Symbiosis

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www.symbiosisonlinepublishing.com
ISSN Online: 2475-4706

Research Article International Journal of Marine Biology and Research Open Access

Checklist of Marine Gastropods around Tarapur Atomic Power Station (TAPS), West Coast of India

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Received: July 30, 2018; Accepted: August 10, 2018; Published: September 04, 2018

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Abstract

The present study was carried out to assess the marine gastropods checklist around ecologically importance area of Tarapur atomic power station intertidal area. In three tidal zone areas, quadrate sampling method was adopted and the intertidal marine gastropods were collected and identified up to species level. Physico chemical parameters of water and sediments are also done. A total of 51 intertidal gastropods species were identified; among them Muricidae family dominant it composed 20% followed by Neritidae (12%), Littorinidae (8%), Turbinidae (8%). Till now, a complete checklist of the intertidal gastropods information along TAPS coastal area is not available. Therefore, our present research work was carried out and taken available evidence of marine gastropods check-list data. The present work is the prima facie result on base line information of checklist of gastropods, which will helpful for further environmental monitoring assessment programs.

Keywords: Marine gastropods; Invertebrate; Checklist; TAPS; Maharashtra;

Introduction

The planet earth is always been changing and the rate of change can be examined by comparing time series data of ecological units with present status of individual species or communities. Individual species or communities also respond to climate change and try to fit in there optimal environmental conditions (Stork, 1997). In current scenario; overexploitation of marine resources such as fishing during which many invertebrates and plant stock get removed, industrialization and chemical pollution which is the main cause of eutrophication, coastal land reclamation, invasion of exotic species, transport and tourism, global warming which alters many nutrients level in ocean, increased in temperature. These all factors contribute to change in marine ecosystem and biodiversity and these multiple stresses affected the marine environment from intertidal area to deep sea. Being a heterogeneous environment, intertidal rocky coastlines provide a multiple range of habitats that support a great variety of living forms [35]. The relationship between species diversity and spatial scale has been a major topic of interest among ecological researchers [22,25,34,39,40].

The change in spatial scale often supposed to alter the diversity pattern, in the sense that an increased in scale could provide more resources to species and that promote an increased in diversity [9]. In case of invertebrates the second largest group on earth is Mollusc [7]. Intertidal molluscan communities are interlinks for the study of morphological and ecological convergence between geographically and temporally isolated communities [13]. The molluscs are soft bodied animals with long evolutionary history and diversity [6,8]. Based on the habitat the molluscs are classified as terrestrial and aquatic community. Molluscan community structure and their diversity indicate the overall ecosystem health [26]. To investigate the relationship between biodiversity and ecosystem function the intertidal ecosystem is very helpful. The intertidal organisms are under continuous stress by environmental as well as anthropogenic cause, which can be better assessed by studying the responses of these organisms. The advantages behind selection of these organisms are many as they are numerous, accessible, slow moving, easy to collect and suitable for experimental manipulation [14]. Biodiversity essentially reflects ecological quality of the habitat [37]. In current scenario with increased interference of manmade activities in coastal area, the flora and fauna are under threat. Hence, continuous monitoring and record through diversity studies is an important. A baseline checklist of marine gastropods around ecologically importance area of Tarapur is not available till yet. Therefore, the present work was done to achieve the baseline information about the marine gastropods checklist along with physcio-chemical parameters around Tarapur Atomic Power Station (TAPS), Tarapur site area. This study will be assisted any future reference study on marine invertebrates diversity in relation to running of the atomic power plant.

Materials and methods

Description of study area

The selected locations are situated at West coast of Maharashtra and within 8.5 km range around Tarapur Nuclear Power point Plant (TAPS). The intertidal locations were all are rocky intertidal and selected on the basis of the distance from the discharge of heated effluent from TAPS 1&2 and TAPS 3&4. Light house and Popharan were selected as were the discharge is released from TAPS 1&2 and TAPS 3&4 respectively. TAPS 1&2 and TAPS 3&4 intake point are the nearest point i.e. within 1.5 km from discharge points. Varor and Nandgaon are situated at the distance of 8.5 km from TAPS 1&2 and TAPS 3&4 respectively, were selected as reference locations table 1 and figure 1.

Table 1: Detailed Geographical location of study area

Sampling location	GPS position	Importance of location
TAPS 1 & 2	N -19^{0}50.003’ E -72^{0}39.139’	Intertidal area near to intake channel (North side)
Light House	N -19^{0}50’32.1” E -72^{0}39’21.6”	Intertidal area at the discharge channel of TAPS 1 & 2 (North side)
Varor	N -19^{0}54’32.4” E -72^{0}40’35.6”	Reference location, at the distance of 8.00 km from the discharge channel of TAPS 1& 2 (North side)
TAPS 3 & 4	N -19^{0}49.533’ E -72^{0}39.557’	Intertidal area near to intake channel (South side)
Popharan	N – 19^{0}50.638” E – 72^{0}40.651”	Intertidal area at the discharge channel of TAPS 3 & 4 (South side)
Nandgaon	N -19^{0}45’09.0” E -72^{0}41’19.2”	Reference location, at the distance of 8.00 km from the discharge channel of TAPS 3& 4 (South side)

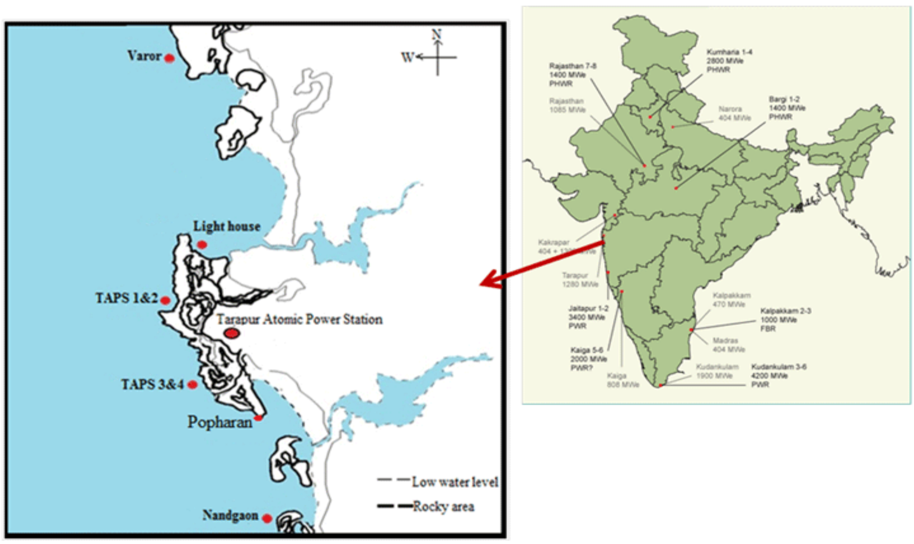

Figure 1: Study area

Collection of samples

The present study was conducted during 2013 and 2014. Each location was surveyed extensively in each season, premonsoon, monsoon and post monsoon. The sea water samples were collected in 500 ml sterile polyethylene bottles. For every collection new bottles were used. The bottles were rinsed two to three times with sea water on the field, before collecting the sample sea water in it. The bottles were filled up to the rim and sealed properly to minimize the gaseous exchange and to prevent any leakage. The bottles were kept in ice box and after returning to laboratory, they brought to normal room temperature allowed for some time for settling of suspended particle, before starting calorimetric and analytical estimations. Sediment samples were collected from the same six locations, in clean polyethylene plastic bags with the help of plastic spatula. In laboratory the sediment were allowed to dry naturally in sunlight and then sieved properly to remove the unwanted debris and big stones and pieces of shells.

The each selected intertidal location was sub-divided into three tidal zone namely High water level (HWL), Mid Water Level (MWL) and Low Water Level (LWL) so that maximum area could get covered. The sampling was started at LWL followed by MWL and then HWL, to get maximum time period for extensive survey. The numbers of sampling techniques are used; the most common for the collection of molluscs is the quadrate sampling

[10,11,16,18,23,24]. At each water level four quadrate of 1 m2 were placed at almost equal distance intervals (Approximately 25 m). The gastropods in quadrate were collected by using scraper (Scissor like tool) that skims the animals, since most of the gastropods are not firmly attached to substratum, it become easy to collect them with this tool. The burrowing and organisms present in rock crevices were collected with the help of small spade like material. The gastropods collected from four quadrates at each water level were kept in different plastic container. 5% buffer formaline prepared in sea water were added to containers to avoid putrid smell after death.

Physcio-chemical analysis

The surface water temperature and pH were recorded on the field itself with help of LCD portable digital multi steam thermometer (MEXTEH, Multi Thermometer) and pH meter (pH tester-Oaklam) respectively. For the estimation of Dissolved Oxygen the water were collected in Winkler bottle of 300 ml and fixed with Wrinkler A and Wrinkler B at the collection point. On field the salinity were recorded by using hand held refractometer (ATAGO, s/Mill – E, Salinity 0-100 ‰). In laboratory, Dissolved Oxygen (Modified Winkler method) and micronutrient in sea water were analysed by following the methods in A Practical Handbook of Sea Water authored by [30].

The 50g of dried sediment sample were taken for analysis. The sediment texture were analyzed by following Hydrometer method explained in Soil Sampling, Preparation and Analysis, authored by [19] and the result is express in percentage value. The Organic Carbon (Corg %) were estimated by Walkley – Black Wet Combustion Method (1934). All the analysis for water and sediment were repeated thrice for each sample and the average value is taken as the final result.

Identification of marine Gastropods

In laboratory each shell were cleaned with soft brush to remove the unwanted fouling biomass and mud. The morphological characteristic of each shell were studied and identification was done by following the key of [3,12,15,27,28,31,32,33]. In addition to that, identified all species name were updated by WoRMS (World Register of Marine Species) site. Further, morphologically identified gastropod samples were preserved with 4% formalin solution and labeled in plastic container at BRNS-Aquatic Radioecology Laboratory, ICAR-Central Institute of Fisheries Education, Mumbai for future purpose.

Statistical analysis

A suit of statistical analysis was carried out by using statistical software Origin (Version 8) and SPSS (Version 21) for spatial variation among the physicochemical parameters.

Results and Discussion

In the present study, the stable environmental factors such as temperature, pH, salinity, and dissolved oxygen, micronutrients such as, ammonia, nitrite, nitrate and phosphate were analyzed during three different seasons table 2. The water temperature was in the range of 25.30C to 38.50C at Nandgaon and Popharan respectively. The high temperature recorded at Popharan throughout the study period was mainly due to discharge water from TAPS 3&4 plant site, which has shown a positive correlation with low pH (7.1), high salinity (36.3 ppt) and low dissolved oxygen concentration (5.9 mg/l) table 3. These physico-chemical parameters had seasonal variation pattern. Lowest water temperature during post-monsoon season (27.13 ± 2.3) was may be due to cold breeze flow from surface. In addition to that, the pH, salinity and dissolved oxygen showed minimum fluctuation with standard deviation values of ± 0.18, ± 0.73 and ± 0.54 respectively. The nutrient values were in normal range with minimum fluctuation during the study period. The sediment texture which plays a key role in community structuring was recorded with sand (%) > silt (%) > clay (%) trend. This trend in sediment structure was mainly due to rocky habitat at all locations. Sediment texture had seasonal table 4 as well as spatial variation. The percentage of organic carbon in sediment was in the range of 0.03 % to 1.8 % at TAPS 3&4 and light house respectively table 5. High percentage of organic carbon at Light house was mainly due to presence of mangrove vegetation at high water level. [26] Also reported that, the different environmental factors such as dilution, evaporation and high rainfall and other physico-chemical parameters are play an important role in distribution of living organisms in coastal ecosystem.

Table 2: Range, mean and standard deviation of physico-chemical parameters recorded during the study period

Seasons	Water Temperature (^{0}C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/l)	Ammonia (NH_4-N) mg/l)	Nitrite (NO_2-N) (mg/l)	Nitrate (NO_3-N) (mg/l)	Phosphate (PO_4^-) (mg/l)
MON-2013	28-33.75 (30.71 ± 1.99)	7.7-8.4 (7.9 ± 0.13)	33.5-35.5 (34.33 ± 0.68)	6.5-7.8 (6.98 ± 0.54)	0.7-1.2 (0.93 ± 0.19)	0.2-0.7 (0.4 ± 0.18)	0.45-0.7 (0.64 ± 0.12)	0.5-0.8 (0.67 ± 0.10)
POST-2013	25.3-32 (27.13 ± 2.37)	7.5-8.0 (7.8 ± 0.18)	33-35 (34.15 ± 0.73)	6.1-7.0 (6.67 ± 0.37)	0.7-1.2 (0.88 ± 0.17)	0.05-0.8 (0.49 ± 0.25)	0.4-0.8 (0.65 ± 0.16)	0.42-1.15 (0.81 ± 0.28)
PRE-2014	28.2-38.5 (31.20 ± 3.78)	7.1-8.17 (7.92 ± 0.4)	35-36.3 (35.22 ± 0.53)	5.9-7.2 (6.47 ± 0.49)	0.75-1.8 (1.08 ± 0.39)	0.2-0.5 (0.43 ± 0.12)	0.18-0.4 (0.26 ± 0.09)	0.84-1.39 (1.06 ± 0.21)

Note: MON-monsoon; POST-post-monsoon; PRE- pre-monsoon;

Table 3: Range, mean and standard deviation of physico-chemical parameters recorded (station-wise) during the study period

Seasons	Water Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/l)	Ammonia (NH_4-N) (mg/l)	Nitrite (NO_2-N) (mg/l)	Nitrate (NO_3-N) (mg/l)	Phosphate (PO_4^-) (mg/l)
TAPS 1&2	27.1-30.5 (28.12 ± 1.54)	7.9-8.1 (7.97 ± 0.15)	33-35 (34.25 ± 0.88)	6.1-7.5 (6.80 ± 0.55)	0.6-1.22 (1.01 ± 0.32)	0.2-0.6 (0.42 ± 0.15)	0.23-0.7 (0.41 ± 0.17)	0.42-0.84 (0.68 ± 0.15)
TAPS 3&4	27-32 (28.92 ± 2.08)	7.5-8.4 (7.99 ± 0.31)	34-35 (34.63 ± 0.5)	6-6.9 (6.57 ± 0.37)	0.75-1.1 (0.89 ± 0.17)	0.2-0.98 (0.68 ± 0.29)	0.2-0.6 (0.33±0.15)	0.7-0.88 (0.81 ± 0.06)
Light House	27-30.6 (28.83 ± 1.43)	7.8-8.26 (8.03 ± 0.14)	33.5-35 (34.17±0.52)	6.3-7.2 (6.88 ± 0.32)	0.7-1.8 (1.02 ± 0.42)	0.3-1 (0.48±0.32)	0.12-0.8 (0.38±0.29)	0.54-1.39 (0.87 ± 0.32)
Popharan	30.5-38.5 (32.96 ± 2.92)	7.1-8.15 (7.80 ± 0.39)	34.5-36.3 (35.38 ± 0.68)	5.9-7.5 (6.75 ± 0.53)	0.7-1.2 (0.92 ± 0.17)	0.3-0.8 (0.58 ± 0.18)	0.25-0.8 (0.50 ± 0.19)	0.65-1.15 (0.89 ± 0.18)
Varor	26.5-28.2 (27.20 ± 0.80)	7.7-8 (7.71 ± 0.21)	33-35.5 (34.5 ± 0.89)	6.4-7.7 (7.08 ± 0.56)	0.8-1.25 (1 ± 0.19)	0.1-0.22 (0.34 ± 0.20)	0.1-0.8 (0.37 ± 0.30)	0.5-1.16 (0.87 ± 0.34)
Nandgaon	25.3-29.5 (27.52 ± 1.66)	7.9-8.4 (8.09 ± 0.17)	32.5-35 (33.98 ± 0.98)	6.1-7.5 6.83 ± 0.64	0.8-1.51 (0.95 ± 0.32)	0.5-0.94 (0.61 ± 0.24)	0.2-0.7 (0.41 ± 0.20)	0.6-1.15 (0.87 ± 0.25)

Note: TAPS – Tarapur Atomic Power Station

Table 4: Seasonal variation in sediment texture and organic carbon content around Tarapur Atomic Power Station costal area

Seasons	Sand (%)	Silt (%)	Clay (%)	Organic carbon (Corg, %)
MON-2013	74.98 - 89.6 (83.3 ± 5.9)	6.5 -18.4 (10.2 ± 4.3)	3.6 – 11.5 (6.7 ± 2.9)	0.65 – 1.91 (1.1 ± 0.6)
POST-2013	73.2 - 90.5 (85.3 ± 7)	5.02 – 10.3 (7.6 ± 2.1)	3.7 – 17.7 (7.7 ± 5.3)	0.18 – 1.6 (1.1 ± 0.5)
PRE-2014	73.2 – 92.3 (84.7 ± 7)	6 – 12.3 (7.9 ± 2.4)	1.7 – 20.7 (7.5 ± 7)	0.04 – 1.32 (0.6 ± 0.3)

Table 5: Spatial variation in sediment texture and organic carbon content around Tarapur Atomic Power Station coastal area

Seasons	Sand (%)	Silt (%)	Clay (%)	Organic carbon (C_{org}, %)
TAPS 1&2	82.18 – 92.3 (87 ± 4.3)	5.02 – 9.5 (7.2 ± 1.7)	1.7 – 9.3 (5.9 ± 3)	0.11 – 1.4 (0.9 ± 0.5)
TAPS 3&4	86.11 – 91 (89.1 ± 1.9)	5.8 – 8.7 (6.9 ± 1.1)	2.6 – 6.49 (4 ± 1.6)	0.03 – 1.91 (0.6 ± 0.8)
Light House	73.2 – 81.2 (77.3 ± 3.9)	6.1 – 10.24 (8.4 ± 2)	8.69 – 20.7 (14.3 ± 4.9)	1.2 – 1.8 (1.4 ± 0.3)
Popharan	85.9 – 95.6 (90.4 ± 3.6)	4.1 – 8.7 (6.6 ± 1.6)	0.3 – 5.4 (3 ± 2.1)	0.09 – 0.7 (0.3 ± 0.2)
Varor	74.98 – 83.7 (78.7 ± 2.2)	10.3 – 18.4 (12.5 ± 3.4)	6.62 – 11.08 (8.7 ± 1.7)	0.9 – 1.68 (1.2 ± 0.3)
Nandgaon	84.3 – 89.4 (86.6 ± 2.6)	6 – 9.5 (7.3 ± 1.4)	4.2 – 8.9 (6.3 ± 2.1)	0.65 – 1.1 (0.9 ± 0.2)

In present study, 51 species of gastropods were recorded belonging to 4 sub-classes, 6 order, 18 families and 34 genera. In order wise the most dominant was Neogastropoda (46%), followed by Caenogastropoda (15%), Trochida (13%), Cycloneritida (12%) and Littorinimorpha (12%), while Seguenziida comprises only 2 % of total population figure 2. Among the families, Muricidae composed 20 % of total families' population recorded followed by Neritidae (12 %), Littorinidae (8 %), Turbinidae (8%), Cerithidae (6%), Pisaniidae (6%) and Planaxidae (6%) figure 3. All other families are in the range of 2-4%. Since, present finding covered the intertidal area within 8 km of radius from Tarapur Nuclear Power Plant site. Generally, biodiversity of coastal ecosystem is represented by the shellfish faunal resources. Among them, Molluscs and Crustaceans are one of the important and dominant groups in invertebrates. This taxonomic and biological diversity creates molluscs an attractive indicator group for biodiversity studies table 6. In India, a total of 3271 numbers of the molluscs are known and its belonging to 220 families and 591 genera of which 1900 predominate species of Gastropods, followed by 1100 species of Bivalves, 210 species of Cephalopods, 41 species of Polyplacophora and 20 species of Scaphopods [36].

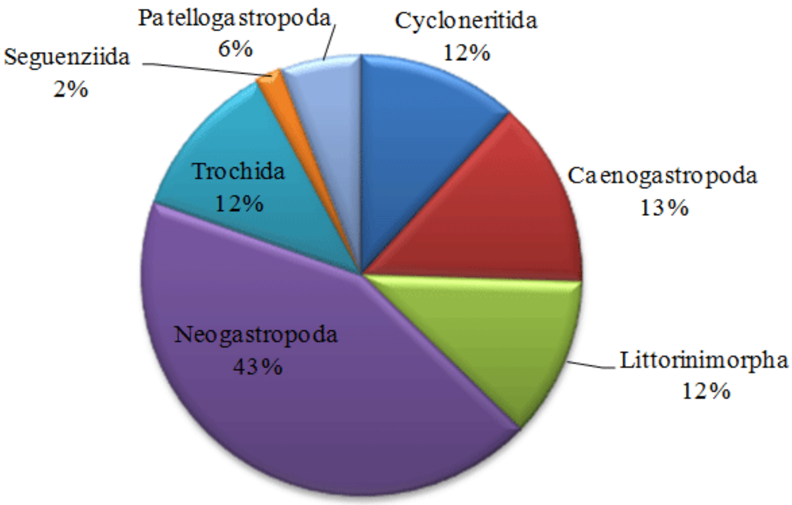

Figure 2: Order wise distribution of marine gastropods around TAPS

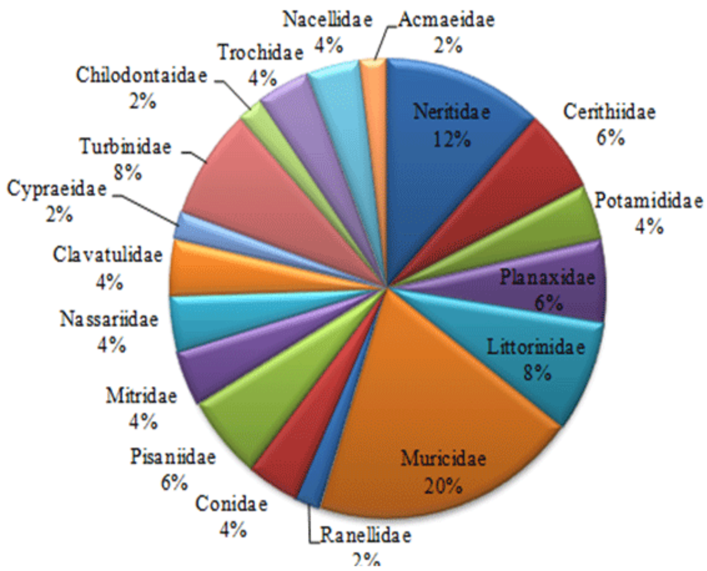

Figure 3: Family wise distribution of marine gastropods around TAPS

Table 6: A list of marine gastropods species identified around TAPS coastal area

Sl. No.	Species	Author
1	Nerita oryzarum	Récluz, 1841
2	Nerita undata	Linnaeus, 1758
3	Nerita chamaeleon	Linnaeus, 1758
4	Nerita polita	Linnaeus, 1758
5	Nerita albicilla	Linnaeus, 1758
6	Neripteron violaceum	Gmelin, 1791
7	Clypeomorus bifasciata	G. B. Sowerby II, 1855
8	Pirenella cingulata	Gmelin, 1791
9	Cerithium echinatum	Lamarck, 1822
10	Cerithium scabridum	Philippi, 1848
11	Planaxis sulcatus	Born, 1778
12	Supplanaxis niger	Quoy & Gaimard, 1833
13	Littoraria undulata	Gray, 1839
14	Indothais lacera	Born, 1778
15	Semiricinula tissoti	Petit de la Saussaye, 1852
16	Semiricinula konkanensis	Melvill, 1893
17	Gyrineum natator	Röding, 1798
18	Echinolittorina malaccana	Philippi, 1847
19	Conus figulinus	Linnaeus, 1758
20	Cantharus spiralis	Gray, 1839
21	Pollia fumosa	Dillwyn, 1817
22	Pollia undosa	Linnaeus, 1758
23	Indothais blanfordi	Melvill, 1893
24	Engina zea	Melvill, 1893
25	Chicoreus brunneus	Link, 1807
26	Littoraria scabra	Linnaeus, 1758
27	Strigatella scutulata	Gmelin, 1791
28	Nassarius stolatus	Gmelin, 1791
29	Nassarius jacksonianus	Quoy & Gaimard, 1833
30	Turricula tornata	Dillwyn, 1817
31	Drupella rugosa	Born, 1778
32	Indothais lacera	Born, 1778
33	Telescopium telescopium	Linnaeus, 1758
34	Conus hyaena	Hwass in Bruguière, 1792
35	Turricula javana	Linnaeus, 1767
36	Strigatella litterata	Lamarck, 1811
37	Echinolittorina vidua	Gould, 1859
38	Naria miliaris	Gmelin, 1791
39	Lataxiena bombayana	Melvill, 1893
40	Tenguella granulata	Duclos, 1832
41	Turbo bruneus	Röding, 1798

42	Astralium semicostatum	Kiener, 1850
43	Clanculus ceylonicus	G. & H. Nevill, 1869
44	Astralium stellare	Gmelin, 1791
45	Herpetopoma aspersum	Philippi, 1846
46	Umbonium vestiarium	Linnaeus, 1758
47	Trochus radiatus	Gmelin, 1791
48	Cellana radiata	Born, 1778
49	Cellana testudinaria	Linnaeus, 1758
50	Acmaea achates	Reeve, 1855
51	Ocenebra bombayana	Melvill, 1893

Earlier, [2] have catalogued 1900 species of gastropods from Indian waters. Later on, [11] have reported 43 species of gastropods around coastal area of Mumbai, with previous record of 49 species of gastropods from similar location [1,10], have reported 86 species of gastropods off which 51 species were reported from rocky intertidal area from coastal area of Goa, west coast of India, suggesting that rocky intertidal inhibit more diversity of gastropods than sub-tidal area. [16,18] recorded 39 species of gastropods from selected localities in Raigad district and also reported that overall diversity of mollusks was abundant at rocky intertidal habitat. From same Raigad district, Borli coast, 30 species of gastropods were identified by [21]. In 2009, 75 species of gastropods were catalogued from 67 locations around Ratnagiri coast, off which highest diversity was reported from rocky intertidal habitat by [20]. Further, has also reported the 26 species of molluscs off which 18 species belongs to gastropods [5]. Very recently have reported 78 species from five different locations around west coast of India [17]

Conclusion

The west coast of India was extensively studied for past many years for diversity of molluscs at intertidal area. However, in the present study we attempt to give preliminary effects around the Tarapur Atomic Power Station which is running from past four decades and it's consider as ecologically sensitive area. These present reports on diversity study will provide valuable present status of intertidal gastropods information to the taxonomists and ecologists in further systematic research with respect to marine invertebrate resources and will helpful for further environmental monitoring assessment programs.

Acknowledgement

All authors are thankful to The Director, ICAR-Central Institute of Fisheries Education, Mumbai for providing facilities to carry out this present study and grateful to BRNS (Board of Research in Nuclear Science), DAE (Department of Atomic Energy), Govt. of India for providing the financial assistance through Aquatic radioecology project work (Studies on present of marine radioecology and biodiversity at Tarapur Costal site: File no: 2010/36/83-BRNS/dt2/2/11).

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