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COMPARATIVE STUDY OF SIGNIFICANT MOLLUSCANS DWELLING AT TWO SITES OF JIWANI COAST, PAKISTAN

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ABSTRACT: During the present study collectively eighty two (82) molluscan species have been explored from Bandri (25 04. 788 N; 61 45. 059 E) and Shapk beach (25 01. 885 N; 61 43. 682 E) of Jiwani coast. This study presents the first ever record of molluscan fauna from shapk beach of Jiwani. Amongst these fifty eight (58) species were found belonging to class gastropoda, twenty two (22) bivalves, one (1) scaphopod and one (1) polyplachopora comprised of thirty nine (39) families. Each collected samples was identified on species level as well as biometric data of certain species was calculated for both sites. Molluscan species similarity was also calculated between two sites. For gastropods it was remain 74 %, for bivalves 76 %, for Polyplacophora 100 % and for Scapophoda 0 %. Meanwhile total similarity of molluscan species between two sites was calculated 75 %. Notable identified species from Bandri and Shapak includes Oysters, Muricids, Babylonia shells, Trochids, Turbinids and shells belonging to Pinnidae, Arcidae, Veneridae families are of commercial significance which can be exploited for a variety of purposes like edible, ornamental, therapeutic, dye extraction, and in cement industry etc.

KEYWORDS: Molluscan, significance, Jiwani, Balochistan

INTRODUCTION

Molluscans have been recognized as an important resource thus over centuries turned out to be a known natural resource of economic importance throughout the world. The coastline of Pakistan is about 990 km long, supporting vivid biodiversity which has direct or indirect impact on coastal communities. Life inhabiting coastal wetlands comprises endangered, endemic and commercially important life forms. Molluscs are one of the most diverse groups among these floral and faunal assemblages (Ahmed, 1977; Ahmed *et al.,* 1982; Burney and Barkati, 1995; Nasreen *et al.,* 2000, Afsar and Siddiqui, 2013; Afsar *et al.,* 2013; Ghani *et al.,* 2017; Ghani *et al.,* 2018).

India and Pakistan share the corresponding eastern and western boundary of the Northern Arabian Sea. Thus they have more or less similar diversity on coast. Like other countries in India gastropods and bivalves are commonly used for ornamental and edible purpose like *Babylonia spirata*, *Bursa spinosa*, *Tonna dolium*, *Oliva gibbosa*, *Conus glans*, *Epitonium scalaris*, *Architectonia perspective,Turritella attenuate*, and several *Umbonium, Cerithium, Cerithedia, Phalium, Planaxis* species along with bivalves *Arca, Gafrarium, Cardium, Donax species* are regularly exploited in making doll models, jewellery, buttons, bangles table lamps, spoons, cups, earrings etc. Additionally edible species *Paphia laterisulca, P. textile*, *Meritrix costa*, *M. meritrix*, *Katelysia opima*, along

with ornamental items are exported to foreign countries to earn valuable foreign exchange. As well as in India a variety of species also used for medicinal purpose i.e., *Placenta placenta* (Nair and Rao, 1974; Babu *et al.*, 2011; Lagade *et al.*, 2013; Santhiya *et al.*, 2013).

Various ornamental gastropod species belonging to trochids and turbinids on rocky intertidal zones of Sindh and Balochistan coast in Pakistan are found to be fairly abundant and these are of marketable value; being exploited by fishermen in indigenous handicraft industry of Pakistan since long (Afsar and Siddiqui, 2013; Afsar *et al.*, 2013).

In view of above mentioned molluscs being a valuable natural resource must be managed properly, if not then these valuable stocks will be at risk because of overexploitation and miss management. There is an urgent need for appropriate administration and management of wild stocks, and to take thorough studies to evaluate the population dynamics, communities structure, habitats and diversity, consisting aspects of biology like as reproductive cycles to define breeding cycle, seasonal maturity peaks, standing stock sizes and by-catch volume. On the basis of these practical and scientific studies within which we can establish the facts for regaining of threatened species, habitat, also we can set critical management plans to achieve our goals (Afsar and Siddiqui, 2013; Afsar *et al.*, 2013; Moazzam 2015; Mohsin *et al.*, 2017). Because organisms of littoral benthic area as a whole but mostly molluscs play a significant role in the basic marine food chain (Barnes, 1974).

During the present study Jiwani area observed with wide stretch of coastline which harbours a variety of edible and ornamental marine molluscs that are a pleasure to taste and for eyes, also offers attractive beaches for tourism, a major source of revenue for fishermen and tourist servers. Hence, marine molluscs have an important role in the economic and cultural life of the municipality of Jiwani. Furthermore potential commercially important molluscan species have been highlighted and discussed that can play vital role in different industries like ornamental, medicines, food, preparing dyes, cement industry etc.

MATERIALS AND METHODS

Study Period:

A short survey was made in October, 2018. Two sampling sites were selected along the Jiwani coast viz a viz (Bandri and Shapk beach). During the study, each sampling sites was surveyed randomly to assert the occurrence of molluscan species at two sites. Collected specimens were procured to laboratory for further taxonomic and biometric analysis.

Study Area:

Bandri and Shapk beaches along the Jiwani coast, Balochistan are located at25 04. 788 N; 61 45. 059 E (Bandri) and 25 01. 885 N; 61 43. 682 E (Shapk). Jiwani is located at north eastern end of Gulf of Oman in the northern part of Arabian Sea, with its important mangrove forest extending across the international border (Iran), and is an important habitat for a wide variety of wildlife, especially the endangered Olive Ridley and Green Turtles. Jiwani beach could be point up in different well know region including Dasht Hor (mangroves area) Bandri beach, Daran beach, Jiwani city coast, and

Shapk beach. However current field visits were limited to Bandri and Shapak beaches.

Description of study sites:

Bandri:

Bandri beach (25 04. 788 N; 61 45. 059) which is situated along the Gawatar Bay, about 4-5 km away from main Jiwani town. The area was chosen for sample collection is about 2-3 km, which is open to direct surf action. Mostly substrate of the supratidal zone 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 substrate profile is a bit different at the center, and there are muddy cum sandy substrate on the west side of the beach with no or very small cave-like shelters, while habitat in the lower intertidal region is predominantly sandy, but on the western side of the beach (Ghani *et al.*, 2017; Ghani *et al.*, 2018).

Shapk:

Shapk beach (25 01. 885 N; 61 43. 682 E) is a mixture of rocky and sandy platform with high cliff profile. The substratum of the shore is of a hard, rocky with flat surfaces of extremely low slopes occupied by boulders on eastern side, whereas in some places the western side and the upper tidal area are mostly sandy with small rocks. Continuous rocky platform are the middle and lower regions. Low-profiled rocky overhangs and cave-like shelters appear to form some parts of the beach.

Collection, handling, preservation, identification, measurements and data analysis:

Hand-picked random sampling scheme used to obtain samples during survey. Small boulders and stone were turned for molluscan species collection and also various hard shells compactly attached to substratum like *Cellana* sp, *Siphonaria* sp, Oysters and Chitons etc. were detached by the help of forceps and hammer. Shell grit or shell sand removed from molluscan samples by washing it in fine mesh bag, in situ they were fixed in buffered 10 % formalin in plastic bottles. Samples were carefully brought to laboratory and after two days transferred into 75% alcohol after soaking in water for a few hours. Detailed taxonomic and morphological examination was made in laboratory. A digital Vernier Calliper used to measure total shell size (SS) nearest to 0.01 from its apex to the distal end of the siphonal canal for each sample.

Different published material used to identify the collected samples including books, research publications and online libraries based on chonchological characteristics features including Khan and Dastagir (1970),Tirmizi and Zehra (1982), Bosch *et al.* (1995), FAO Manual (1998), Afsar *et al.* (2012); Ghani *et al.* (2017). To compare the similarity of species between two sites and groups, Sorenson's Similarity Index was used as an estimation tool.

Sorenson's Similarity Index (Krebs 1999)

$Cs = 2j / a + b$

Where,

J = is the number of species common to a given pair of location.

A and b = the number of species occurring in either of the two location.

RESULTS AND DISCUSSION

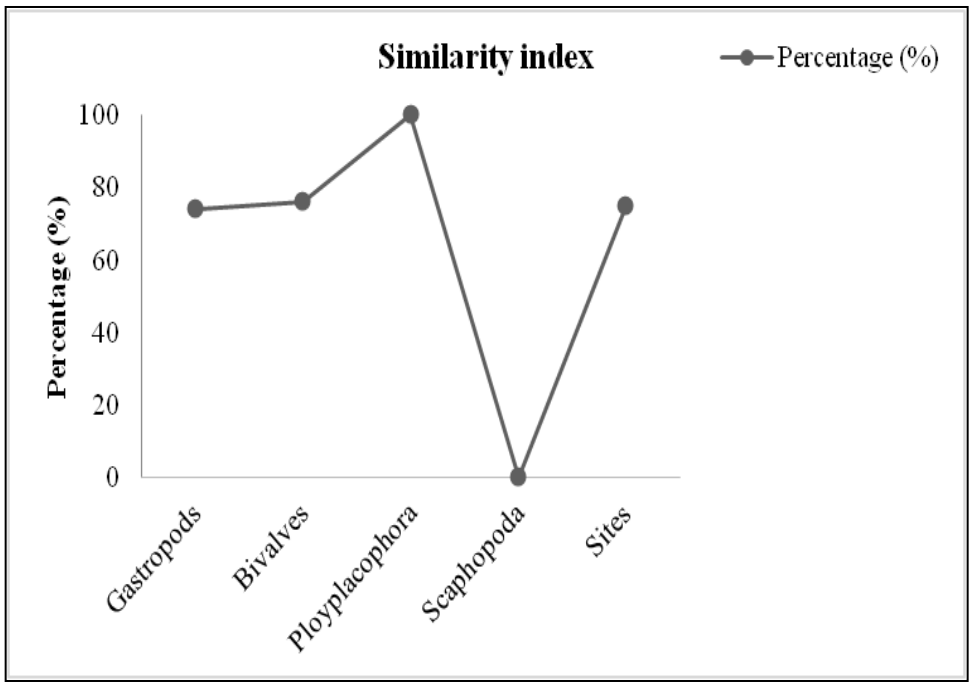

Fig. 1. Species similarity within sites and among different groups of molluscan species.

Phylum mollusca is divided into seven (7) classes, which are Aplacophora, Polyplacophora, Monoplacophora, Gastropoda, Bivalvia, Scaphopoda and Cephalopoda. During the current study collectively a total of eighty two (82) molluscan species have been identified belonging to aforementioned groups from Bandari and Shapk beach as shown in Table 1 and 2. Amongst these eighty two (82) species, fifty eight (58) were found belonging to class gastropoda, twenty two (22) bivalves, one (1) scaphopods and one (1) polyplachopora species contributing to thirty nine (39) families (Table 1, Fig. 2). Average shell size (SS) and standard deviation calculated for all species of two selected sites (Table 1 and 2). There is no earlier published record of benthic molluscan fauna available in literature from the Shapk beach. So, this is the first ever report of molluscans inhabiting the Shapak beach.

Besides several molluscan species of commercial importance have been identified at two sites. Molluscs of commercial importance can be easily classified into two major categories which are edible (Oysters, clams, mussels etc) and ornamental molluscans (Turbinids, trochids etc.). Furthermore, many marine molluscs are used to extract vibrant dyes to color cotton, yarn, and clothing, stuff (i.e., Muricoids). While shells and shell products are used for a variety of purposes including lime and cement manufacturing.

Notable ornamental gastropod species *Diodora singaporensis, Monodonta nebulosa, Umbonium vestiarium, Nerita adenensis, N. longii, N. textiles, Cerithium zonatum,*

Clypeomorus bifasciata, *Turritella fultoni* and *Natica sancta*, not found at Shapak whereas *Naticarius alapapilionis* and , *Gyrineum natator* were found at Shapak but contrastingly these were not found at Bandri. Muricoid species which are well known species to extract dye were found at two sites which are namely *Purpura panama, Purpura bufo, Indothais lacera, Drupella rugosa, Tylothais savignyi, Semiricinula tissoti.* All aforesaid species are important which are mostly in artiCrafts as well as commonly used for food (Table 1).

Table 1. Species checklist: List of molluscan found at two sites (Bandari & Shapk) in Jiwani. Presence (♣) Absence (-) while * is indicating commercially important molluscan species collected during the study period.

S. No	Species Names	Shapk	Bandri
	Gastropods		
1	*Diodora funiculata* (Reeve, 1850)	♣	♣
2	*Diodora singaporensis* (Reeve, 1850)	-	♣
3	*Cellana rota* (Gmelin, 1791)	♣	♣
4	*Euchelus asper* (Gmelin, 1791)	♣	♣
5	*Monodonta nebulosa* (Forsskal, 1775)	-	♣
6	*Trochus erithreus* (Brocchi, 1823)*	♣	♣
7	*Umbonium vestiarium* (Linnaeus, 1758)*	-	♣
8	*Lunella coronata* (Gmelin, 1791)	♣	♣
9	*Turbo bruneus* (Roding, 1798)*	♣	♣
10	*Nerita adenensis* (Mienis, 1978)*	-	♣
11	*Nerita albicilla* (Linnaeus, 1758)	♣	♣
12	*Nerita longii* (Recluz, 1842)	-	♣
13	*Nerita textilis* (Gmelin, 1791)	-	♣
14	*Echinolittorina natalensis* (Philippi, 1847)	♣	-
15	*Echinolittorina vidua* (Gould, 1859)	♣	-
16	*Planaxis sulcatus* (Born, 1780)	♣	♣
17	*Cerithium caeruleum* (Sowerby, 1855)	♣	♣
18	*Cerithium scabridum* (Philippi, 1848)*	♣	♣
19	*Cerithium zonatum*(W.Wood, 1828)*	-	♣
20	*Clypeomorus bifasciata* (G.B. Sowerby II, 1855)*	-	♣
21	*Rhinoclavis sinensis* (Gmelin, 1791)*	♣	♣
22	*Pirenella cingulata* (Gmelin, 1791)*	♣	♣
23	*Turritella fultoni* (Melvill, 1898)*	-	♣
24	*Turritella maculata* (Reeve, 1849)*	♣	-

Continued…….

25	*Turritella cochlea* (Reeve, 1849)	♣	♣
26	*Tibia curta* (G. B. Sowerby II, 1842)*	♣	♣
27	*Naria turdus* (Lamarck, 1810)*	♣	♣
28	*Natica sincta (Recluz, 1850)**	-	♣
29	*Neverita didyma* (Roding, 1798)*	♣	♣
30	*Polinices mammilla* (Linnaeus, 1758)*	♣	♣
31	*Naticarius alapapilionis* (Roding, 1798)*	♣	-
32	*Gyrineum natator* (Roding, 1798)*	♣	-
33	*Hexaplex kuesterianus* (Tapparone-Canefri, 1875)*	♣	♣
34	*Semiricinula konkanensis* (Melvill, 1893)*	♣	♣
35	*Tenguella granulata* (Duclos, 1832)*	♣	♣
36	*Purpura panama* (Roding, 1798)*	♣	♣
37	*Purpura bufo* (Lamarck, 1822)*	♣	-
38	*Indothais lacera* (Born, 1778)*	♣	♣
39	*Drupella rugosa* (Born, 1778)*	♣	-
40	*Tylothais savignyi* (Deshayes, 1844)*	♣	♣
41	*Semiricinula tissoti (Petit de la Saussaye, 1852)**	♣	♣
42	*Babylonia spirata* (Linnaeus, 1758)*	♣	♣
43	*Anachis fauroti* (Jousseaume, 1888)*	-	♣
44	*Anachis terpischore (G.B. Sowerby II, 1822)**	♣	♣
45	*Mitrella blanda* (G. B. Sowerby I, 1844)*	-	♣
46	*Nassarius deshayesianus* (Issel, 1866)*	♣	♣
47	*Nassarius persicus* (Martens, 1874)*	-	♣
48	*Nassarius marmoreus* (A.Adams, 1852)*	♣	♣
49	*Bullia persica* (E. A. Smith, 1878)*	♣	♣
50	*Bullia tranquebarica* (Roding, 1798)*	♣	♣
51	*Peristernia forskalii* (Tapparone-Canefri, 1875)	-	♣
52	*Oliva bulbosa* (Roding, 1798)*	♣	♣
53	*Mitra subruppeli* (Finlay, 1927)*	♣	♣
54	*Conus biliosus* (Roding, 1798)	♣	-
55	*Turricula nelliae spuria* (Hedley, 1922)	♣	♣
56	*Myurella nebulosa* (G. B. Sowerby, 1825)	♣	-
57	*Siphonaria asghar* (Biggs, 1958)	♣	♣
58	*Siphonaria savignyi* (Krauss, 1848)	♣	♣

Continued…….

	Scaphopoda		
59	*Dentalium octangulatum* (Donovan, 1804)*	-	♣
	Polyplacophora		
60	*Chiton peregrinus* (Thiele, 1909)	♣	♣
	Bivalves		
61	*Barbatia foliata* (Forsskal in Niebuhr, 1775)*	-	♣
62	*Barbatia obliquata* (Wood, 1828)*	♣	♣
63	*Barbatia trapezina* (Lamarck, 1819)*	♣	♣
64	*Anadara natalensis* (Krauss, 1848)*	♣	♣
65	*Perna viridis(Linneaus, 1758)**	-	♣
66	*Brachidontes variabilis* (Krauss, 1848)	-	♣
67	*Atrina vexillum* (Born, 1778)*	♣	♣
68	*Atrina pectinata* (Linnaeus, 1767)*	♣	♣
69	*Pinna muricata* (Linnaeus, 1758)*	♣	♣
70	*saccostrea cucullata* (Born, 1778)*	♣	♣
71	*Saccostrea echinata (Quoy & Gaimard, 1835)**	-	♣
72	*Magallana bilineata* (Röding, 1798)*	-	♣
73	*Chlamys townsendi* (Sowerby, 1895)*	♣	♣
74	*Cardites bicolor* (Lamarck, 1819)	♣	♣
75	*Afrocardium richardi* (Audouin, 1826)	♣	♣
76	*Vasticardium assimile lacunosum* (Reeve, 1845)	♣	♣
77	*Mactra lilacea* (Lamarck, 1818)*	-	♣
78	*Solen vagina (Linnaeus, 1758)**	-	♣
79	*Siliqua radiata (Linnaeus, 1758)**	♣	♣
80	*Circenita callipyga* (Born, 1780)*	♣	-
81	*Dosinia sp (Scopoli, 1777)*	♣	-
82	*Paratapes undulatus* (Born, 1778)*	♣	♣

Similarly commercially important edible bivalves *Perna viridis, Brachidontes variabilis, Saccostrea echinata, Magallana bilineata, Mactra lilacea, Solen vagina,* were not found at Shapak but all these were present at Bandri whereas *Circenita callipyga, Dosinia sp,* were not present at Bandri but found at Shapak. Popular pearl oysters *Atrina vexillum, Atrina pectinata, Pinna muricata* were found at both sites. (Table 1).

Similarity index:

For each group (Gastropods, Bivalves, Scapophoda and polyplacophora) and between two selected sites, the Sorenson Similarity Index was calculated 75% as shown in Fig. 1. Species similarity among gastropods at two sites was calculated 74% and among bivalves 76% respectively. In general except Scapophoda, (0%) species similarity between groups and sites was remains high due to almost the same topographic condition

and beach profile.

Table 2. Average shell size (SS) and standard deviation (SD) of molluscans inhabiting two sites.

	Bandri			Shapak		
S. No	**Species Names**	**SS (mm)**	**SD (±mm)**	**Species Names**	**SS (mm)**	**SD (±mm)**
	Gastropods			**Gastropods**		
1	*Diodora funiculata*	5.5	0.71	*Diodora funiculata*	20.50	2.12
2	*Diodora singaporensis*	17	1.414	*Cellana rota*	26.00	5.48
3	*Cellana rota*	43.08	2.78	*Euchelus asper*	25.50	15.84
4	*Euchelus asper*	9.5	0.71	*Trochus erithreus*	14.43	7.61
5	*Monodonta nebulosa*	19	1.41	*Lunella coronata*	35.55	3.31
6	*Trochus erithreus*	33.18	2.13	*Turbo bruneus*	50.00	0.00
7	*Umbonium vestiarium*	7.30	1.08	*Mienerita debilis*	16.00	3.46
8	*Lunella coronata*	38.63	2.98	*Nerita albicilla*	23.44	2.08
9	*Turbo bruneus*	42.18	3.11	*Echinolittorina natalensis*	9.20	1.11
10	*Nerita adenensis*	19.5	0.71	*Echinolittorina vidua*	8.50	0.71
11	*Nerita albicilla*	23.67	1.15	*Planaxis sulcatus*	18.23	1.00
12	*Nerita longii*	27.73	1.08	*Cerithium caeruleum*	28.45	1.88
13	*Nerita textilis*	34	1.41	*Cerithium scabridum*	14.40	1.52
14	*Planaxis sulcatus*	16	1.83	*Rhinoclavis sinensis*	30.00	2.83
15	*Cerithium caeruleum*	27.5	0.71	*Pirenella cingulata*	25.33	0.85
16	*Cerithium scabridum*	18.82	0.19	*Turritella maculata*	45.23	2.11
17	*Cerithium zonatum*	12.3	1.42	*Turritella cochlea*	30.00	1.66
18	*Clypeomorus bifasciata*	14.3	1.57	*Tibia insulaechorab curta*	80.00	6.88
19	*Rhinoclavis sinensis*	38.23	1.28	*cypraea turdus*	31.00	1.41
20	*Pirenella cingulata*	27.21	0.14	*Neverita didyma*	33.00	0.11
21	*Turritella fultoni*	24.5	0.71	*polinices mammilla*	30.00	1.25
22	*Turritella cochlea*	40	2.72	*Natica alapapilionis*	20.00	2.00
23	*Tibia insulaechorab curta*	120.08	4.91	*Gyrineum natator*	26.35	1.05
24	*Naria turdus*	39.01	1.10	*Hexaplex kuesterianus*	48.25	3.18
25	*Natica sincta*	21	1.41	*Cronia cf konkanensis*	20.50	2.12

Continued…….

26	*Neverita didyma*	40.5	0.71	*Tenguella granulata*	27.25	5.74
27	*polinices mammilla*	33.38	1.63	*Purpura panama*	44.33	14.01
28	*Hexaplex kuesterianus*	50.33	7.09	*Purpura bufo*	39.50	0.71
29	*Semiricinula konkanensis*	25	0.73	*Indothais lacera*	52.11	4.73
30	*Tenguella granulata*	19	1.41	*Drupella rugosa*	35.00	0.00
31	*Purpura panama*	58.61	4.41	*Tylothais savignyi*	29.50	0.71
32	*Indothais lacera*	55.19	3.97	*Semiricinula tissoti*	26.00	3.56
33	*Tylothais savignyi*	21.17	8.98	*Babylonia spirata*	32.50	0.71
34	*Semiricinula tissoti*	30.15	2.20	*Anachis terpischore*	13.83	2.32
35	*Babylonia spirata*	55.13	8.11	*Nassarius deshayesianus*	13.50	0.71
36	*Anachis fauroti*	11.35	0.71	*Nassarius marmoreus*	19.00	1.41
37	*Anachis terpischore*	12	0.08	*Bullia persica*	19.50	2.12
38	*Mitrella blanda*	13.375	0.74	*Bullia tranquebarica*	15.58	1.48
39	*Nassarius deshayesianus*	14	1	*Mitra subruppeli*	21.65	1.05
40	*Nassarius persicus*	18.67	1.21	*Oliva bulbosa*	40.38	3.43
41	*Nassarius marmoreus*	20.51	1.10	*Conus biliosus*	33.50	3.54
42	*Bullia persica*	21.93	1.65	*Turricula nelliae spuria*	26.44	2.08
43	*Bullia tranquebarica*	28.67	6.11	*Myurella nebulosa*	46.43	1.76
44	*Peristernia forskalii*	25.21	2.69	*Siphonaria ashgar*	25.40	4.21
45	*Oliva bulbosa*	47.33	1.15	*Siphonaria savignyi*	12.71	2.36
46	*Mitra subruppeli*	22.47	1.06	**Polyplacophora**		
47	*Turricula nelliae spuria*	26.93	1.98	*Chiton peregrinus*	23.50	6.36
48	*Siphonaria ashgar*	26.46	2.15	**Bivalves**		
49	*Siphonaria savignyi*	17.01	0.43	*Barbatia obliquata*	11.00	1.41
	Scaphopoda			*Barbatia decussata*	17.00	1.41
50	*Dentalium octangulatum*	26.12	1.39	*Anadara natalensis*	43.90	3.20
	Polyplacophora			*Atrina vexilium*	145.10	10.67
51	*Chiton peregrinus*	29.15	0.33	Servitrina pectinata	250.32	10.11
	Bivalves			*Pinna muricata*	248.43	15.70
52	*Barbatia foliata*	98.96	4.88	*Saccostrea cucullata*	48.66	10.89
53	*Barbatia obliquata*	60.1	3.17	*Chlamys townsendi*	130.12	4.68
54	*Barbatia trapezina*	58.95	2.3	*Cardites bicolor*	43.15	3.61

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55	*Anadara natalensis*	59.24	1.76	*Afrocardium richardi*	44.00	2.83
56	*Perna viridis*	80	0.91	*Acrosterigma lacunosa*	60.30	5.41
57	*Brachidontes variabilis*	14.14	1.35	*Acrosterigma assimile*	40.05	3.19
58	*Atrina vexilium*	195.38	2.25	*Sliqua radiata*	50.94	3.21
59	*Servitrina pectinata*	280.73	14.21	*Circenita callipyga*	32.33	1.53
60	*Pinna muricata*	255.34	16.08	*Dosinia sp*	13.00	1.41
61	*saccostrea cuccullata*	51.33	11.19	*Paphia undulata*	70.28	3.82
62	*Saccostrea echinata*	65.32	8.99	-	-	-
63	*Magallana bilineata*	55.63	9.04	-	-	-
64	*Chlamys townsendi*	132.43	12	-	-	-
65	*Cardites bicolor*	29	1.41	-	-	-
66	*Afrocardium richardi*	10	0.23	-	-	-
67	*Acrosterigma lacunosa*	68.35	3.65	-	-	-
68	*Acrosterigma assimile*	50.89	4.37	-	-	-
69	*Mactra lilacea*	30	2.82	-	-	-
70	*Solen vagina*	90.56	2.11	-	-	-
71	*Siliqua radiata*	55.31	4.45	-	-	-
72	*Paphia undulata*	23	2.82	-	-	-

During this study various gastropods and bivalve shells were observed and collected which are commercially important served for a variety of purposes i.e., pearls production, ornamentals and edible purpose like Oysters, Muricids, Babylonia shells, Trochids, Turbinids and others comprised of Pinnidae, Arcidae, Veneridae etc. which found in fair amount at Bandri and Shapak and these can easily fulfil all above mentioned industrial uses in future. These objects are of high market value especially in foreign markets due to recent advances in commercial industries related to pharmaceuticals (Gul and Hamann 2005), dye extraction (Mitchel and McGovern 1987; Fulcher 2017; Brons 2017; Cooksey 2017) and cement industry that have become a potential replacement of calcium carbonate (Mohammad *et al.,* 2017). Molluscans are considered "treasures" from the sea. The byssal threads of pen shells used to weave fabric known as sea silk, and purple dye extracted from the hypobranchial glands of muricoids (Fulcher 2017; Ghani and Afsar 2017). Hence, sea silk, purple dye, uses in preparation of several drugs to treat certain diseases and cement production from sea shells make them unique objects.

Due to increased demand for meat and other industrial use these have received significant attention globally in recent years. Various products made from molluscan shells are becoming highly priced objects in the indigenous and foreign markets (Appukuttan, 1996). There are various commercially important species caught along the coasts bordering Arabian Sea and Indian Ocean which are *Turritella attenuata*, *Polystira sp*., *Crassispira sp*., (screw shells). *Architectonia perspectiva* (staircase shell), *Epitonium scalaris* (ladder shells), *Xenophora sp*. (carrier shells), *Tibia curta* (wing shells), *Natica albula*, *Natica lineata* (naticas), *Phaltum glaucum*, *P. canaliculatum* (helmet shells), *Bursa spinosa* (purse shells), *Tonna dolium* (tun shells), *Ficus ficus* (fig shells), *Rapana bulbosa* (purples), *Murex trapa*, *M. virgineus*, *M. badius*, *Murex sp*., (venus combs), *Babylonia spirata*, *B. zeylanica* (whelks), *Hemifusus pugilinus*, *Fusinus toreuma* (spindle shells), *Olive gibbossa*, *Oliva sp*, (olive shells), *Xancus pyrum* (sacred chank), *Harpa conoidalis* (harp shells), *Conus glans* and *Conus sp*. (cone shells), *Placenta placenta* (Window-pane). *Tibia curta*, *Bursa spinosa*, *Babylonia spirata* and *B. zeylanica* are dominant among these species, followed by *Turritella attenuata*, *Rapana bulbosa*, *Xancus pyrum* and *Conus glans*, contributing 80 percent of total gastropod landings (Appukuttan, 1996; Santhiya *et al.*, 2013).

During this study various commercially important gastropods including *Babylonia spirata, Umbonium vesterium, Purpura panama, Purpura bufo, Indothais lacera, Tylothais savignyi, Semiricinula tissoti, Anachis fauroti, A. Terpischore, Mitrella blanda, Nassarius persicus, Bullia persica, B. Tranquabarica, Oliva bulbosa* etc. found and among these *Babylonia spirata, Umbonium vesterium, Purpura panama, T. savignyi, Anachis terpischore* found as dominant species. Commercially important edible bivalves, especially oysters, are very abundant along the Jiwani coast, including *Saccostrea cucullata, Srassostrea madrasensis, Saccostrea echinata* and various species of the Arcidae and Veniridae family (Fig. 2). Earlier Ghani *et al.* (2017) and Ghani *et al.* (2018) reported the above mentioned molluscan from Bandri beach.

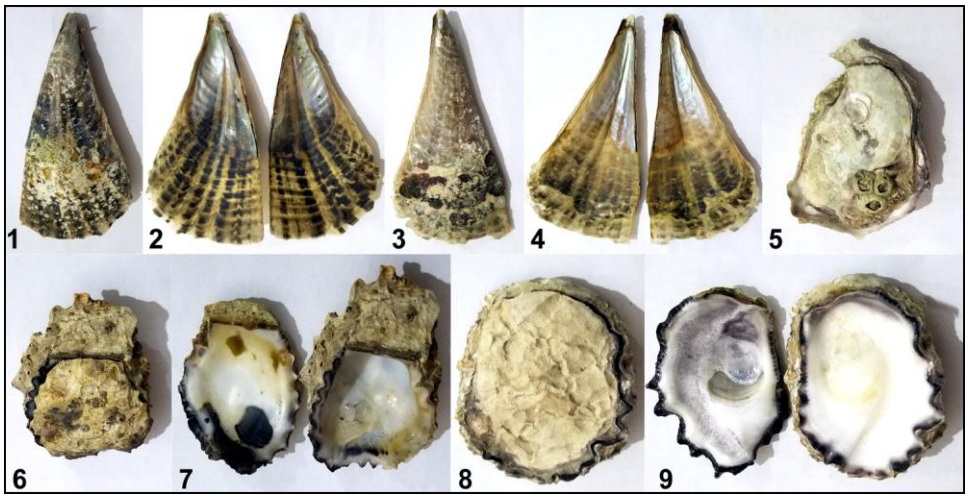

Fig. 2. 1-4, *Pinna muricata*; 5, *Magallana bilineata*; 6-7, *Saccostrea cucullata*; 8-9, *Saccostrea echinata.*

Different species of bivalves and gastropods inhabit Jiwani are important in shell trade including oysters, whelks, mussel *Perna viridis* etc. Oysters are important molluscs exploited throughout the world. Much attention has not been paid on restoration of oyster beds in Pakistan as oyster beds have been depleted along most of the coast of Pakistan (Beg, 1995; Siddiqui *et al.*, 2008; Moazzam, 2015; Afsar *et al.*, 2014) but sufficient natural stock of molluscans including oyster species is available along the Jiwani coast specially at three main beaches which are Bandri, Jiwani city rocky ledge and Shapk.

Among marine gastropods univalves are fished for bait in many parts of the world for their beautiful shells and lime production (Appukuttan and Ramadoss, 2000; Babu *et al.*, 2011; Santhiya *et al.*, 2013). The current study showed that only a small number of species are considered to be used in the food industry, including *Turbo bruneaus*, *Purpura panama*, *Indothais lacera, Tylothais savignyi, Purpura bufo*, etc. in Pakistan. On the other hand, bivalves counting (22) species, most of which are commercially important food commodities including *Crassostrea* and *Sacostrea sp, Perna viridis* as well as species of Pinnadea, Arcidae and Veneridae, are also very common along the Jiwani coast. In addition to window-pane oysters and mussels which are commonly used to cure certain diseases in many countries (Baby *et al.*, 2010). Apart from that, dense population of *Perna viridis* and other ornamental species are present along the Jiwani coast. Different molluscan species are used to make table lamps, lamp shades, domes, doles, garlands, chain pendants, necklaces, ear drops, neck beats, hair pin, pen stands, bangles, flower vases, window shell screens and door curtains (Appukuttan and Ramadoss, 2000 ; Babu *et al.*, 2011).

There is no significant use of molluscs in Pakistan and we could not find their recorded data on consumption. They are consumed in Pakistan, but in very low quantities (Mohsin *et al.*, 2017). They are gaining popularity over the course of time but the rate is very low. They are eaten as delicacy in major hotels in large cities. Thus they are only tasted by the elite class. Many factors, including social and cultural selection, are responsible for low molluscan use in Pakistan. Other factors include high prices, lower local market availability, and lack of awareness and less familiarization with this food**.**

Recommendations for resource management are based on onsite observations. Molluscs had an incredible impact on tradition and economy since the dawn of human civilization. As a popular panacea for diseases and as a mascot for warding off evil spirits, as currency, ornaments in olden days, molluscs have been in great demand throughout the world. Now, in addition to edible usefulness, molluscs have expected greater importance in technological, industrial and aesthetic aspects of life (Appukuttan 2008). At present, marine molluscs appear most exploited at the optimum level. In particular, illegal commercial exploitation (black marketing) along the Balochistan' coast is obvious (personal observations) by means of trawling for *Babylonia spirata* and other important species. The magnitude of destruction caused is very little known. Therefore detailed study of world's best practices can be helpful to formulate animal safety and conservation regulation in the province as well as in order to generate revenue, farming activities should be undertaken to increase production of edible oysters and mussels in future. Corrective management measures should be planned and discussed with scientific and Coastal Zone Management authorities that are deemed appropriate. So, presented work deals with occurrence of molluscan species at two different beaches of Jiwani and

identification of economically important species, overview on their uses in industry and some recommendation of resource management are given here in view of significance of molluscan resource.

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