Branchiodontes variabilis* dominated the populations at ST-I and II, respectively, at all three tidal levels. Besides calculating species similarities between two stations and over total area, it remained maximum in November 2014 (0.44) and minimum in March 2015 (0.11).

Key words: Molluscan diversity, Bandri beach, Jiwani, Arabian Sea.

1. Introduction

Molluscs are dominating animal group in term of the diversity in the intertidal areas, and due to their ecological adaptation they are found in nearly every habitats; from deepest ocean trenches to the intertidal zone, land and freshwater where they cover a wide range of habitats. Due to easy accessibility, intertidal zones always remain highly sampled than any other ambiance. (Vaghela and Kundu, 2011; Khade and Mane, 2012). For its biodiversity, the intertidal zone has been extensively studied (Little and kitching, 1996). In the intertidal zone measures of species richness, density and abundance are dependent in the difference between spatial patterns of mobile and sessile taxa (Davidson *et al*., 2004). Within the area of few meters of the intertidal zone numerous kind of fauna and flora are observed and is considered as the most productive and diverse (Underwood, 2000). Rocky intertidal zones are found with different zones and bands, containing different biodiversity in which vertical zonation is the most effective phenomena or process to observed rocky intertidal fauna and flora from lower to upper intertidal area (Bandel and Wedler, 1987; Ellis, 2003).

Certainly, many factors or anthropogenic activities that affect the natural habitats of coastal molluscan populations are mainly overexploitation, urbanization of coastal areas, pollution, and conversion of natural area, industrialization and development of public facilities (Ahmed, 1997; Lardicci *et al.*, 1997). However, estuaries and coastal zone are used for a variety of purposes because of their socioeconomic and ecological significance and these activities are subjected to increasing pressure and anthropogenic impact on coastal habitats, which in turn results in environmental stress public health issues. From the research point of view, factors controlling the biodiversity of an area and their functions are mainly in focus (Tilman, 2000). Comparable and meaningful measures of biodiversity are needed to grow awareness related to biodiversity issues to take these into a sharp focus (Gray, 1997; McCann, 2000).

Several published reports from Pakistan are available on molluscan fauna found along the Sindh and Balochistan coast's containing details of species diversity, abundance, population structure, seasonal variations, zonation patterns, etc. (Barkati and Rahman, 2005). However, in the present study, attempts have been made to record macrobenthic molluscan diversity, species composition and population structure at Bandri beach area of Jiwani coast, Balochistan

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for the first time. This site has never been explored previously; therefore, there is no available published record of molluscan diversity from the subjected area, except for a brief systemic account of two flag pen shells from the area (Ghani and Afsar, 2017). Moreover, Bandri is a cleaner site and anthropogenic pressures are uncommon there so far.

2. Material and Methods

2.1. Study Area

Bandri beach along the Jiwani coast, Balochistan is located at 25.0667° N, 61.8000° E (Figure 1). Study surveys were made during October 2014 to March 2015. In the present study, the site was selected in Jiwani is Bandri beach, which is located along Gawatar Bay, touching the boundary line between Iran and Pakistan, and facing entrance of Gulf of Oman. Two stations were selected side by side along the Bandri beach that is open to direct surf action. Generally, substrate of the beach is hard with plain surface of extremely low slope occupied by boulders. Some parts of substrate appeared to form low profiled rocky overhangs and cave, like shelters. Primarily, the physical substrate profile is a bit different at both stations, such as at 1st station there is no or very small cave-like shelters are present with sandy and muddy substrate, whereas 2nd station is flourish through boulders and rocks with prominent cave-like shelters.

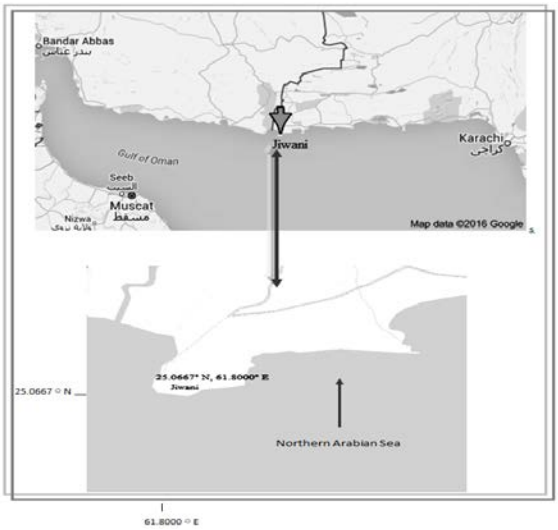

Figure 1. Map is showing collection site Bandri beach, Jiwani.

2.2. Sample Collection and Data Analysis

Quadrate sampling technique is used to carry out the field surveys by placing random quadrates (0.19 m²) on upper mid and lower tidal zones to measure benthic molluscan assemblages by means of quantitative analysis. Data collected by this method are summed up for data analysis; species abundance, density, frequency, diversity, richness, evenness and dominance were calculated by statistical software (PRIMER 5). Formulas of all calculated indices are given below:

Abundance: Total number of individual's recorded/Total number of quadrate where the individuals occurred.

Density: Total number of individuals recorded from the quadrate/ Total number of quadrate studied.

*Frequency (%)***:** Number of quadrate where the species occurred X 100/ Total number of quadrate where the individual occurred.

*Margalef's Diversity Index***:** Dmg = (S-1) /ln N. Where, N= the total number of individuals in the sample; S= the number of species recorded; Ln= natural logarithm.

*Shannon's Diversity Index***:** H= ∑ pi*ln pi. Where, Pi= S/N; S= number of individuals of one species; N= Total number of all individual in the sample or number of individuals (of all species); Ln= natural logarithm.

*Pielou's Evenness Index***:** E = H/lnS. Where, H= Shannon's-Wiener Diversity Index; S= Total number of species in the sample.

*Berger-Parker Dominance Index***:** D = N max/S. Where, N max = the number of individual of most abundant species; S = Total number of observed species.

3. Results

During the present study, by using randomly placed quadrate sampling technique, collectively a total of (13) molluscan species were recorded along station one. Calculation revealed that only 4 species given more than 1% mean cover (overall an average composition %), while rest contributed less than 1% of the total mean cover (Table 1). Whereas a total of (31) molluscan species were found at station two. Among 31 species, gastropod amounted 24 species 6 bivalves and 1 polyplchopora, and not more than 21 species were found constantly in any single collection. There is only one species provided more than 1% mean cover that is *Branchidontes variabilis* (98.46%). Whereas other 30 molluscan species showed less than 1% mean cover during the study period as detailed in Table 2.

Table 1. Molluscan species composition, abundance, density and frequency (no/0.19m²) along Bandri Beach (ST-I). Whereas ST-I= station one; A.C= Average Composition; A.A= Average Abundance; A.D= Average Density and A.F= Average Frequency.

S. No	Species Names	A.C	A.A	A.D	A.F
	Gastropods				
1	*Anachis fauriti*	0.29	1.96	0.44	22.22
2	*Anachis terpischore*	0.23	1.50	0.33	22.22
3	*Cellana radiata*	0.16	2.00	0.22	11.11
4	*Cerithium caeruleum*	0.33	4.33	0.48	11.11
5	*Clypeomorus bifaciata*	0.59	5.00	1.11	22.22
6	*Mitrella blanda*	2.42	5.79	3.65	51.11
7	*Nassarius(Plicarcularia) fissilabiris*	0.46	6.00	0.67	11.11
8	*Nassarius(Plicarcularia) persicus*	1.26	3.75	1.91	46.30
9	*Nerita albicilla*	0.63	2.88	0.89	27.78
10	*Siphonaria savignyii*	0.18	2.50	0.44	11.11
11	*Lunella cronata*	0.61	3.05	0.19	31.11
12	*Umbonium vesterium*	94.11	132.82	126.32	95.45
	Bivalves				
13	*Branchidontes variabilis*	1.79	30.00	3.33	11.11

Table 2. Molluscan species composition, abundance, density and frequency (no/0.19m²) along Bandri Beach (ST-II). Whereas A.C= Average Composition; A.A= Average Abundance; A.D= Average Density and A.F= Average Frequency.

S. No	Species Names	A.C	A.A	A.D	A.F
	Gastropods				
1	*Anachis terpischore*	0.01	2.67	0.29	11.11
2	*Bullia tranquabarica*	0.01	1	0.11	11.11
3	*Cellana radiata*	0.01	2.50	0.28	11.11
4	*Cerithium caeruleum*	0.03	3.40	0.64	17.78
5	*Clypeomorus bifaciata*	0.10	14.20	1.73	13.33
6	*Diodora funiculata*	0.02	2.25	0.33	13.89
7	*Euchelus asper*	0.01	2.25	0.25	11.11
8	*Hexaplex kuesterianus*	0.01	1.50	0.17	11.11
9	*lunella cronata*	0.08	4.06	1.54	37.03
10	*Mitrella blanda*	0.03	5.00	0.56	11.11
11	*Morula granulata*	0.02	2.67	0.45	18.52
12	*Morula nodulosa*	0.01	1.33	0.25	11.11
13	*Nassarius(Plicarcularia) fissilabris*	0.01	2.00	0.22	11.11
14	*Nassarius deshyesiana*	0.03	6.00	0.67	11.11
15	*Nassarius marmmorius*	0.01	2.00	0.22	11.11
16	*Nerita albicilla*	0.12	4.28	2.20	51.85
17	*Nerita longii*	0.01	2.33	0.26	11.11
18	*Planaxis sulcatus*	0.07	5.25	0.17	18.52
19	*Purpura persicus*	0.01	2.00	0.22	11.11
20	*Siphonaria asghar*	0.10	12.83	1.74	14.81
21	*siphonaria savignyii*	0.02	2.50	0.37	14.81
22	*Thais lacera*	0.07	5.50	0.81	14.81
23	*Thais tissoti*	0.13	4.50	2.35	50.00
24	*Trochus eurytheus*	0.05	3.29	0.91	25.92
	Bivalves				
25	*Barbatia obliquata*	0.01	1.00	0.11	11.11
26	*Branchidontes variabilis*	98.54	2138.12	1847.90	87.03
27	*Crassostrea madrasenses*	0.75	44.04	14.11	33.33
28	*Perna viridis*	0.01	1.00	0.11	11.11
29	*Saccostrea cuccullata*	0.01	1.33	0.18	14.81
30	*Saccostrea echinata*	0.02	2.67	0.35	14.81
	Polyplacophora				
31	*Chiton perguiensis*	0.01	1.00	0.11	11.11

A varying abundance of different species was found over the study period at ST-I. The highest value of average abundance was calculated (132.82 no/0.19 m²) for *Umbonium vesterium*, while the highest abundance value was found in the month of January 2015 and lowest in March 2015; however mid tidal zone with highest value of abundance followed by low and high tidal range, and lowest average abundance (1.50 no/0.19 m²) was calculated for *Anachis terpischore* that falls in February 2015 (Table 3). Moreover, average highest molluscan species abundance at ST-II was shown by *Branchidontes variabilis* (2023 no/0.19 m²). The maximum average abundance found in January 2015 and the minimum in December 2014, while along tidal levels it was higher in mid tide followed by low and high tide zones (Table 3).

Table 3. Temporal and spatial variation in the number of molluscan species in three different tidal levels and total area along Bandari Beach Jiwani, ST-I and ST-II. T.A=Total Area.

	ST-I				ST-II			
Months	High	Mid	Low	T.A	High	Mid	Low	T.A
Oct 2014	6	4	3	7	7	10	6	16
Nov 2014	4	8	3	8	8	11	7	19
Dec 2014	3	7	3	7	9	10	7	21
Jan 2015	8	5	3	10	8	7	6	16
Feb 2015	6	5	3	9	8	7	6	16
Mar 2015	2	2	2	4	8	6	4	14

Average molluscan species density at ST-I was observed, and the calculated values showed that among all the species *Umbonium vesterium* the population density remained higher on average (126.32 no/0.19 m²). The same pattern of variation was observed for the density values as for abundance in the months and the tidal range. Other species, found with a very less density values, are shown in Table 1. By calculating the species density, ST-II revealed the highest population density of *Branchidontes variabilis*, which remained dominant all along the study period. The average density of *Branchidontes variabilis* remained 1774.39 no/0.19 m². The highest species density was observed in the month of February 2015 and lowest in December 2014; the rest of the species along station two with their average density are given in Table 3.

The average species frequency remained higher for *Umbonium vesterium* (95.45 no/0.19 m²) at ST-I (Table 1). The highest frequency values were observed in the months of November and December 2014 and lowest in the month of March 2015. Average high frequency at ST-II was shown by *Branchidontes variabilis* (88.89 no/0.19 m). The average frequency was calculated maximum in the month of October 2014 and minimum in December 2014, as detailed in Table 3.

The number of molluscan species during the present study was found highest at ST-I in the month of January 2015 with total number (10), and the lowest was observed during March, 2015 with (4) numbers of species (Table 3). The Number of the individuals of the molluscan species during January 2015 was found maximum (565±359.87) and minimum in the month of March 2015 with a total number of (98±62.55) (Table 4); whereas at ST-II the overall calculated values per total area showed the highest number of molluscan species in December'14 with an average value (21/0.19 m²) and lowest in March 2015 (14/0.19 m²), as illustrated in Table 3. Along tidal levels, it was maximum in mid tide followed by high and low; while the average number of molluscan individuals remained higher in November 2014 (6495±7073.07) and lower in January 2015 (5146±5161.60) (Table 4).

Table 4. Temporal and spatial variation in the number of individuals of molluscan species in three different tidal levels and total area (± standard deviation); ST-I= Station one; ST-II= Station two and T.A= Total Area along Bandri Beach.

	ST-I				ST-II			
Months	High	Mid	Low	T.A	High	Mid	Low	T.A
Oct 2014	69	733	415	406 ± 332.10	3685	10043	2339	5356 ± 4114.76
Nov 2014	123	598	584	435 ± 270.29	3035	14632	1818	6495 ± 7073.07
Dec 2014	118	855	524	499 ± 369.14	1841	12039	4038	5973 ± 5367.22
Jan 2015	171	876	649	565 ± 359.87	1637	11073	2729	5146 ± 5161.60
Feb 2015	51	871	364	429 ± 413.81	1238	12023	3522	5594 ± 5683.31
Mar 2015	26	129	139	98 ± 62.55	1985	10059	3518	5187 ± 4288.05

3.1. Diversity Indices (ST-I) (Figures 2-6)

Along the study, area samples were collected by using quadrate method from three different tidal levels, which were summed up and analyzed. The Shannon Diversity index showed that the overall average species diversity was found to be higher in November 2014 (0.39), whereas the least diversity (0.09) was found in March 2015. Whereas on tidal levels on average remained higher along the high tide zone (0.84), followed by mid (0.23) and low (0.17). The highest variation was observed along the high tide followed by mid and low tide.

Generally, calculated indices (Margalef's Richness Index) showed that with an increase in the number of species in the sample plot, the value of richness also increases. Average molluscan species richness of the total area was found higher in January 2015 (1.42) and remained lower in March 2015 (0.65). On tidal levels, with an average, values were high tide zone (1.08), mid (0.75) and low (0.36), while the variation pattern was the same as observed for the diversity.

The value of evenness (Pielou's Evenness Index) became minimum if a single species became more and more dominant in a sample, while species evenness became maximum when all species were distributed evenly in a sample; and maximum species evenness of the total area was observed in November 2014 (0.19) and minimum in March 2015 (0.06). At tidal levels, average species evenness was observed to be high in high tide (0.54) followed by low (0.16) and mid (0.14). Generally, there was no significant changes in evenness between mid and low tidal range because both tidal levels were dominated with a single species *Umbonium vesterium*, as compared to the high tide that had small rock boulders harbored with various species.

On the other hand, dominance (Berger-Parker Dominance Index) per total area remained highest during December 2014 (200.57) and lowest during March 2015 (72.50). Species dominance, on average, along tidal levels, showed a maximum activity in low tidal range (145.17), followed by mid (126.31) and high (16. 24), while the greatest variation was observed in low and mid tide.

3.2. Diversity Indices (ST-II) (Figures 2-6)

Along station two, the maximum diversity (Shannon's Diversity Index) was observed during March 2015 (0.12) and the minimum during February 2015 (0.08). Species diversity along tidal levels was highest in high tide (0.37), followed by mid (0.08) and low (0.07).

By calculating species richness (Margalef's Richness Index) for each month during the study period, the highest value was observed during December 2014 (2.30) and the lowest during March 2015 (1.52). On tidal levels, the maximum was in high tide (1.10), followed by mid (0.91) and low (0.75).

Species evenness (Pielou's Evenness Index) showed the greatest value (0.04) during October 2014 and January, March 2015, while the lowest value (0.03) was in the months of November & December 2014 and February 2015. For the tidal range, it was highest in high tide (0.18) and lowest in mid and low tidal range with (0.04).

Species dominance (Berger-Parker Dominance Index) was observed per total area and it was higher in March 2015 (1092.86) and lower in January 2015 (950). On tidal levels, it was observed as maximum in mid tide followed by low and high tidal zone.

3.3. Species Similarity between Two Stations

Molluscan species similarity (Soreson's similarity index) remained maximum during November 2014 (0.44) and minimum during March (0.11). Among tidal ranges, it was calculated as high at high tide with a similarity value (0.30), followed by mid tide (0.14) and low tide (0.00) with a minimum similarity.

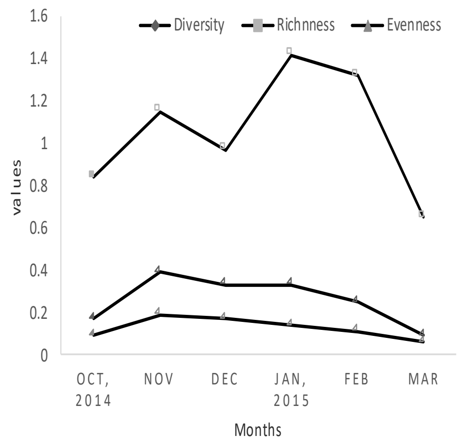

Figure 2. Mean monthly diversity (Shannon's Diversity Index), richness (Margalef's Diversity Index) and evenness (Pielou's Evenness Index) for ST-I

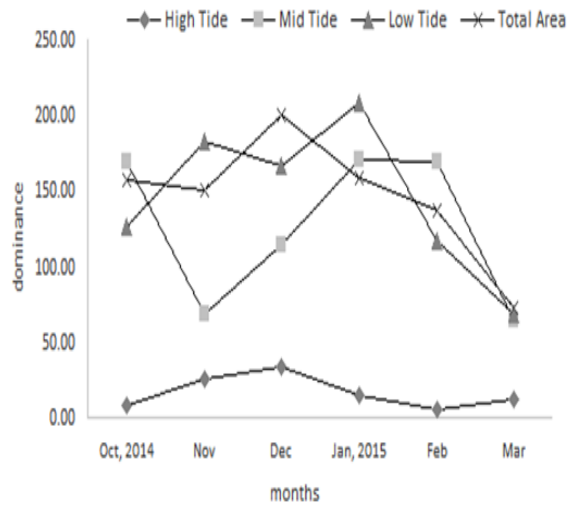

Figure 3. Temporal and spatial variation (no/0.19m²) in species dominance (Berger-ParkerDominanceIndex) for ST-I

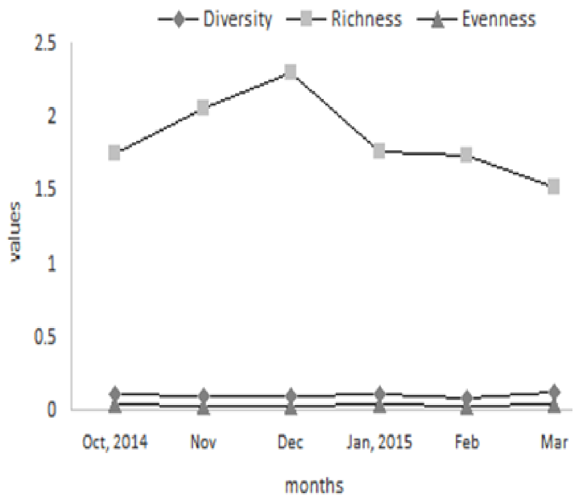

Figure 4. Mean monthly diversity (Shannon's Diversity Index), richness (Margalef's Diversity Index) and evenness (Pielou's Evenness Index) for ST-II.

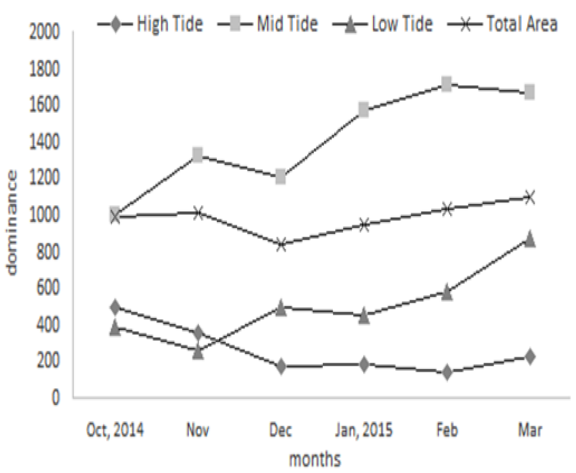

Figure 5. Temporal and spatial variation (no/0.19m²) in species dominance (Berger-Parker Dominance Index) for ST-II.

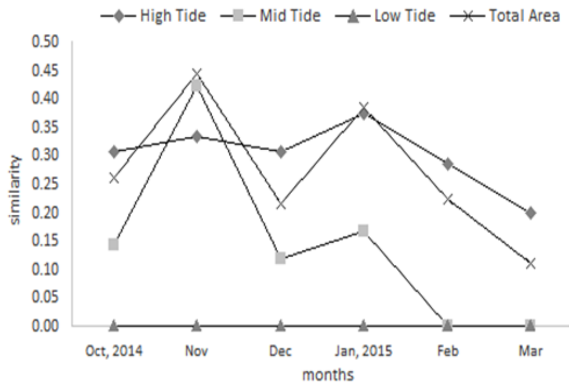

Figure 6. Temporal and spatial variation in species similarity (Sorenson's Similarity Index) between two stations and three tidal levels.

4. Discussion

During the present study, efforts have been made to analyze macro benthic molluscan assemblages found along the Bandri beach, Jiwani for the first time on species level, in addition to species composition, abundance, density, frequency, dominance, etc. that were calculated to establish a baseline study, by using quadrate analysis techniques, which can assist in future detailed studies and resource management of the area. During the present study, by using a randomly placed quadrate sampling technique collectively, a total of (34) molluscan species were found and identified for the first time from the Bandri beach along the Jiwani coast. Specimens were procured from selected stations (ST-I and ST-II). While 10 species were found common in both stations.

Formerly, Ahmed *et al*. (1982) studied the distribution and abundance of the intertidal organisms on some beaches of Makeran coast, Baluchistan and a total of 51 species were recorded from the Gawadar West Bay; whereas on the Gawader east Bay 39 species were reported. On the other hand, 42 species were found at Jiwani along the Rest House Beach (Now WWF-Pak Office), among which 24 were molluscs. Comparing the composition, abundance and density of common molluscan species at two stations, the calculated values showed that, in general, the overall composition, abundance, density values remained higher at station two, which has a predominately rocky intertidal profile as compared to station one, which offers a sandy muddy habitat to dwell in. Whereas, the maximum distribution was found at mid tidal zones of both of the stations specifically. At Daya Bay, according to China Rongguan *et al.* (1993), the highest vertical distribution of species remained higher at mid tidal zone. From Pakistan, Barkati and Burney (1991) also estimated the highest number of individuals from mid tidal region at Buleji abide throughout the year. Species composition for station two one species only had provided more than 1 % mean cover, which is *Branchidontes variabilis* (98.54 %). *Branchidontes* dominated the species composition (%) at the second station and overall at all three tidal levels. *Branchidontes variabilis* was investigated on species level for the first time from Pakistan. Moreover, the collective list of species found in quadrate sampling showed that among the 13 species no more than 10 species were found persistently in any single collection during October 2014 to March 2015 at station one; and no more than 21 species were found constantly in any single collection at station two. Similar findings were presented by Bight and Littler (1980) from all the 10 study sites along the Southern California, where they found only 15 species out of 227 macro invertebrates to be common to all the 10 study sites over the study period. Along the station, one average molluscan species density showed that, among all species population densities, *Umbonium vesterium* remained higher on average (132.82/0.19 m²), whereas at station two the calculated species density revealed the highest population density of *Branchidontes variabilis* which remained dominant all along the study period. On average, the density of *Branchidontes variabilis* remained (1847.90/0.19 m²) among all species. It seems that this difference in indices is due to the topographic conditions of substratum, as the benthic profile, at station one, is more sandy muddy, unlike station two, where the bottom profile is predominantly rocky. Several other such studies dealing with molluscan ecology, explaining the faunal composition and distribution of macro benthic molluscan communities, also showed similar findings and rocky intertidal systems were found largely rich in fauna and flora when compared to sandy muddy habitats (Atapattu, 1972; Fuxue *et al.*, 1994). Benthic species composition and distribution were strongly related to environmental factors, such as tidal flow, sediment forms, water currents and temperature. Species horizontal distribution shows the effect of sediment forms on benthos while the vertical distribution of species is concerned by the tidal action (McQuaid *et al*., 1985; Ruxing *et al.*, 1991; Warwick *et al.*, 1991; Barkati and Burney, 1991). Spight (1978) suggested that the distributional patterns may reflect a habitat selection but it may also be due to random colonization and subsequent biotic interaction.

In contrast, comparatively, species frequencies and diversity were found to be higher at station one; and, on average, the molluscan species frequency and species diversity along station one remained higher throughout the study period. Calculated species frequency for *Umbonium vesterium* dominated the profile (95.45/0.19m²) at station one. Whereas, on average, high frequencies at station two were shown by *Branchidontes variabilis* (87.03/0.19m²). It is believed that there are so many factors which can affect the distribution of communities in the intertidal areas. Therefore, it is suggested that a quantitative horizontal distribution of communities in the intertidal area may be related to wave exposure and tidal currents which are more prevalent at sandy shores due to the absence of barriers that break the force (Kaandorp, 1986; Rauxing *et al.*, 1991; Ghamrawy, 1991).

The comparison of species richness between two stations revealed an average richness between two stations, which was found higher at station two. While comparing the variation between tidal level and total area in station one showed the greatest variation in species richness at high and mid tidal zone with a gradual decreasing trend from mid to high zone. In contrast, molluscan inhabiting Parangua Bay (Brazil) showed a subsequent decrease in the species richness and abundance from low tidal zone to high tidal zone, as observed by Boehs *et al.* (2004). According to Rahman and Barkati (2012), the individuals and the number of species of molluscs generally decrease from low to high tide mark, while remain highest in mid tide zone.

The comparison of species evenness at two stations of Bandri exhibited an average evenness that remained high at station one among the three tidal levels and total area. Generally, along station one and station two, species evenness decreased from high tide to low tide. However, comparing the variation of species evenness in station one showed a higher variation among the three tidal levels and the total area, compared to station two. Whilst comparing species dominance studies revealed that both stations were dominated by different species; station one was dominated by *Umbonium vesterium* and station two by *Branchidontes variabilis.* Observations showed that species dominance remained much higher along station two as compared to station one at three tidal levels and total area, but the overall dominance was found much pronounced at mid tidal zone. Barkati and Rahman (2005) observed seasonal changes in species diversity among the three mangroves associated sites of Karachi coast; at the sands spit coast species richness was found minimum during summer, while it remained maximum during autumn (1.25-3.1); whereas in spring it ranged between 3.83 to 5.7 in autumn. Calculated evenness values were found to be lower during spring and higher during summer. Similarly, from Clifton, the minimum richness was recorded during spring and the maximum in summer, whereas lower evenness was recorded in winter and higher in summer.

Diversity Indices are normally used to characterize the biodiversity of a habitat with respect to the abundance of each species, their richness, and evenness, etc. For instance, species diversity refers to the measure of diversity in an ecological community; whereas species richness is the number of different species representing an ecological community. Species evenness refers to how each species is closely distributed in number in an environment; these measures may affect the species diversity. Moreover, species richness increases in response to the decreasing sand particle size as both grain size and beach slope contribute positively in the species richness at a global scale (Barboza and Dafeo, 2014). A community dominated by one or two species is considered to be less diverse than one in which several different species have similar abundance. Therefore, species richness and evenness increase tends to increase in diversity as it is found higher at ST-I. Seapy and Littler (1978) studied the macro invertebrates along the California coast, and concluded that, at sheltered beaches, species richness remained higher, while by calculating Shannon's index and evenness values it pointed a higher diversity on exposed Sea stack. Richness was of a greater value (9.18) on boulder beach as compared to (7.40) at Sea stack. McQuaid and Branch (1984) studied species richness and evenness based on their observation and they found high evenness whereas richness was low; they concluded that this difference was due to unstable substratum.

Rahman and Barkati (2012) found, while studying molluscan fauna along 4 rocky beaches of Karachi coast Pakistan (Buleji, Nathiagali, Manora and Cape Monze), that between sites, there were no significant changes in species diversity, richness and evenness. Datta *et al.*

(2010) found that species richness (Margalef Richness Index) ranged from 2.93-5.71, and evenness (Pielou's Evenness Index) ranged from 0.81-0.83 while studying three different sites of Mumbai, India. David (2013) studied the biodiversity and distribution of marine gastropod (Mollusca) during pre and post-monsoon season along the Goa coastline India, and calculated Shannon's-Weiner biodiversity index which ranged from 2.1749 during pre-monsoon to 5.7641 in post-monsoon month. Species richness ranged from 0.5412 in pre-monsoon to 4.4866 in the post-monsoon, while evenness values ranged from 0.9128 during pre-monsoon months to 1.9534 during the post-monsoon.

In light of the discussion above, it is concluded that these findings have presented a better insight into the molluscan assemblages and their natural habitats along the Bandri beach of Jiwani coast, Baluchistan for the first time. Obtained data and baseline studies could be useful in the bio resource management of the area. Research based quadrate analysis and taxonomic identifications (Ghani and Afsar 2017) are useful to initiate detailed studies on commercially important species of the area, to investigate their reproductive patterns, biochemical properties, natural product research, physicochemical properties, etc.

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