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ORIGINAL ARTICLE

Diversity and Distribution of marine Gastropods (Mollusca) along the intertidal zone of ship breaking yard-Alang, Gujarat, India

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ABSTRACT
Diversity and distribution of marine gastropods were studied seasonally summer (March to June), monsoon (July to October) and winter (November to February) along the intertidal zone of large ship breaking yard of Asia-Alang, India. Reported gastropod fauna were represented by 17 families comprising of 44species.Members of families like Cerithiidae, Trochidae and Littorinidae were reported throughout the year. Most dominated gastropod genera Tectus, Trochus, Umbonium, Calliostoma, Clypeomorus were encountered during all the seasons .Clypeomorus batillariaeformis showed highest density, abundance and frequency while Umbonium vestiarium showed lowest density, abundance and frequency during seasons of summer and monsoon. Results of physicochemical parameters indicated that there were no marked variations among air temperature, water temperature, pH, salinity and turbidity during all the seasons, but marked variation was seen in total dissolved solids and conductivity.
Key words: *Mollusca, Gastropoda, Diversity, Distribution, Physicochemical parameters, Alang, India*

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INTRODUCTION

Mollusca are probably the second largest invertebrate phyla with estimated species around 45,000 to50,000marines 25,000 terrestrial and 5,000 freshwater [1-2-3]. Among the marine regime, total 80,000 to 100,000 species of marine mollusca were recorded [4]. In India, total number of molluscan species recorded are 3271, comprises 1900 gastropod species [5]. Marine molluscan diversity of India include about 3,400 species [6]. Recently, there were approximately5,169 molluscs species foundin India[7]. However, there is no well-defined and updated checklist on marine molluscs of India [8].

Many authors have contributed their knowledge in the taxonomy, diversity and distribution of marine molluscs of India[4, 9 to 32].

From Gujarat different authors described and listed marine mollusca however there is no updated checklist exist. Singh et al. [33]reported 200 species of marine mollusc from Gulf of Kutch. Gohil et al. [34] reported 17 species of molluscan from Dwarka sea coast. Bhadja et al. (2014)[35] reported 35 mollusc species from the coastal areas of Dwarka, Mangrol, Veraval and Kodinar. Recently, Vadher et al. [36] reported69 species in 31 family of molluscan from Chorwad coast, Gujarat, India.In case of Gulf of Khambhat, there were no updated record of marine molluscsexcept, Solankiet al. (2016)[37] reported 9 species of molluscs from 7 families in 8 genera from Ghogha coast of Gujarat. Population dynamics and distribution pattern of *Cellanakarachiensis* and *Siphonariasiphonaria* were studied from Veraval coast, Gujarat[38-39].

The variations in the distribution of macrobenthic organisms could be a result of differences in the local environmental conditions. However, the composition, abundance, and distribution of invertebrate macrofauna in the rocky intertidal zones are generally influenced by water quality.Thus, the study of animal distribution and quality of nearby habitat is needed to understand health of any local ecosystem. Ship scrapping industry release a large number of dangerous pollutants including toxic wastes, oil and heavy metals in the water and seabed, so creates numerous hazards for the coastal and marine Environment. Another major sources of pollutant are Petroleum hydrocarbon, asbestos, scrap paint material, glass items, empty drink cans, mineral water bottles and thermocol pieces in this coastal area. Workers of ship scrapping yard and local villagers of Alang and near area use the intertidal region for all domestic waste and so high concentration of nutrients and bacteria were found here (Fig.1-D, E, and F). However detail information on the ecology of gastropoda of this area is not available. Earlier research shown that highest diversity of mollusca phylum because of the gastropoda species occurring in upper intertidal zone to lower intertidal zone and wave action is responsible for this diversity status [40-41-42]. Very less number of researchers and students worked on diversity and distribution status of gastropoda particular in this study site. Worked carried out only in thesis, dissertation and report writing as a one part. The present research work deals with the diversity and distribution of intertidal gastropod of Alang coast, Gujarat, India.

MATERIALS AND METHODS

Study area

Gujarat state is situated at western coast of India with longest coastline about 1600 km with two gulfs i.e. Gulf of Kutch and Gulf of Khambhat. Study was carried out in Alang-Sosiya ship braking yard (21°23'26.92"N, 72°10'32.67"E) (Fig. 1 and 2) located on north-west edge of Gulf of Khambhat. Coastal area of Alang having the mix type of intertidal habitat rocky, muddy and sandy (Fig. 1-A, B, C). Supratidal zone is covered with sand, upper and middle intertidal zone is rocky with muddy, lower intertidal zone mostly muddy.

Diversity survey

Extensive photography was done onsite for identification of mollusc species. Molluscs were identified using standard literatures, i.e. Apte [43], Subbarao [44], Modayil [45] and WoRMS (World Register of Marine Species). A checklist of reported species was prepared.

Water Sampling and analysis of physico-chemical parameters

Water samples were collected monthly from March-2015 to February-2016. Samples were brought to the laboratory. Samples were stored in cleaned, air dried plastic bottles for further water analysis. The air and water temperature were measured using a standard mercury centigrade thermometer. The water pH, total dissolved solid(TDS) and Conductivity were measured by Multi-Parameter PCSTestr-35(OAKTON, EUTECH). The Multi-Parameter PCSTestr-35 was calibrated with standard buffer chemicals prior to use. The water salinity was measured by using hand refractometer. The turbidity was measured by Nephelometer CL 52D(ELICO).

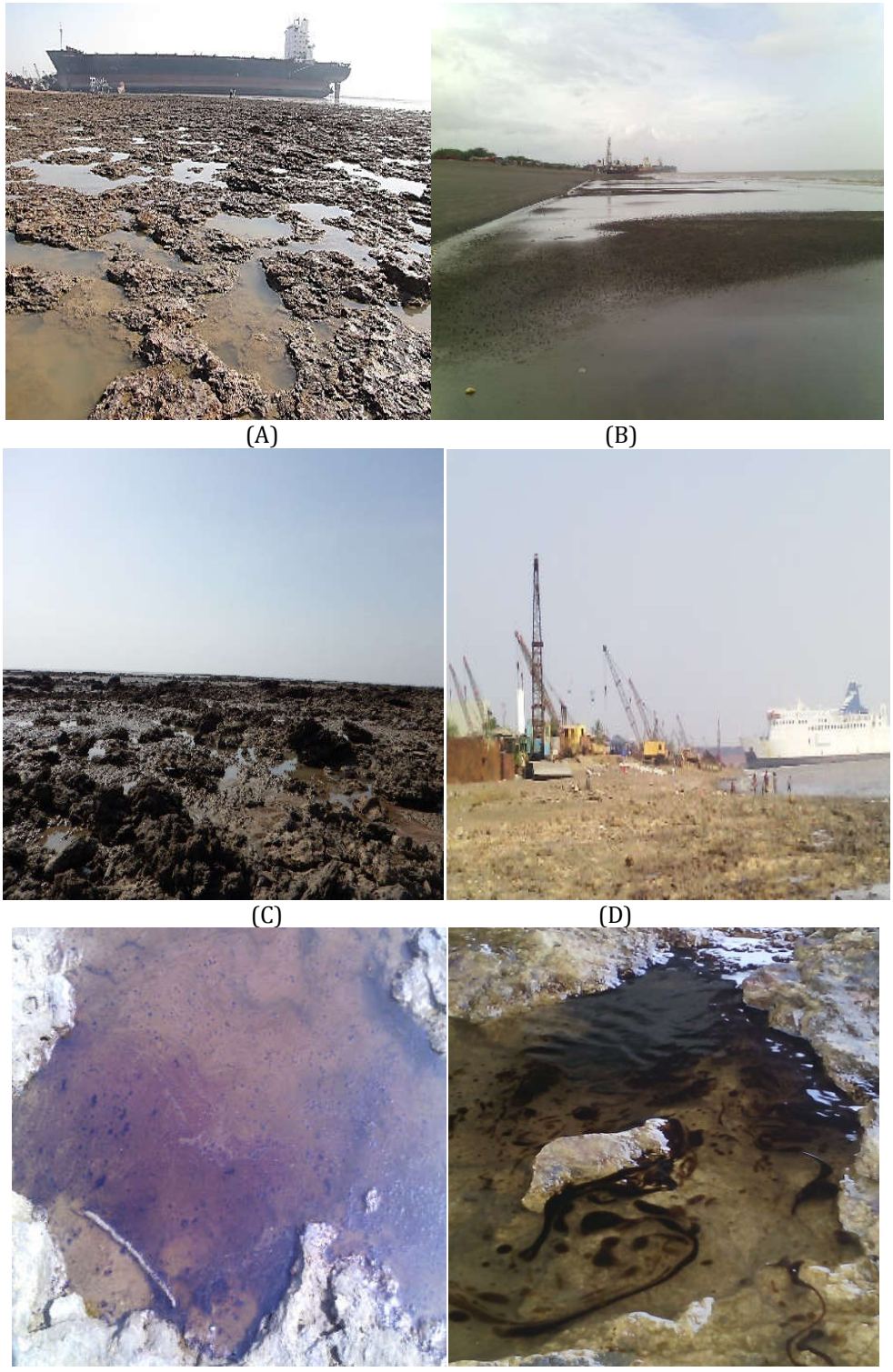
Population

Among the population ecological attributes, seasonal variations in the population density and abundance of prominent mollusc species in each sampling stations were calculated [46]. Random quadrates were laid down in order to cover the whole intertidal zone (quadrate size $0.25m^2$) [46]. The data were collected monthly from March-2015 to February-2016 and represented seasonally. The collected data of ecological attributes were calculated by below formula.(Statistical formula) can add

$$\text{Density} = \frac{\text{Total number of individuals recorded from the sample plot}}{\text{Total number of sample plot studied}}$$

$$\text{Abundance} = \frac{\text{Total number of individuals recorded}}{\text{Total number of sample plot where the individuals occured}}$$

$$\text{Frequency} = \frac{\text{Total numbers of sample plot where the individuals occurred}}{\text{Total numbers of sample plot surveyed}} \text{ X100}$$



(A) (B)

(C) (D)

(E) (F)

Figure 1. (A, B, C) Different habitats of Study site Alang, (D, E, F) scrapping activity and oil pollution at Alang coastal area.

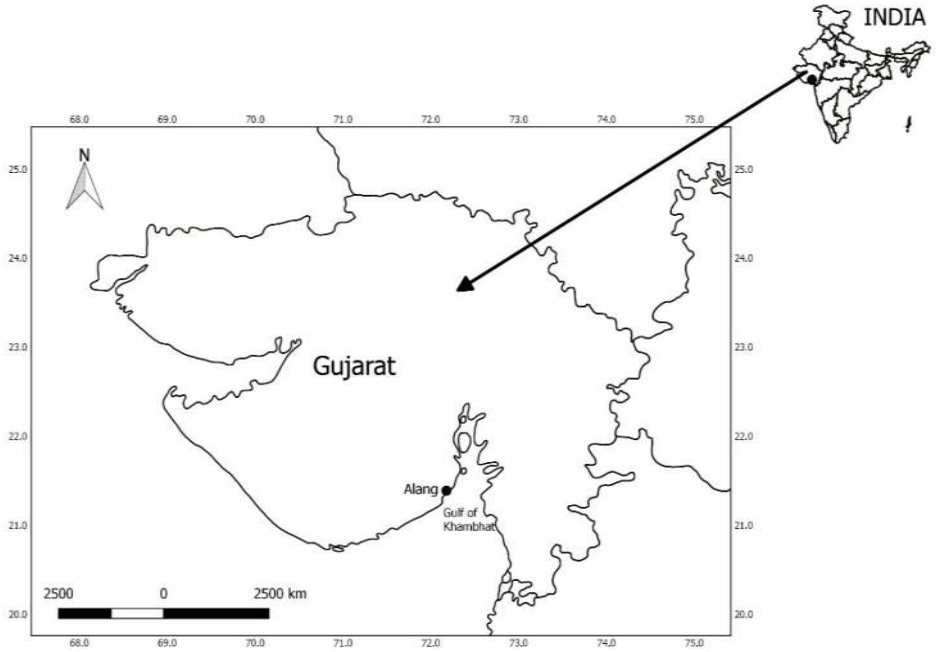


Figure: 2 Location map of Alang coast, Gujarat, India.

RESULT AND DISCUSSIONS

Total 44 species in 17 families of gastropod molluscs were recorded from the intertidal zone of Alang ship breaking yard of Gujarat state, India (Table 1). The highest diversity of molluscs was found during summer season and lowest during winter season. Species of few families like Cerithiidae, Muricidae, Nassaridae, Onchididae and Trochidaewere observed common during all the seasons (Table 1).The distribution pattern of selected gastropod species shown that all 7 selected species were mostly found in upper intertidal zone throughout study period. *Calliostoma zizyphinum, Clypeomorus bifasciata* and *Clypeomorus batillariaeformis* were also observed in middle intertidal zone in more numbers compare to other species.

Out of 44 species, 07 prominent species were studied for population status.Population attributes like density, abundance and frequency were evaluated by standard formula. *Clypeomorus batillariaeformis* showed highest density during monsoon (6.58 no./0.25 m^2) and lowest during winter (3.80 no./0.25 m^2). *Clypeomorus bifasciata* showed highest density during monsoon (5.10 no. /0.25 m^2) and lowest during summer (3.47 no./0.25 m^2). *Trochusniloticus* showed highest density during winter (2.47 no. /0.25 m^2) and lowest during summer (2.13 no. /0.25 m^2). *Trochusradiatus* showed highest density during winter (2.47 no. /0.25 m^2) and lowest during summer (1.27 no. /0.25 m^2).*Calliostoma zizyphinium* showed highest density during winter (1.70 no./0.25 m^2) and lowest in summer (1.15 no./0.25 m^2). *Tectusconus* showed highest density during monsoon (1.63 no. /0.25 m^2) and lowest during winter (0.90 no./0.25 m^2).*Umbonium vestiarium* showed highest density during summer (0.43 no./0.25 m^2) and lowest during monsoon (0.18 no./0.25 m^2) (Figure 3). *Clypeomorus batillariaeformis* showed highest abundance during monsoon (16.06 no./0.25 m^2) and lowest during winter (7.26 no./0.25 m^2). *Clypeomorus bifasciata* showed highest abundance during monsoon (11.18 no. /0.25 m^2) and lowest during summer (6.85 no. /0.25 m^2).*Tectusconus* showed highest abundance during monsoon (5.88 no. /0.25 m^2) and lowest during winter (4.08 no./0.25 m^2). *Trochusniloticus* showed highest abundance during monsoon (9.83 no. /0.25 m^2) and lowest during summer (4.97 no. /0.25 m^2).*Calliostoma zizyphinium* showed highest abundance during winter (5.19 no. /0.25 m^2) and lowest in summer (3.17 no./0.25 m^2).*Umbonium vestiarium* showed highest density during summer (2.88 no./0.25 m^2) and lowest during monsoon (1.50 no./0.25 m^2)(Figure 4). *Clypeomorus bifasciata* showed highest frequency during summer (56.67%) and lowest during winter (48.33%). *Clypeomorus batillariaeformis* showed highest frequency during winter (48.33%) and lowest during summer and monsoon (43.33%). *Trochusniloticus* showed highest frequency during winter (45%) and lowest during summer (43.33%).*Calliostoma zizyphinium* showed highest frequency during monsoon (56.67%) and lowest during summer (48.33%).*Trochusradiates* showed highest frequency during winter (43.33%) and lowest during monsoon (30%).*Tectusconus* showed highest frequency during monsoon

(28.33%) and lowest during winter (21.67%).*Umbonium vestiarium* showed highest frequency during summer (15%) and lowest during winter (8.33%) (Figure 5).
Some physicochemical parameters like air temperature, water temperature, pH, salinity, turbidity, TDS and conductivity were analyzed to assess the effect of pollution if any on marine gastropod diversity (Table 2). Result showed that there were no marked variation among air temperature, water temperature, pH, salinity and turbidity during all the seasons, but there was a marked variation seen in total dissolved solids and conductivity, TDS was seen most in summer (24.65)and least in winter (7.87) while conductivity were observed less (7.05 mS) during summer and highest during monsoon (20.90 mS). Bhadja and Kundu [47]examined sea water quality of Dwarka,Mangrol, Veraval and Kodinarcoasts that indicated ideal condition of water at Dwarka and Mangrolcoast and polluted state at Veraval and Kodinar coast may due to industrial influence and anthropogenic activities.The result of physicochemical parameters of Alang water also showed ideal condition as Dwarka and Mangrol sea water. Intertidal micro niches andalgal cover on the littoral zone offers variety of habitats formolluscs, hermit crabs, annelids, flat worms, sea anemones and sponges [42]. Alang comprises rocky-muddy substratum with few pools, puddles that supports the gastropods diversity.Among 7 selected and dominant species, *Tectusconus, Trochus niloticus, Trochusradiatus, Calliostoma zizyphinum and Clypeomorus batillariaeformis* were mostly associated with green algae (*Ulva*sp.). Association between green algae and gastropoda shown that may be food source of these gastropods were spores, filamentous and other nutrient material of algae.

CONCLUSION

The present study reports the diversity and population status of gastropods at an industrially influenced intertidal zone of Alang sea coast, Gujarat. Inspite of polluted nature of seacoast, studied area supports good diversity of gastropods as they may be habituated or sustained in polluted areas.However, physicochemical parameters of the seawater of Alang, Gulf of Khambhat did not show fluctuated conditions. Hence, there was notany major effects reported due to slight varied quality of water on distribution and population status of gastropods. This results also suggesting the need of further investigation for adaptability of faunal communities those are thrives here.

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CONFLICT OF INTEREST STATEMENT

We declare that we have no conflict of interest.

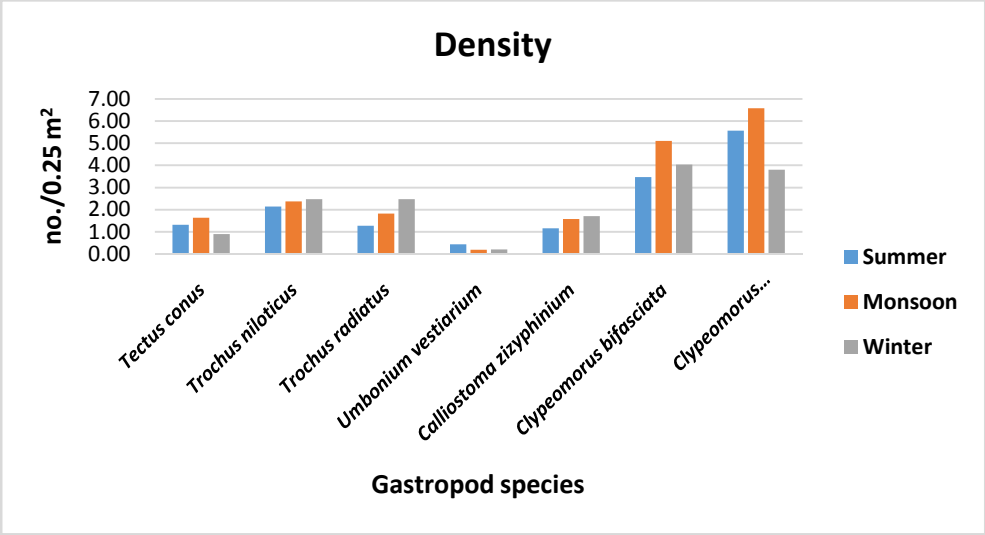

Figure 3. Density of gastropods species along the intertidal zone of Alang.

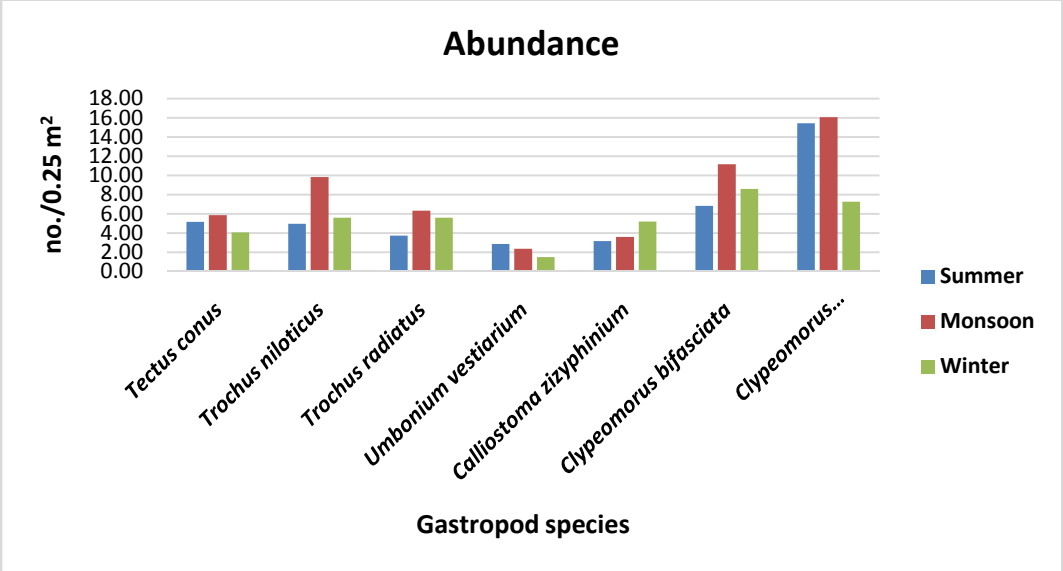

Figure 4. Abundance of gastropodsspecies along the intertidal zone of Alang.

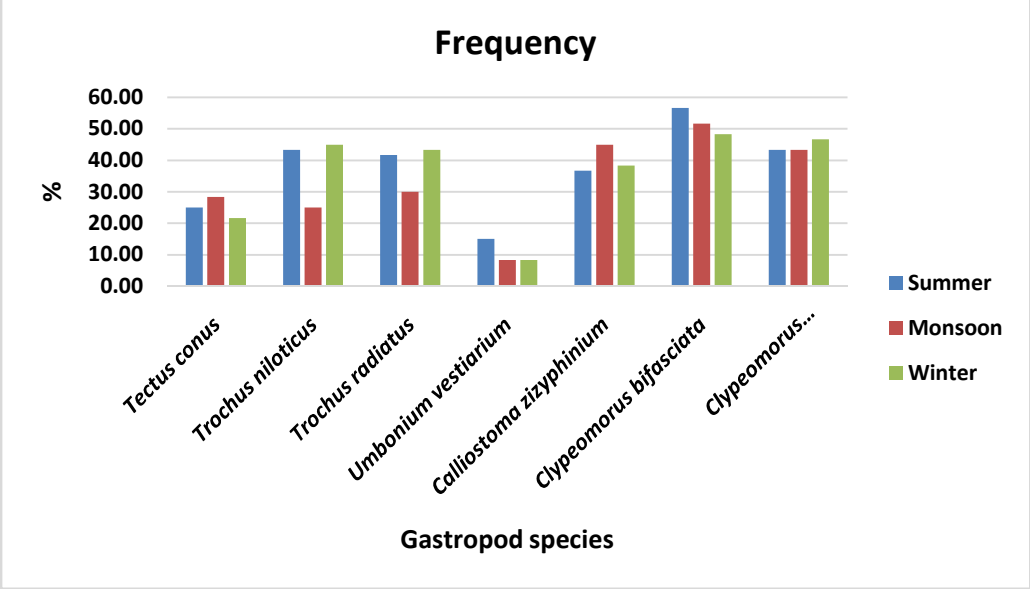

Figure 5.Frequency of gastropods species along the intertidal zone of Alang.

Table 1. Diversity of Gastropods along the coast of Alang.

No	Family	No	Name of Genus or Species	1	2	3
1	Assimineidae	1.	*Assimineasp.*	X	√	X
2	Bursidae	2.	*Gyrineumnatator*(Roding, 1798)	√	X	X
3	Buccinidae	3.	*Cantharusspiralis*(Gray, 1839)	√	X	X
4	Cerithiidae	4.	*Cerithiumechinatum*(Lamarck, 1822)	√	X	X
		5.	*Cerithiumvulgatum*(Bruguiere, 1792)	√	√	X
		6.	*Cerithiumcoralium*(Kiener, 1841)	√	√	√
		7.	*Cerithiumlividulum*(Risso, 1826)	X	√	X
		8.	*Clypeomorusbifasciata*(G.B.Sowerby II, 1895)	√	√	√
		9.	*Clypeomorusbatillariaeformis*(Habe&Kosuge, 1966)	√	√	√
		10.	*Cerithium sp.*	√	X	√
5	Haminoeidae	11.	*Haminoeagalba*(Pease, 1861)	X	√	√

6	Littorinidae	12.	*Littorariascabra*(Linnaeus, 1758)	X	X	√
		13.	*Littorariaundulata*(Gray, 1839)	√	√	√
		14.	*Littorariaarticulata*(Philippi, 1846)	√	X	X
		15.	*Littorariaintermedia* (Philippi, 1846)	X	√	X
		16.	*Echinolittorinamalaccana (*Philippi, 1847)	X	√	X
7	Muricidae	17.	*Semiricinulatissoti* (Petit de la Saussaye, 1852)	√	√	√
8	Nassaridae	18.	*Nassariusstolatus*(Gmelin, 1791)	√	√	√
		19.	*Nassariusdorsatus* (Roding, 1798)	√	√	X
		20.	*Nassariuslivescens*(Philippi, 1849)	√	√	√
9	Nacellidae	21.	*Cellanarota*(Gmelin, 1791)	√	X	√
		22.	*Cellanakarachiensis*(Winckworth, 1930)	√	X	X
		23.	*Cellana grata* (Gould, 1859)	√	X	X
10	Naticidae	24.	*Poliniceslacteus*(Guilding, 1834)	√	X	X
		25.	*Tanealineata* (Roding, 1798)	X	X	√
11	Neritidae	26.	*Neritaundata* (Linnaeus, 1758)	√	X	X
12	Olividae	27.	*Agaronianebulosa*(Lamarck, 1811)	√	X	√
		28.	*Olivaannulata* (Gmelin, 1791)	X	X	√
		29.	*Olivagibbosa* (Born, 1778)	√	X	X
		30.	*Olivacaerulea*(Roding, 1798)	√	X	X
13	Onchididae	31.	*Onchidiumverruculatum*(Cuvier, 1830)	√	√	√
14	Tegulidae	32.	*Tectusconus*(Gmelin, 1791)	√	√	√
15	Trochidae	33.	*Calliostomazizyphinum*(Linnaeus, 1758)	√	√	√
		34.	*Umboniumvestiarium*(Linnaeus, 1758)	√	√	√
		35.	*Trochusniloticus* (Linnaeus, 1767)	√	√	√
		36.	*Trochusradiatus* (Gmelin, 1791)	√	√	√
		37.	*Halistyluscolumna*(Dall, 1890)	X	√	√
16	Turbinidae	38.	*Astraliumsemicostatum*(Kiener, 1850)	√	√	X
		39.	*Astraliumstellare* (Gmelin, 1791)	√	√	X
		40.	*Uvanillabuschii* (Philippi, 1844)	X	√	X
		41.	*Turbo brunneus*(Roding, 1791)	√	√	√
17	Turridae	42.	*Lophiotomaindica* (Roding, 1798)	√	X	X
		43.	*Turrisannulata*(Reeve, 1843)	X	√	√
		44.	*Turriculajavana* (Linnaeus, 1767)	X	√	X
	Total	44.		**32**	**27**	**23**

*1=Summer, 2=Monsoon and 3=Winter

Table 2. Physicochemical parameters of Alang sea coast.

Sr. No	Parameters	Summer	Monsoon	Winter
1.	Air Temperature(°C)	31.38	29.13	27.88
2.	Water Temperature(°C)	31.00	30.50	25.13
3.	pH	7.90	8.10	7.95
4.	Salinity(‰)	32.25	33.25	35.00
5.	Turbidity(NTU)	515.25	472.00	535.75
6.	TDS(ppt)	24.65	14.89	7.87
7.	Conductivity(mS)	7.05	20.90	11.32

* ‰=Parts per thousand; NTU=Nephelometric unit; ppt=parts per trillion; mS=Millisiemens

REFERENCES

1. Appeltans, W. et al. (2012).The magnitude of global marine species diversity.Curr. Biol., 22: 1–14.
2. Rosenberg, G. (2014). A new critical estimate of named species-level diversity of the recent Mollusca. Am. Malacol. Bull., 32(2), 308-322.
3. MolluscaBase (2016). Accessed at http://www.molluscabase.org on 2016-05-03.
4. Venkataraman, K., R. Rajan., C.H. Satyanarayana., C. Raghunathan and C. Venkatraman (2012). Marine Ecosystems and Marine Protected Areas of India. Zoological Survey of India; Kolkata; 296pp. Appukuttan KK (1996). In: Marine molluscs and their conservation. Published by CentralMarineFisheries Institute, Cochin, India.
5. Venkataraman, K and C. Raghunathan. (2015). Coastal and Marine Biodiversity of India pp.303-372 In: Venkataraman, K. and C. Sivaperuman (Eds.). Marine Faunal Diversity in India: Taxonomy, Ecology and Conservation. Academic Press, London, pp.519.
6. MoEF (2014). India's fifth national report to the convention on biological diversity. Ministry of Environment and Forests, New Delhi, pp.100.
7. Biju Kumar, A., Ravinesh, R. (2016). Taxonomy of Marine Molluscs of India: Status and Challenges Ahead. Training Manual1st International Training Workshop on Taxonomy of Bivalve Molluscs.
8. Apte, D. (2004). Molluscan Fauna of Point Calimere Wildlife Sanctuary Part 1:Gastropoda, Bombay NaturHist Soc., 101: 201-210.
9. Apte, D.A. (2009). Opisthobranch fauna of Lakshadweep Islands; India with 52 new records to Lakshadweep and 40 new records to India. Part 1. Bombay NaturHist Soc., 106: 162-175.
10. Apte, D.A. (2012). Field Guide to the Marine Life of India. Stusa Mudra PrivateLimited, Mumbai, pp.503.
11. Apte, D.A.,Bhave, V. (2014). New records of opisthobranchs from Lakshadweep, India (Mollusca: Heterobranchia). J Threat Taxa 6(3): 5562–5568.
12. Apte, D.A.,Bhave V., Parasharya, D (2010). An annotated and illustrated checklist of the opisthobranch fauna of Gulf of Kutch, Gujarat, India, with 20 new records for Gujarat and 14 new records for India. Part 1.Bombay NaturHistSoc, 107: 14–23.
13. Apte, D., V. Bhave, R. Pitale, P. Nagale, and A. Prasade (2012). A Preliminary Report on Diversity of Coastal Ecosystems of Maharashtra Part 3: Ecologically Sensitive Coastal Areas of Ratnagiri, Rajapur and Vijaydurga. Bombay NaturHistSoc, Mumbai. pp.173.
14. Bhave, V. and D. Apte. (2011). Opisthobranch fauna of Ratnagiri, Maharashtra, India with 8 new records to India. Hist Soc., 108(3): 172-182.
15. Bijukumar, A., R. Ravinesh., A.R. Arathi and K.K. Idreesbabu (2015). On the molluscan fauna of Lakshadweep included in various schedules of Wildlife (Protection) Act of India. J Threat Taxa 7(6): 7253– 7268.
16. Dey, A. (2006) Contribution to the knowledge of Indian Marine Molluscs (Part - IV) Family Tellinidae; Rec. Zool. Surv. Ind, Occ. Paper No. 249 : 1124
17. Dey, A. and Ramakrishna, (2007). Marine molluscs of Andhra Pradesh: Bivalvia, Scaphopoda and Cephalopoda, Fauna of Andhra Pradesh, State Fauna series, Rec. Zool. Surv. Ind, 5 (Part 7): 149-260.
18. Franklin, B.F., Subramanian, K. A., Fernando, S.A and K. S. Krishnan (2009). Diversity and Distribution of Conidae from the Tamil Nadu Coast of India (Mollusca: Caenogastropoda: Conidae), Zootaxa, 2250: 1–63.
19. Lutaenko, K.A. (2006). On the fauna of bivalves of the subfamily Anadarinae (Arcidae) from Southern India. Bull. Russian Far East malac. Soc., 10: 10212.
20. Modayil, M.J. (2007). A Field Guide to the Common Marine Molluscs of India, CMFRI, Kochi, pp.80.
21. Mukhopadhyay, A.K., Sharma, A.K. and Ramakrishna (2012). Two new species of molluscs, (Naticidae: Gastropoda) from India. Rec. Zool. Surv. India, 112: 7-12.
22. Pati, S.K. Sharma, R.M. (2012) Marine gastropods (Mollusca: Gastropoda), Fauna of Maharashtra, State Fauna Series, Rec. Zool. Surv. India 20: 29130.
23. Raghunathan, C., C. Sivaperuman and Ramakrishna (2010). An account of newly recorded five species of nudibranchs (Opisthobranchia, Gastropoda) in Andaman and Nicobar Islands, pp. 283–288. In: Ramakrishna, C. Raghunathan& C. Sivaperuman (Eds.). Recent trends in biodiversity of Andaman and Nicobar Islands. Rec. Zool. Surv. Ind, pp.542.
24. Ramakrisna, A and Dey, A. (2003) Manual on Identification of Scheduled Molluscs from India. Rec. Zool. Surv. Ind, Kolkata, pp39.
25. Ramakrishna, A and Dey, A. (2010). Annotated Checklist of Indian Marine Molluscs (Cephalopoda, Bivalvia and Scaphopoda): Part-I. Rec. Zool. Surv. Ind, Occ. Paper No, 320: 1-357.
26. Ramakrishna and Dey A., Barua, S. and Mukhopadhyaya, A. (2007) Marine Molluscs.Polyplacophora and Gastropoda. In: Fauna of Andhra Pradesh, State Fauna Series, Rec. Zool. Surv. Ind.5 (Part-7): 149- 260.
27. Ramakrishna, A and Dey, A. (2010). Annotated Checklist of Indian Marine Molluscs (Cephalopoda, Bivalvia and Scaphopoda): Part-I. Rec. Zool. Surv. Ind, Occ. Paper No, 320: 1-357.
28. Sreeraj, C.R., C. Sivaperuman& C. Raghunathan (2012). An annotated checklist of opisthobranch fauna (Gastropoda: Opisthobranchia) of the Nicobar Islands, India. J Threat Taxa. 4(4): 2499–2509.
29. Sreeja V., Norman M.D. and Biju Kumar A. (2015). A new species of pouched octopus, Cistopus Gray, 1849 (Cephalopoda: Octopodidae) from the southwest coast of India. Zootaxa., 4058(2): 244-256.
30. Venkataraman, K., Jeyabaskaran, R., Raghuram, K.P., Alfred, J.R.B., (2004). Bibliography and checklist of corals and coral reef associated organisms of India. Rec. Zool. Surv. Ind., Occ. Paper 226, 1–648.

31. Poriya, P., Vakani, B., Chaudhari, B.,Kachhiya, P., &Kundu, R. (2015). Diversity and first record of heterobranch gastropods (opisthobranchs) from Saurashtra coast of Kathiawar Peninsula, India. Mar Biodivers Rec., 8; e82; 1-7.
32. Singh H. S., Pandey C. N, Yennawar P, Asari R. J, Patel B. H., Tatu K, Raval B. R. (2004). The marine national park and sanctuary in the Gulf of Kachchh – a comprehensive study on biodiversity and management issues. GEER Foundation, Gandhinagar.
33. Gohil B, Poriya P and Kundu R. (2011) Status of intertidal macro faunal and floral diversity of Dwarka Sea coast in prospects of some environmental factor. Bionanofrontier. 4 (2): 290-293.
34. Bhadja P.,Poriya P. and Kundu R. (2014). Community Structure and Distribution Pattern of IntertidalInvertebrate Macrofauna at Some Anthropogenically InfluencedCoasts of Kathiawar Peninsula (India).Adv.Ecol.Res., Volume 2014, Article ID 547395, 11 pageshttp://dx.doi.org/10.1155/2014/547395.
35. Vadher P., GadhviI. R., ParekhH. and DabhiJ. (2014). Occurrence of marine molluscan along the Chorwad Coast, Gujarat-India.Pelagia Research Library,Adv. Appl. Sci. Res.,5(5):24-28.
36. Solanki, D., Kanejiya, J, Beleem I, and Gohil B. (2016). Checklist of intertidal marine fauna in mangrove ecosystem, Ghogha coast, Gulf of Khambhat, India J. Entomol. Zool. Stud., 4(4):1281-1284.
37. Vakani B, Poriya P and Kundu R. (2014). Spatio-Temporal Variations inThe Population Ecology of Two Limpets In A Rocky Intertidal Shore Of SouthSaurashtra Coast (Gujarat: India). The Ecoscan.8(1&2):71-75.
38. Faladu, J., Vakani, B., Poriya, P. &Kundu, R. (2014). Habitat preference and population ecology of limpets *Cellanakarachiensis* (Winckworth) and *Siphonariasiphonaria* (Sowerby) at Veraval coast of Kathiawar Peninsula, India. J.Ecosys., 1-6pp, http://dx.doi.org/10.1155/2014/874013.
39. Prasad, M. N., &Mansuri, A.P. (1982). Population density of the Limpet, Cellanaradiata (Born) in polluted waters at Porbandar, West coast of India. Indian J.Geo.Mar.Sci, 11, 180-181.
40. Misra, S., &Kundu, R. (2005). Seasonal variations in population dynamics of key intertidal molluscs at two contrasting locations. Aqua.Ecol, 39, 315-324.
41. Vaghela A., P. Bhadja, J. Ramoliya, N. Patel, and R. Kundu (2010) Seasonal variations in the water quality, diversity and population ecology of intertidal macrofauna at an industrially influenced coast. Water Sci. Technol., 61(6): 1505– 1514.
42. Apte, D. (1998). The book of Indian shells, Bombay Natural History Society, pp.1-114.
43. Subba Rao, N.V. 2003. Indian Seashells (Part-I): Polyplacopora and Gastropoda. Occ Paper. Rec. Zool. Surv. India, 19 (i-x): 2-416.
44. Modayil, M.J. (2007). A Field Guide to the Common Marine Molluscs of India, CMFRI, Kochi, pp.80.
45. Misra, R. (1968). Ecology Work Book. Oxford and IBH Publishing Co., Calcutta, India.
46. Bhadja, P. &Kundu, R. (2012). Status of seawater quality at few industrially importantcoasts of Gujarat (India) off Arabian Sea. J.Geo.Mar.Sci,41 (1), 954-961.
47. Website: www.WoRMS.org.