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Diversity and Abundance of Marine Mollusca from coast of Damb (Sonmiani) Balochistan, Pakistan

Shazia Rasheed[1], Nazeer Ahmed[2], and Zahid Ali[3]

[1]Department of Marine Sciences, Faculty of Marine Sciences, Lasbela University, Agriculture, Waters and Marine Science, Balochistan, Pakistan

[2]Pakistan Agriculture Research Council, Agricultural Research Institute, Turbat, Balochistan, Pakistan

[3]Pakistan Agriculture Research Council, Coastal Agriculture Research Institute, Lasbela Balochistan, Pakistan

ABSTRACT: This research was focused on the molluscan diversity along the coast of Damb, Balochistan. 3 classes (Gastropoda, Bivalvia, and Cephalopoda) of phylum Mollusca were collected, identified and counted from this site from June-2022 to November 2022. 3 classes 23 families and 61species were identified from this site. A total 4818 specimens of molluscs were collected, among them 3283 (68%) specimens of 38 species of 16 families of class Gastropoda, while 1531 (31.56%) specimens of 22 species of 6 families of class Bivalvia were reported from this site. 14 specimens of 2 species of two families of class Cephalopod were collected. Simpson's Diversity Index (SDI) of gastropoda was about 0.1503 which shown the low diversity of gastropoda of this area. While Simpson's Diversity Index (SDI) of bivalvia was about 0.2795 which shown the high diversity of bivalvia of this site as compared to gastropoda. 3025 specimens of 6 species of family Potamididae of gastropoda was found in highest % of abundence which about (92.14%) of total collection of gastropoda. Family Tellinidae of class bivalvia with 3 species was found in highest % of abundence which about (84.64%) of total collection of bivalvia.

KEYWORDS: Diversity, Mollusca, Damb, occurrence, Simpson diversity Index (SDI).

1 INTRODUCTION

Molluscs provide a vital source of protein for human after fish [1]. Molluscs are benthic macro invertebrates and its play an important part in intertidal ecosystem [2]. It can be found in many parts of the biosphere such as ocean, brackish, freshwater and terrestrial areas. Molluscs are one of the most diverse phylum in terms of species diversity, showing a diverse variety of form, size, colour and shape. Their size range start from microscopic species to the massive squid (weighing about 270 kg). Molluscs generally have shells and this shell secreted by the mantle. Mantle is a visceral hump which is the main part of the molluscs. Foot and a radula are also main parts of the any molluscs' species. Molluscs are different from other phylum because they have these things, most of which are unique to the phylum Mollusca.

Phylum Mollusca consists of eight classes, all eight classes are represented in the sea with highest masses, followed by freshwater where only two groups (Gastropoda and Bivalvia), and terrestrial habitats where only class (Gastropoda) occurs. Molluscs are importance within food chains and as members of ecosystems. Certain species are of direct or indirect commercial and even medical importance to humans. Human being have been eating shellfish like clams, mussels and squid for at least 160,000 years as well as these objects are commercially important and valuable in different industries such as jewellary, food, medicinal and dyes preparation, cement industries and million tons of molluscan species are harvested yearly by countries for food and commercial purpose [3]. Molluscs are nutritive power houses due to rich in protein, minerals and healthy fats. They are also good for the oceans too.

Molluscs is grouped into two large groups of gastropoda and bivalvia that differ in the modification of their shells [4].Pakaenoni, 2019). Belly animals usually have a single shell folded in a circle. Without a clear skull, there are two wide tents, flat feet. The gums, which contain one or two fragments, breathe with one or two reproductive organs, placing internal or external fertilization. The shell of the bivalve class is symmetrical and has two parts that can be opened and closed. There are hollow teeth and connectors at the back of the shell. The coat of the right and left lobes is flattened. Two shell siphons are located at the rear. Bivalve gills are bowls of one or two pairs. Bivalves without head and jaw (radula). Reproductive organs are bipolar. In addition, the bivalve gonads open into the mantle cavity.

Regarding to Pakistan coastline the available published literature signifying information relating available molluscans, specially gastropod catches of commercial importance by several authors such as [5], [6], [7], [8], [9] and [10]. However, from Balochistan coast information's are very tapering in molluscan which includes some basic work formerly carried out by [11], [12], [13], [14]. Biologist focusing on molecular and (organizational studies for decades. The information should be useful for fisheries biologists as well as shell fisheries managers to determine the fishing efforts for this shellfishery from Pakistani waters. Taxonomical determination is the first step of any biological studies. Identification of

species level and study on diversity of Mollusca from Balochistan coast yet not carried out and update information on malacofauna is irregular and inadequate. The aim of this study to initiate this work along the coast of Lasbela Balochistan. Detailed survey of the coast of Damb was conduct with an objective to report on diversity and occurrence of mollusca.

2 MATERIALS AND METHODS

Samples were collected on monthly basis from coast of Damb, Sonmiani (25°09' N, 66°29' E) district Lasbela, Balochistan. The sites was thoroughly investigate for molluscan diversity and their distribution pattern. Samples of Molluscs were collected by two ways: 1. Collected as epifauna, (Molluscs living on the substrate); 2. Collected as infauna (Molluscs living in the substrate) taking the substrate upto15 cm depth.

Samples were collected by using hand picking method.The other tools including hamer, forceps, sieves, chisels were assisted to detach species from their substratum. Samples were also kept in different polythene bags even of the same site for comparative study of rock and sandy muddy sides of the coast. Samples was sorted and preserve 70% alcohol. Each sample was labeled with their detail like date, location and other important data. The samples were then put forward to the laboratory and were freeze to avoid spoiling of samples and to keep them fresh till the further investigation was done.Then samples were identified by references of [9], [15], and [16]. The index of World Register of Marine Species (WoRMS) [17] and Marine Molluscan fauna of the Pakistani coastal waters, was checked for the authenticity of species taxonomy and identification.

All identified sample were counted, and further statistical analysis was conducted. Molluscans samples were identified on the basis of chonchological characteristics such as shell characters, color and shap [18] also spire length & shape, mouth opening, opercula shape, umbilicus shape & size colour, and ornamentation of the shell were primarily used to identify the gastropoda. For bivalves shell were characters such adductor mucle scars, pallial line and no of lateral tooth were noticed to identify the species.

Quantitative analysis were conducted for the study of occurrence and diversity. For this purpose randomly three replicates quadrates of 1x1m^2 from each site was set, to detect the distribution and occurrence pattern of malacofauna in different coastal areas of Balochistan. Simpson's Diversity Index is a method to measure the diversity of species in a community. Diversity was calculated by Simpson diversity index equation as:

$$D = 1- \Sigma n_i (n_i-1) / N (N-1)$$

Where:

D: diversity of Index;
n_i: number of organisms of a particular species;
N: Total number of organisms of all species.

3 RESULTS AND DISCUSIONS

A total of 4818 specimens of molluscs were collected, counted, and identified from this site. 3283 (68%) specimens of 38 species of 16 families of Gastropoda were collected, while 1531 (31.56%) specimens of 21 species of 6 families of bivalvia were reported from this site. 14 specimens of 2 species of two families of Cephalopod were collected (Fig. 1).

Simpson's Diversity Index (SDI) of families of gastropoda was about 0.1503 which shown the low diversity of families of gastropoda of this area. While Simpson's Diversity Index (SDI) of bivalvia was about 0.2795 which shown the high diversity of bivalvia of this site as compared to gastropoda. Species richness of gastropoda and bivalvia were about 38 and 22 respectively.

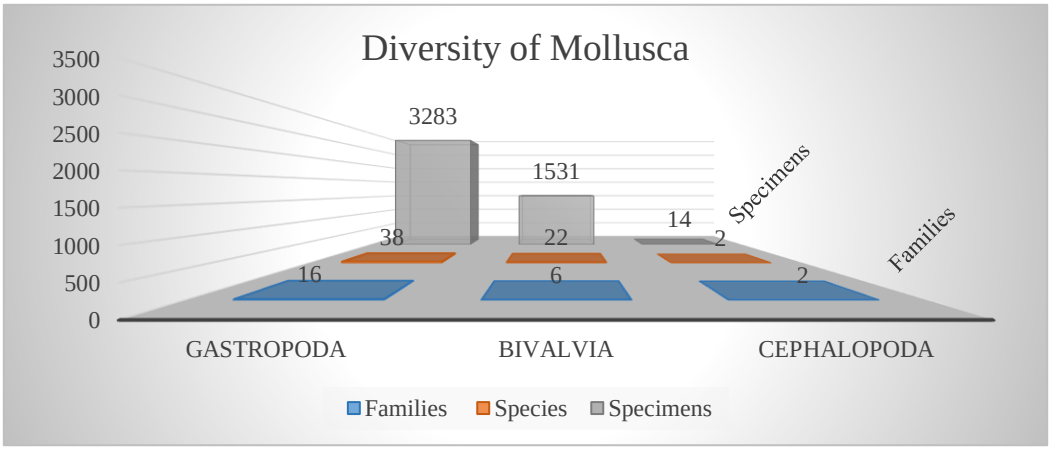

Fig. 1. Diversity and abundance of Marine Mollusca from Coast of Damb (Sonmiani), Balochistan

3.1 CLASS GASTROPODA

Gastropoda was reported in highest percentage of abundence about 68% of total collection of malacofauna from Damb. Species richness of this class was about 38 species of 16 families of 3283 specimens. Name of families and their species present in table I.

Table 1. Name of Families and species of class Gastropoda collected from Damb site

Families	Species
Neritidae Rafinesque, 1815	*Neritina comorensis* Morelet, 1877
	Nerita debilis Dufo, 1840
	N. albicilla Linnaeus, 1758
Fissurellidae Fleming, 1822	*Scutus antipodes* Montfort, 1810
Potamididae Adams and Adams, 1854	*Pirenella cingulata* (Gmelin, 1791)
	P. incisa (Hombron & Jacquinot, 1848)
	P. conica (Blainville, 1829)
	Terebralia sulcata (Born, 1778)
	T. palustris (Linnaeus, 1767)
	Cerithidea alata (Philippi, 1849)
Rostellariidae Gabb, 1868	*Tibia insulaechorab* Röding, 1798
Naticidae Guilding, 1834	*Neverita duplicata* (Say, 1822)
	N. didyma (Röding, 1798)
	Natica stellata Hedley, 1913
	N. royi Pin, 1992
	N. marchadi Pin, 1992
	Naticarius cruentatus (Gmelin, 1791)
Tonnidae Suter, 1913 (1825)	*Tonna dolium* (Linnaeus, 1758)
Muricidae Rafinesque, 1815	*Rapana venosa* (Valenciennes, 1846
	Purpura bufo Lamarck, 1822
	Murex trapa Röding, 1798
Babyloniidae Kuroda, 1971	*Babylonia spirata* (Linnaeus, 1758)
	B. japonica (Reeve, 1842)
Nassariidae Iredale, 1916(1835)	*Bullia natalensis* (F.Krauss, 1848)
Turridae Adams & Adams, (1838)	*Turricula javana* (Linnaeus, 1767)
Litiopidae	*Rissoa virgata* Philippi, 1849
Pyramidellidae Gray, 1840	*Obeliscus sanctaehelenae* Smith, 1890
PupillidaeTurton, 1831	*Pupoides albilabris* (Adams, 1841)
	P. myoporinae (Tate, 1880)
	P. adelaidae (Adams & Angas, 1864)
	Pupa coenopicta Hutton, 1834
Amphibolidae	*Salinator tectus* Golding, 2007
Tornatinidae P. Fischer, 1883	*Tornatella fumata* Reeve, 1865
Haminoeidae Pilsbry, 1895	*Haminoea antillarum* (d'Orbigny, 1841)
	H. hydatis (Linnaeus, 1758)
	H. vesicula (Gould, 1855)
	H. succinea (Conrad, 1846)
	Haloa natalensis (Krauss, 1848)

Table 2. SDI (Simpson's Diversity Index), Number and % of abundance of individuals (Indi.) and species of 16 different families of class Gastropoda in DAMB site from June 2022 to December 2022

Families	Jun. 22	Jul. 22	Aug. 22	Sep. 22	Oct. 22	Nov. 22	Total No.of Ind.	%	Total No.of Species	%
Neritidae	2	1	1	1	0	3	8	0.24	3	7.89
Fissurellidae	1	0	0	0	0	0	1	0.03	1	2.63
Potamididae	514	501	519	434	526	531	3025	92.14	6	15.79
Rostellariidae	3	1	1	8	0	1	14	0.43	1	2.63
Naticidae	1	0	2	2	1	19	25	0.76	6	15.79
Tonnidae	0	0	0	0	0	2	2	0.06	1	2.63
Muricidae	6	13	2	6	2	9	38	1.16	3	7.89
Babyloniidae	0	4	0	5	12	3	24	0.73	2	5.26
Nassariidae	2	0	0	0	0	0	2	0.06	1	2.63
Turridae	1	0	0	0	0	0	1	0.03	1	2.63
Litiopidae	0	0	0	0	0	30	30	0.91	1	2.63
Pyramidellidae	15	0	0	0	0	0	15	0.46	1	2.63
Pupillidae	0	0	0	0	0	60	60	1.83	4	10.53
Amphibolidae	0	0	0	0	0	25	25	0.76	1	2.63
Tornatinidae	7	0	0	0	0	0	7	0.21	1	2.63
Haminoeidae	0	0	0	0	0	6	6	0.18	5	13.16
Total	**552**	**520**	**525**	**456**	**541**	**689**	**3283**	**100**	**38**	**100**
%	**16.81**	**15.83**	**15.99**	**13.9**	**16.47**	**20.98**	**100**			
SDI	**0.132**	**0.071**	**0.023**	**0.09**	**0.054**	**0.395**	**0.1503**		**0.9246**	

Table II shows the SDI, % abundence of 16 families of Gastropoda which were collected from the Damb site from June 2022 to November, 2022. Family Potamididae with 6 species was found in highest % of abundence which about 3025 specimens (92.14%) of total collection of gastropoda. These species were *Cerithidea alata* (Philippi, 1849), *Pirenella conica* (Blainville, 1829), *Pirenella cingulata* (Gmelin, 1791), *Pirenella incisa* (Hombron & Jacquinot, 1848), *Terebralia palustris* (Linnaeus, 1767), *Terebralia sulcata* (Born, 1778). All 6 species were collected collected in every month in high quantity. Among these 6 species, *Pirenella conica* was found in high % of occurrence which was about 973 specimens (32.17%), than *Pirenella cingulate* was found in 24 % (754 specimens). *Cerithidea alata* was found in 15% of abundance, *Pirenella incisa* was in 13.17% and *Terebralia sulcata* was found in 13.32% of occurence. *Terebralia sulcata* was collected in least number which was about 0.33%. Second abundant family Pupillidae with 60 specimens of 4 species of was found only in Nov. 2022 in 1.83% of occurence. These species, *Pupoides albilabris* (40 specimens), *Pupoides myoporinae* (15 specimens), *Pupoides adelaidae* (01 specimen) and *Pupa coenopicta* (4 specimens) were collected. Family Muricidae with 38 specimens of 3 species was found in 1.16% of occurrence. One specimen of *Murex trapa* Röding, 1798 was collected in Nov.2022, while one specimen of *Purpura bufo* Lamarck, 1822 was found in June 2022. 36 specimens of *Rapana venosa* (Valenciennes, 1846) were collected in every months. Remaing all 13 families were found in less than 1% of abundance. 25 specimens (0.76%) of 6 species of family Naticidae were collected. These species were *Neverita duplicata* (Say, 1822), *N. didyma* (Röding, 1798), *Natica stellata* Hedley, 1913, *N. royi* Pin, 1992, *N. marchadi* Pin, 1992 *and Naticarius cruentatus* (Gmelin, 1791). All 13 specimens of *Natica stellata* were collected in Nov. 2022 while 6 specimens of *Neverita didyma* were collected in Oct and Nov. 2022. 15 specimens *Obeliscus sanctaehelen* of family Pyramidellidae were collected only in June 2022.

The lowest % of occurrence to be found in Fissurellidae and Turridae which was about 0.03% (one specimen). 6 Families namely, Tonnidae, Litiopidae, Pupillidae, Amphibolidae, Tornatinidae and Haminoeidae were found only one month in Nov.2022. Among them, family Haminoeidae have 5 species and six specimens while family Pupillidae have 4 species and 60 specimens and remaining 4 familes have only species.

Simpson's Diversity Index (SDI) of different families of Gastropoda in different months from Damb site shown in fig 2. Highest SDI was observed in Nov 2022 which was about 0.3947 and lowest SDI in August 2022 with 0.0227. 11 families were collected in November 2022, while only five families were found in August. Second highest SDI seen in June 2022 with 0.1321. Remaing all four months had below 0.1 values of SDI which were about 0.0711 in July, 0.0937 in September and 0.0543 in October, 2022.

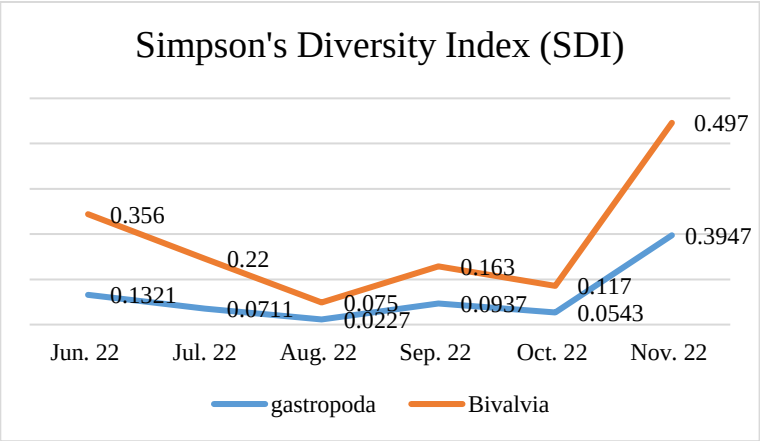

Fig. 2. Simpson's Diversity Index (SDI) of different families of Gastropoda and Bivalvia in different months from Damb site

3.2 CLASS BIVALVIA

Bivalvia was reported in second highest percentage of abundence which was about 31.56% of total collection of malacofauna from Damb. Species richness showed that less diversified class which were about 22 species of 6 families of 1531 specimens. Name of families and their species presented in table III.

Table 3. Name of 6 Families and Species of class Bivalvia from Damb site

Families	Species
Mytilidae Rafinesque, 1815	*Perna canaliculus* (Gmelin, 1791)
Arcidae Lamarck, 1809	*Anadara trapezia* (Deshayes, 1839)
	A. transversa (Say, 1822)
Ostreidae Rafinesque, 1815	*Crassostrea (Magallana) saidii* Wong & Sigwart, 2021
	C. belcheri Sowerby, 1871
	Saccostrea malabonensis (Faustino, 1932)
	S. glomerata (Gould, 1850)
	S. cucullata (Born, 1778)
Solenidae Lamarck, 1809	*Solen marginatus* Pulteney, 1799
Tellinidae Blaninville, 1814	*Macoma nasuta* (Conrad, 1837)
	M. petalum (Valenciennes, 1821)
	Limecola balthica (Linnaeus, 1758)
Veneridae Rafinesque, 1815	*Protapes cor (Sowerby, 1853)*
	Anomalocardia flexuosa (Linnaeus, 1767)
	Agriopoma catharium (Dall, 1902)
	Tivela stultorum (Mawe, 1823)
	Clementia papyracea (Gmelin, 1791)
	Callista chione (Linnaeus, 1758)
	Pitar (Pitarina) citrinus (Lamarck, 1818)
	Katelysia scobinellata (Lamarck, 1805)
	Marcia hiantina (Lamarck, 1818)

Table 4. SDI (Simpson's Diversity Index), Number and % of abundance of individuals (Indi.) of 22 species of 6 different families of class Bivalvia in DAMB site from June 2022 to December 2022

Families	Jun. 22	Jul. 22	Aug. 22	Sep. 22	Oct. 22	Nov. 22	Total No. of Ind.	%	Total No. of Species	%
Mytilidae	0	1	0	0	0	10	11	0.72	1	4.55
Arcidae	17	3	0	1	2	6	29	1.89	2	9.09
Ostreidae	4	8	2	6	0	2	22	1.44	5	22.73
Solenidae	0	2	2	1	0	0	5	0.33	1	4.55
Tellinidae	214	218	227	209	213	206	1287	84.06	3	13.64
Veneridae	36	15	5	12	12	97	177	11.56	10	45.45
Total	**271**	**247**	**236**	**229**	**227**	**321**	**1531**	**100**	**22**	**100**
%	**17.7**	**16.1**	**15.41**	**14.95**	**14.82**	**21**	**100**			
SDI	**0.356**	**0.22**	**0.075**	**0.163**	**0.117**	**0.5**	**0.721**		**0.7445**	

SDI, % abundence of 6 families of bivalvia which were collected from the Damb site from June, 2022 to November, 2022 shown in Table IV. Family Tellinidae with 3 species was found in highest % of abundence which about (84.64%) of total collection of bivalvia. These species were *Macoma nasuta* (Conrad, 1837), *Macoma petalum* (Valenciennes, 1821) and *Limecola balthica* (Linnaeus, 1758). All these 3 species were collected in every month in high quantity, among these 3 species, *Macoma nasuta* was found in high % of occurrence which was about 658 specimens than *Limecola balthica* was found with 399 specimens and *Macoma petalum* was found in 230 specimens. Second abundant family Veneridae with 177 specimens of 10 species was collected during study period. 85 specimens of *Marcia opima* (Gmelin, 1791) was collected in July, September and Novemer 2022 and than 38 speciemens of *Protapes cor* (Sowerby, 1853) were collected in June and August 2022. *Katelysia scobinellata* (Lamarck, 1805) was found with 23specimens than *Clementia papyracea* (Gmelin, 1791*)* was found with 15 speciemens and than *Anomalocardia flexuosa* (Linnaeus, 1767) with 14 specimens. Remaining 5 species, namely: *Callista chione* (Linnaeus, 1758), *Pitar (Pitarina) citrinus* (Lamarck, 1818), *Agriopoma catharium* (Dall, 1902), *Tivela stultorum* (Mawe, 1823) and *Marcia hiantina* (Lamarck, 1818) were found in 4,3,2,2, and 1specimens, respectively. Family Ostreidae was found with 22 specimens of 5 species in 1.45% of occurrence. These 5 species were *Saccostrea cucullata* (Born, 1778), S. *glomerata* (Gould, 1850), *S. malabonensis* (Faustino, 1932), *Crassostrea (Magallana) saidii* Wong & Sigwart, 2021 and *C. belcheri* Sowerby, 1871. 11 specimens of *Saccostrea cucullata* were collected in July, September, and November 2022 while 8 specimens of S. *glomerata* were collected everu month except October 2022. One specimen of *S. malabonensis, Crassostrea (Magallana) saidii* and *C. belcheri* were collected only in June 2022.

Remaing 3 families were found in less than 2% of abundance. 29 specimens (1.45%) of 2 species of family Arcidae were collected. These species were *Anadara trapezia* (Deshayes, 1839) and *Anadara transversa* (Say, 1822). 24 specimens of *Anadara trapezia* were collected in four monts except July and August 2022 and 5 specimens of *A. transversa* were collected in June and July 2022. 5 specimens of *Perna canaliculus* (Gmelin, 1791) of family Mytilidae was collected in July and Nov 2022. The lowest % of occurrence to be found in family Solenidae which was about 0.33%. One species *Solen marginatus* Pulteney, 1799 with 5 specimens were collected in three months July to September 2022.

Simpson's Diversity Index (SDI) of different families of class Bivalvia in different months from Damb site shown in fig 2. Highest SDI was observed in Nov 2022 which was about 0.497and lowest SDI in August 2022 with 0.075. Second highest SDI seen in June 2022 with 0.356 than 0.22, 0.163 and 0.117 in July, September and October, respectively.

3.3 CLASS CEPHALOPODA

2 specimens of *Sepia officinalis* Linnaeus, 1758 of family Sepiidae Keferstein, 1866 of Class Cephalopoda were found in September and November 2022. 12 specimens of *Cycloteuthis sirventi* Joubin, 1919 of family Cycloteuthidae, Naef, 1923 were collected every month of study period. % abundence of 2 families of class cephalpoda which were collected from the Damb site from June, 2022 to November, 2022 shown in Table V.

Table 5. Number and % of abundance of individuals (Indi.) of 2 species of 2 different families of class Cephalopoda in DAMB site from June 2022 to December 2022

Families		Jun. 22	Jul. 22	Aug. 22	Sep. 22	Oct. 22	Nov. 22	Total No.	%
Sepiidae Keferstein, 1866	*Sepia officinalis* Linnaeus, 1758	0	0	0	1	0	1	**2**	**14.29**
Cycloteuthidae, Naef, 1923	*Cycloteuthis sirventi* Joubin, 1919	2	3	2	1	3	1	**12**	**85.71**
Total		**2**	**3**	**2**	**2**	**3**	**2**	**14**	**100**
%		14.29	21.43	14.29	14.29	21.43	14.29	100	

Taxonomical determination was the first step for this study. Total 3 classes 23 families and 62 species were identified from this site. Species richness of gastropoda, bivalvia and cephalpoda were about 38, 22 and 2, respectively. Family Potamididae of calss Gastropoda with 6 species was found in highest % of abundance which about (92.14%) of total collection from Damb. All 6 species were collected in every month in high quantity. 6 species of family Naticidae of Gastropoda also recorded from this site. Family Tellinidae with 3 species was found in highest % of abundence which about (84.64%) of total collection of bivalvia from Damb. These species were *Macoma nasuta* (Conrad, 1837), *M. petalum* (Valenciennes, 1821) and *Limecola balthica* (Linnaeus, 1758). All these 3 species were collected in every month in high quantity, among these 3 species, 658 specimens of *M. nasuta* was collected than *Limecola balthica* was found with 399 specimens and 230 specimens of *M. petalum.* 5 species of family Ostreidae of class Bivalvia was reported from Damb. 2 species of family Sepiidae Keferstein, 1866 of Class Cephalopoda were collected from this site.

Ref. [9] described a total of 1149 species of 5 classes of Mollusca from all over the Pakistan coast. They were found 9 species of Polyplacophora, 16 species of Scaphopoda, 713 species of Gastropoda, 349 species of Bivalvia and 62 species of Cephalopoda species from all over Pakistan. During the present study it was observed that the *Macoma nasuta* (family Tellinidae) species occurs in greater numbers as compare to other species in this area of Balochistan coast. Along the shore of Balochistan, a few genera of the phylum mollusca have been discovered. *Mitra sp.* were found by [11] and [19]. *Cerithium sp.* and *Thais* sp. were found by [20] and [21], who found these species in Jiwani, Balochistan. These species were also reported by Gondal [19] from Balochistan. 14 specimens of 2 species *Cycloteuthis sirventi* and *Sepia officinalis* were collected from Damb site.

Comparison of Simpson's Diversity Index (SDI) of different families of Calss Gastropoda and Bivalvia in different months from Damb site are interesting that highest SDI of Gastropda and Bivalvia were observed in Nov 2022 and lowest SDI in August 2022. Average Simpson's Diversity Index (SDI) of families of gastropoda was about 0.1503 which shown the low diversity while SDI of Bivalvia was about 0.2795 which shown the high diversity as compared to gastropoda of this site.

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