

The Gulf has mixed semi-diurnal type of tides (Sengupta & Deshmukh, 2000). In southern part of GoK, most of the intertidal areas have been declared as the Marine National Park and Sanctuary. Area of 457 km² has been declared as Sanctuary and 162.89 km² as National Park (Singh, 1994). The present study was carried out in intertidal area of 37 sites which includes islands and coastal area from southern coast of GoK which includes rocky, muddy, sandy, mangrove and coral reef ecosystems.

MATERIALS AND METHODS

The extensive study for mollusc was carried out from October-2011 to January-2015. Qualitative and quantitative data including opportunistic observations were compiled for achieving main research objective i.e. species occurrence and inventory. The observations were made on 37 identified locations. According to this extent of areas and biodiversity the efforts have made for the observations. For preparing the species inventory, the entire reef area was extensively surveyed. Efforts were made for search of species in various micro habitats and potential area through opportunistic based observations. Sampling design was further followed by transect layout and observation. The number of transects on a location vary from one to five according to extent of intertidal area as well as biodiversity status. These transects were almost perpendicular to high tide line (HTL). The line transect for the observation was treated as 2m fixed width (each side

1m) for invertebrate observation. These transects were walked for observations of three taxa. Transects were laid with the help of GPS instrument, magnifying lens, digital camera, identification manuals etc. The studied sites were divided into three major regions viz., West GoK, Middle GoK and East GoK. Bray-Curtis species similarity index, non-metric multidimensional scaling and biodiversity indices were analysed using PAST software for quantitative biodiversity and species similarity between sites.

RESULTS AND DISCUSSION

A total 108 species of mollusc were recorded from the sampled intertidal area of the GoK. There were 91 species of Gastropoda, 14 species of Bivalvia, 2 species of Cephalopoda and 1 species of Scaphopoda in the GoK. About 522 species have been recorded from different regions of the Gulf of Kachchh (Hornell, 1909; Eliot, 1909; Gideon *et al.*, 1957; Menon *et al.*, 1961; Kundu, 1965; Narayanan, 1968; Narayanan, 1969; Narayanan, 1970; Burn & Narayanan, 1970; Narayanan, 1971; Rudman, 1980; Patel, 1985; Deomurari, 2006; Apte *et al.*, 2010). Some of the very common species found were *Pinna bicolor*, *Vasticardium flavum*, *Murex ternispina*, *Pollia undosa*, *Turbo bruneus*, *Onchidium verrucul*, *Paphia rotundata*, *Pinctada fucata*, *Angaria delphinus* and *Erronea onyx*.

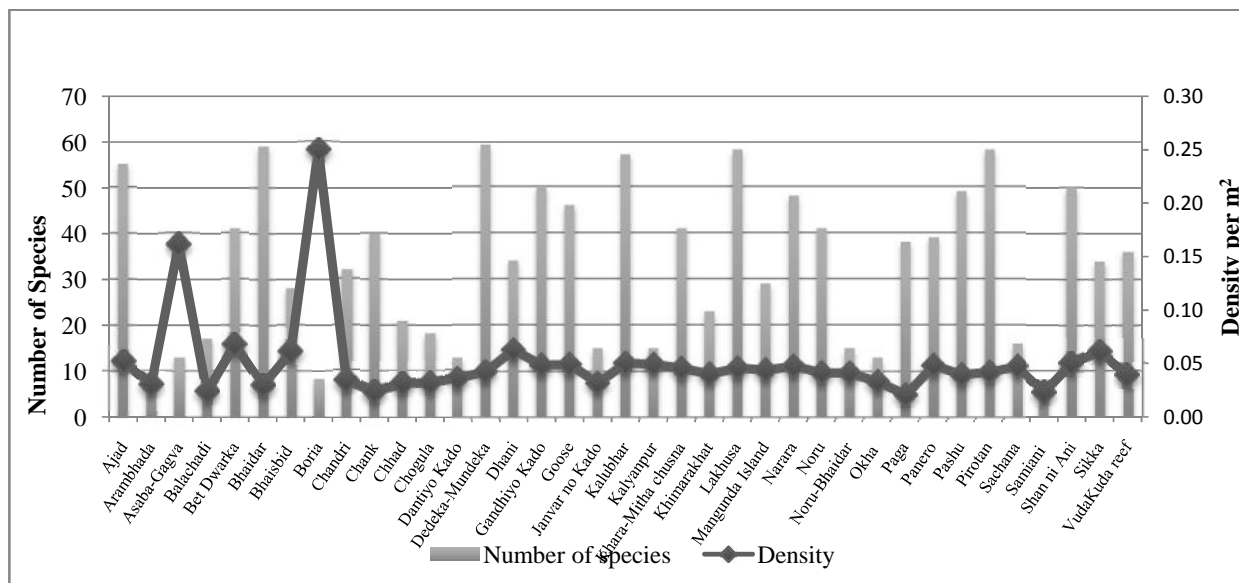


FIGURE 2: species diversity and density

Maximum species were recorded from Dedeka-Mundeka and Bhaidar islands (reefs) which were followed by Lakhusa, Pirotan and Kalubhar. Such locations are endowed with habitat diversity and significantly larger intertidal area and reef. However, considering the density, it was higher in Boria (0.25m²) even though species diversity was less followed by Asaba Gagva. Among the recorded species many of them were very common in entire GoK. To compare biodiversity of the three major regions of GoK (West GoK, Middle GoK and East GoK), was drawn by ranking species in decreasing order of

abundance in the dominance plot. The graph (Fig. 3) showed almost similar species diversity in all the regions of GoK but among them West GoK shows rich diversity compared to East GoK and Middle GoK as the curves of West is lying below the curve of East GoK and Middle GoK. While Middle GoK and East GoK curves are overlapping and thus we can conclude having almost similar type of diversity. But the curves are much closer with each other and somewhat overlapping which shows no remarkable difference between the fragmented regions.

TABLE 2: Summary of Diversity Indices

Sites	Richness	Indices			
		Dominance	Evenness	Simpson	Shannon
Ajad	55	0.04	0.72	0.96	3.38
Arambhada	9	0.19	0.85	0.81	1.78
Asaba-Gagva	13	0.08	0.96	0.92	2.52
Bet_Dwarka	41	0.06	0.74	0.94	3.16
Bhaidar	59	0.03	0.74	0.97	3.55
Boria	8	0.19	0.94	0.81	1.73
Chandri	32	0.07	0.74	0.93	2.95
Janvar no Kado	15	0.13	0.79	0.87	2.16
Samiani_	6	0.19	0.93	0.81	1.72
Shan_ni_Ani	50	0.03	0.86	0.97	3.51
Kalyanpur	15	0.09	0.88	0.91	2.44
Khara-Mithachusna	41	0.04	0.85	0.96	3.33
Khimarakhat	23	0.08	0.79	0.92	2.81
Lakhusa	58	0.03	0.76	0.97	3.57
Noru	41	0.05	0.78	0.95	3.18
Noru-Bhaidar	15	0.11	0.88	0.89	2.35
Paga	38	0.06	0.70	0.94	3.08
Pashu	49	0.03	0.85	0.97	3.55
Okha_	13	0.10	0.94	0.90	2.33
Mangunda_Island	29	0.06	0.87	0.94	2.95
Narara	48	0.04	0.75	0.96	3.38
Panero	39	0.05	0.78	0.95	3.12
Sikka	34	0.04	0.87	0.96	3.23
VudaKuda_reef	36	0.08	0.67	0.92	2.94
Goose	46	0.04	0.83	0.96	3.31
Kalubhar	57	0.03	0.86	0.97	3.61
Dhani	34	0.04	0.89	0.96	3.22
Gandhiyo_Kado	50	0.04	0.74	0.96	3.31
Chank	40	0.04	0.82	0.96	3.27
Dantiyo_Kado	13	0.12	0.90	0.88	2.19
Dedeka-Mundeka	59	0.03	0.85	0.97	3.69
Sachana	16	0.10	0.87	0.90	2.43
Pirotan	58	0.03	0.79	0.97	3.57
Chhad	21	0.08	0.80	0.92	2.66
Chogula	18	0.10	0.87	0.90	2.43
Balachadi	17	0.09	0.94	0.91	2.42
Bhaisbid	28	0.06	0.90	0.94	2.94

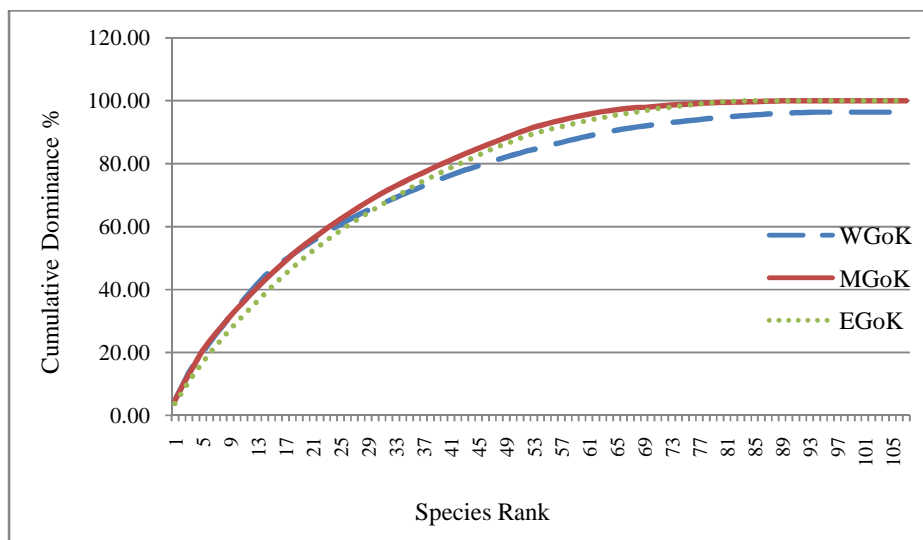


FIGURE 3: Dominance plot for mollusca

Bray Curtis species similarity was analyzed in PAST software which shows that West GoK have 87.56% species similarity with Middle GoK and 90% similarity with East

GoK while 82.85% similarity was observed between Middle and East GoK. Among the sites of West GoK the similarity ranged between 0 to 81% with an average

Staphylokinase producing *staphylococcus* spp. From different sources

42.82% similarity, in Middle GoK it ranged between 41% - 81% with an average 62.14% similarity while in East GoK it ranged between 0 to 82% with 41.67% average similarity. The dendrogram shows the similarity of different sites of the three parts of the GoK (Fig.). The highest similarity (82 %) is there between Chogula and

Balachadi of East GoK and the group has 10.1% similarity with all the other sites of GoK which is seen to be the lowest. The pattern of similarity was also evaluated by MDS – Plot (Fig.4) which shows close similarity between sites of Middle GoK followed by West GoK and East GoK.

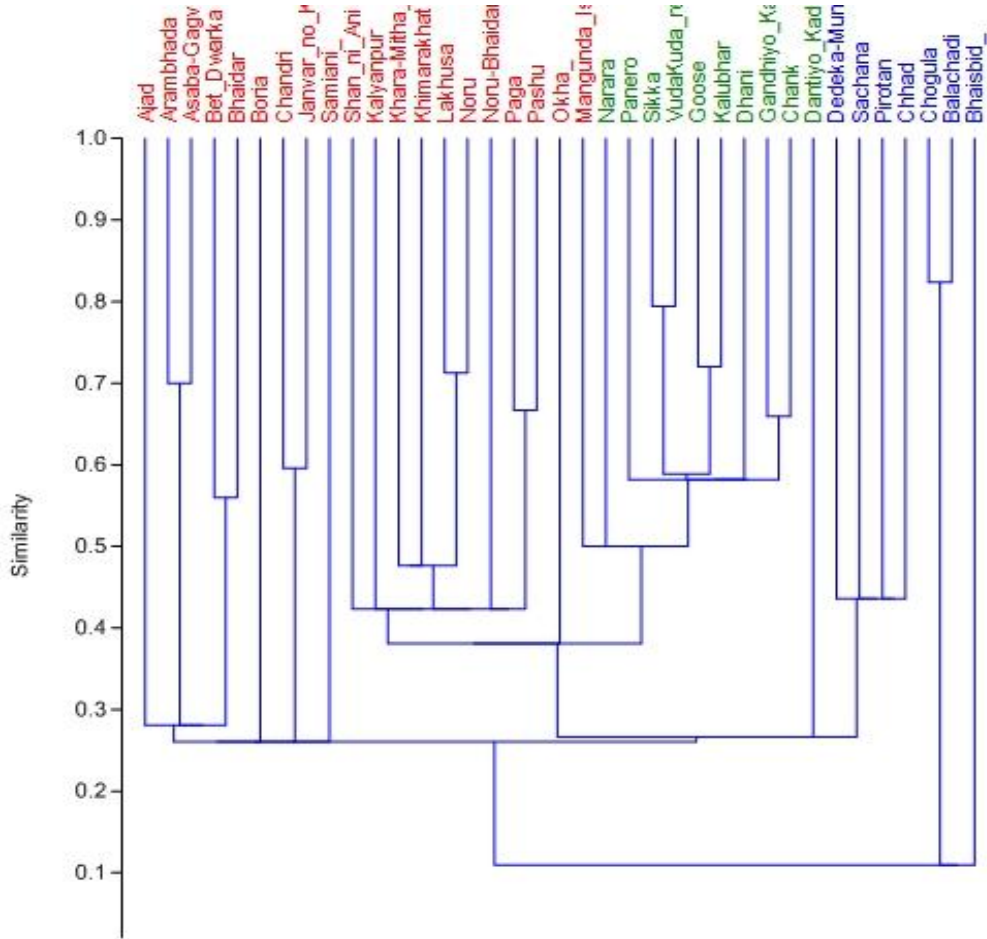


FIGURE 4: Dendrogram of Bray-Curtis similarity of different sites of GoK

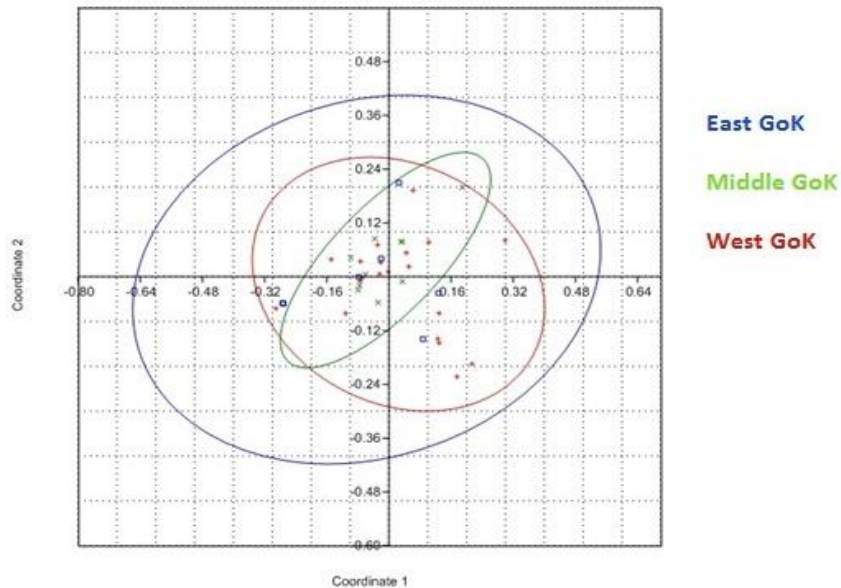


FIGURE 5: NMDS – plot for Molluscan diversity of GoK

TABLE 1: Molluscan diversity recorded from the GoK

SN	Class	Family	Species
1	Bivalvia	Aloidiidae	<i>Aloides modesta</i> (Hinds, 1843)
2	Bivalvia	Ostreidae	<i>Crassostrea</i> sp.
3	Bivalvia	Veneridae	<i>Pelecypora nana</i> (Reeve, 1850)
4	Bivalvia	Veneridae	<i>Dosinia cretacea</i> (Reeve, 1850)
5	Bivalvia	Veneridae	<i>Protapes gallus</i> (Gmelin, 1791)
6	Bivalvia	Macluridae	<i>Paphia rotundata</i> (Linnaeus, 1758)
7	Bivalvia	Veneridae	<i>Paratapes textilis</i> (Gmelin, 1791)
8	Bivalvia	Pectinidae	<i>Pecten</i> sp.
9	Bivalvia	Pteridae	<i>Pinctadaim bricatafucata</i> (Gould, 1850)
10	Bivalvia	Pinnidae	<i>Pinna bicolor</i> Gmelin, 1791
11	Bivalvia	Veneridae	<i>Protapes gallus</i> (Gmelin, 1791)
12	Bivalvia	Arcidae	<i>Barbatia obliquata</i> (Wood, 1828)
13	Bivalvia	Carditidae	<i>Cardita calyculata</i> (Linnaeus, 1758)
14	Bivalvia	Carditidae	<i>Cardites antiquatus</i> (Linnaeus, 1758)
15	Cephalopoda	Octopodidae	<i>Octopus cyanea</i> Gray, 1849
16	Cephalopoda	Octopodidae	<i>Octopus vulgaris</i> Cuvier, 1797
17	Gastropod	Pyrenidae	<i>Pyrene flava</i> (Bruguière, 1789)
18	Gastropod	Pyrenidae	<i>Mitrella scripta</i> (Linnaeus, 1758)
19	Gastropod	Pyrenidae	<i>Euplica scripta</i> (Lamarck, 1822)
20	Gastropod	Potamididae	<i>Telescopium telescopium</i> (Linnaeus, 1758)
21	Gastropod	Muricidae	<i>Purpura bufo</i> Lamarck, 1822
22	Gastropod	Strombidae	<i>Tibia insulaechorab</i> Röding, 1798
23	Gastropod	Trochidae	<i>Trochus radiatus</i> Gmelin, 1791
24	Gastropod	Trochidae	<i>Tectus niloticus</i> (Linnaeus, 1767)
25	Gastropod	Trochidae	<i>Trochus stellatus</i> Gmelin, 1791
26	Gastropod	Trochidae	<i>Tectus tentorium</i> (Gmelin, 1791)
27	Gastropod	Xancidae	<i>Turbinella pyrum</i> (Linnaeus, 1767)
28	Gastropod	Turbonidae	<i>Turbo argyrostomus</i> Linnaeus, 1758
29	Gastropod	Turbonidae	<i>Turbo bruneus</i> (Röding, 1798)
30	Gastropod	Turbonidae	<i>Turbo intercostalis</i> Menke, 1846
31	Gastropod	Turritellidae	<i>Turritellacolumnaris</i> Kiener, 1843
32	Gastropod	Turritellidae	<i>Turritellaattenuata</i> Reeve, 1849
33	Gastropod	Trochidae	<i>Umboniumvestiarium</i> (Linnaeus, 1758)
34	Gastropod	Carditidae	<i>Vasticardiumflavum</i> (Linnaeus, 1758)
35	Gastropod	Carditidae	<i>Vepricardiumasiaticum</i> (Bruguière, 1789)
36	Gastropoda	Discodorididae	<i>Carminodorisgrandiflora</i> (Pease, 1860)
37	Gastropoda	Potamididae	<i>Pirenellacingulata</i> (Gmelin, 1791)
38	Gastropoda	Cerithiidae	<i>Clypeomorusbifasciata</i> (G. B. Sowerby II, 1855)
39	Gastropoda	Cerithiidae	<i>Cerithiumscabridum</i> Philippi, 1848
40	Gastropoda	Cerithiidae	<i>Cerithiumechinatum</i> Lamarck, 1822
41	Gastropoda	Muricidae	<i>Chicoreusbrunneus</i> (Link, 1807)
42	Gastropoda	Muricidae	<i>Chicoreustorrefactus</i> (G. B. Sowerby II, 1841)
43	Gastropoda	Muricidae	<i>Chicoreusramosus</i> (Linnaeus, 1758)
44	Gastropoda	Muricidae	<i>Chitonlatricus</i> Winckworth, 1930
45	Gastropoda	Muricidae	<i>Chiton</i> sp.
46	Gastropoda	Trochidae	<i>Clanculusceylonicus</i> G. & H. Nevill, 1869
47	Gastropoda	Conidae	<i>Conasprella dictator</i> (Melvill, 1898)
48	Gastropoda	Conidae	<i>Conusachatinus</i> Gmelin, 1791
49	Gastropoda	Fissurellidae	<i>Diodorafuniculata</i> (Reeve, 1850)
50	Gastropoda	Fissurellidae	<i>Diodora lima</i> (G. B. Sowerby II, 1862)
51	Gastropoda	Dendrodorididae	<i>Doriopsilla miniata</i> (Alder & Hancock, 1864)
52	Gastropoda	Muricidae	<i>Drupella rugosa</i> (Born, 1778)
53	Gastropoda	Plakobranthidae	<i>Elysia ornata</i> (Swainson, 1840)
54	Gastropoda	Plakobranthidae	<i>Elysia tomentosa</i> K. Jensen, 1997
55	Gastropoda	Cypraeidae	<i>Erosaria ocellata</i> (Linnaeus, 1758)
56	Gastropoda	Cypraeidae	<i>Erosaria turdus</i> (Lamarck, 1810)
57	Gastropoda	Cypraeidae	<i>Erronea onyx</i> (Linnaeus, 1758)
58	Gastropoda	Ranellidae	<i>Gyrineum natator</i> (Röding, 1798)
59	Gastropoda	Haminoeidae	<i>Haminoeavitrea</i> (A. Adams, 1850)
60	Gastropoda	Chromodorididae	<i>Hypselodorisinfucata</i> (Rüppell & Leuckart, 1830)
61	Gastropoda	Chromodorididae	<i>Hypselodoris sagamiensis</i> (Baba, 1949)
62	Gastropoda	Muricidae	<i>Indothais lacera</i> (Born, 1778)
63	Gastropoda	Muricidae	<i>Indothais sacellum</i> (Gmelin, 1791)
64	Gastropoda	Gastrodontidae	<i>Janulus</i> sp.
65	Gastropoda	Discodorididae	<i>Jorunna funebris</i> (Kelaart, 1859)
66	Gastropoda	Littorinidae	<i>Littoraria intermedia</i> (Philippi, 1846)
67	Gastropoda	Turbinidae	<i>Lunella coronata</i> (Gmelin, 1791)

68	Gastropoda	Cardiidae	<i>Maoricardium setosum</i> (Redfield, 1846)
69	Gastropoda	Cypraeidae	<i>Mauritia arabica</i> (Linnaeus, 1758)
70	Gastropoda	Cypraeidae	<i>Mauritia grayana</i> Schilder, 1930
71	Gastropoda	Cypraeidae	<i>Mauritiam auritiana</i> (Linnaeus, 1758)
72	Gastropoda	Tethyidae	<i>Melibe viridis</i> (Kelaart, 1858)
73	Gastropoda	Mitridae	<i>Nebularia aurantia</i> (Gmelin, 1791)
74	Gastropoda	Mitridae	<i>Mitra subruppeli</i> Finlay, 1927
75	Gastropoda	Mitridae	<i>Mitrella blanda</i> (G. B. Sowerby I, 1844)
76	Gastropoda	Muricidae	<i>Murex ternispina</i> Lamarck, 1822
77	Gastropoda	Nassariidae	<i>Nassarius distortus</i> (A. Adams, 1852)
78	Gastropoda	Nassariidae	<i>Nassarius olivaceus</i> (Bruguère, 1789)
79	Gastropoda	Nassariidae	<i>Nassarius hepaticus</i> (Pulteney, 1799)
80	Gastropoda	Nassariidae	<i>Nassarius sufflatus</i> (Gould, 1860)
81	Gastropoda	Naticidae	<i>Tanea picta</i> (Récluz, 1844)
82	Gastropoda	Naticidae	<i>Tanea lineata</i> (Röding, 1798)
83	Gastropoda	Neritidae	<i>Nerita albicilla</i> Linnaeus, 1758
84	Gastropoda	Neritidae	<i>Nerita oryzarum</i> Récluz, 1841
85	Gastropoda	Neritidae	<i>Nerita dombeyi</i> Récluz, 1841
86	Gastropoda	Naticidae	<i>Neverita didyma</i> (Röding, 1798)
87	Gastropoda	Olividae	<i>Oliva caerulea</i> (Röding, 1798)
88	Gastropoda	Facelinidae	<i>Phyllodesmium</i> sp.
89	Gastropoda	Planaxidae	<i>Planaxis sulcatus</i> (Born, 1778)
90	Gastropoda	Buccinidae	<i>Pollia rubiginosa</i> (Reeve, 1846)
91	Gastropoda	Buccinidae	<i>Pollia undosa</i> (Linnaeus, 1758)
92	Gastropoda	Ovulidae	<i>Procalpurnus lacteus</i> (Lamarck, 1810)
93	Gastropoda	Facelinidae	<i>Pteraeo lidiaianthina</i> (Angas, 1864)
94	Gastropoda	Discodorididae	<i>Sclerodoris tuberculata</i> Eliot, 1904
95	Gastropoda	Onchidiidae	<i>Peronia verruculata</i> (Cuvier, 1830)
96	Gastropoda	Turbinidae	<i>Turbinaria stellulata</i> (Lamarck, 1816)
97	Gastropoda	Olividae	<i>Agaronia gibbosa</i> (Born, 1778)
98	Gastropoda	Angariidae	<i>Angaria delphinus</i> (Linnaeus, 1758)
99	Gastropoda	Angariidae	<i>Angaria rugosa</i> (Kiener, 1838)
100	Gastropoda	Aplysiidae	<i>Aplysia dactylomela</i> Rang, 1828
101	Gastropoda	Turbinidae	<i>Astralium stellare</i> (Gmelin, 1791)
102	Gastropoda	Turbinidae	<i>Astralium semicostatum</i> (Kiener, 1850)
103	Gastropoda	Bornellidae	<i>Bornella stellifera</i> (A. Adams & Reeve [in A. Adams], 1848)
104	Gastropoda	Bursidae	<i>Bufoaria echinata</i> (Link, 1807)
105	Gastropoda	Bullidae	<i>Bulla ampulla</i> Linnaeus, 1758
106	Gastropoda	Bursidae	<i>Bursa granularis</i> (Röding, 1798)
107	Gastropoda	Facelinidae	<i>Sakuraeolis gujaratica</i> Rudman, 1980
108	Scaphopoda	Dentaliidae	<i>Dentalium lephantinum</i> Linnaeus, 1758

CONCLUSION

The present study recorded 108 species of mollusks from the intertidal region of the different regions of the GoK which includes 91 species of Gastropods, 14 species of Bivalvia, 2 –Cephalopods and 1 species of Scaphopoda. In this area *Pinna bicolor*, *Vasticardium flavum*, *Murex ternispina*, *Polliaundosa*, *Turbo bruneus*, *Onchidium verrucul*, *Paphiarotundata*, *Pinctadafucata*, *Angaria delphinus* and *Erronea onyx* species were found to be the most common throughout the study period. Highest species diversity was recorded from Dedeka–Mundeka and Bhaidar Islands while the highest density was found in Boriaeven though low species diversity. The study was bifurcated in three regions for analysis to evaluate any difference in biodiversity but no remarkable difference has been noticed between different regions.

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