Ecological status of biofouling animals along coastal areas of Palghar, Maharashtra with special reference to anthropogenic activities and climate change

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Abstract- The present study was undertaken during June 2016 to May 2017 to evaluate water quality and macro fouling pattern, dominant species and their seasonal changes to explore the distribution and diversity of macrofoulers along the coastal areas of Tarapur Atomic Power(19.86ºN,72.68ºE)and Dahanu Thermal Power Station (19.97º,72.73ºE) in Palghar district of Maharashtra state. Macrofoulers being a prominent community in rocky coasts, the influence of environmental parameters on the prevailing species was also explored.Total 16 species of macrofoulers recorded during study period including *Hydroideselegans, Pernaviridis, Modiolusmodiolus, Modiolusstriatulus, Modiolus undulates, Balanus Amphitrite, Crassostreacuttackensis, Saccostreacuculata, Ilyanassaobsoleta ,Chiton,Nassariussp. ,Mytilusgalloprovincialis , Myaarenaria, Martesiastriata, Pholas sp.,Bankiasp.*,etc. There was a wide variation in the colonies of macrofoulers. The overall dominant species were hydroids and barnacles throughout the study period. In Tarapur coast, hydroids were dominant during January, followed by barnacles and amphipods. Additionally, complete dominance of barnacles was observed in the Dahanu coast during May. Barnacles were found dominant on the bottom of boats during April, followed by hydroids and crabs. Barnacles formed a major contribution of the macro fouling organisms throughout the study period. Significant variation in the occurrence and abundance of fouling organisms was observed between two coastal sites. Physico-chemical parameters including Depth, temperature, pH, Salinity, DO, BOD, Nitrates, Nitrites, total nitrogen, inorganic phosphate, total phosphorus, chlorophyll a , phyophytin and phytoplankton showed significant variations during pre-monsoon, monsoon and post monsoon seasons.

Index Terms- Macrofoulers, Diversity, Barnacles, Hydroids, Amphipods.

I. INTRODUCTION

India has long coastline of about 8000 km including two groups of islands. The mainland coastline admeasures to ~ 6100 km length bounded by the sea to the west, the Bay of Bengal to the east and therefore the ocean to the south. The geographical region extends from Rann de Kutch Gujarat in the north to Kanyakumari Tamil Nadu in the south with a length of approximately 3**,**287 km. Western coastline encompasses a wide ocean bottom having a locality of 0.31 million km2 which is marked by backwaters and mudflats. Geographic region consists of Madras coast, Andhra coast, Orissa coast and West Bengal coast, which is flat and deltaic and rich in mangroves. The mangroves are located right along estuarine areas, tidal creeks, mudflats, salt marshes and reach about 6740 km2 contributing about 7% of the world's mangrove areas.

Major estuarine areas located along the Indian coast extend about 2.6 million hectares (Gouda & Panigrahy, 1996). Currently, Indian coast is facing growing human density viz, overexploitation of marine resources, dumping of business and toxic wastes, oil spills and leakages which have resulted in damage to marine ecosystem and loss of marine biodiversity. The Maharashtra coastline that stretches between Bordi -Dahanu in the north and Redi- Terekhol in the south is about 720 km long and 30 -50 km wide. The coast is indented by various west-flowing estuaries**,** **s**treams**,** headlands**,** promontories and cliffs.. There are about 18 important creeks/estuaries along the shore many of which harbour mangrove surroundings. Like elsewhere within the world, the coastal region of the state is thus a place of hectic human action, intense urbanization in pockets and enhanced industrialization, leading to degradation, directly or indirectly, of marine environment through indiscriminate releases of domestic and industrial effluents, reclamation, offshore constructions, movement of ships and loading and unloading of a spread of cargo at ports etc. Biofouling or biological fouling is that the accumulation of microorganisms, plants algae and benthic invertebrates on hard and submerged marine structures. Such accumulation is observed as epibiosis when the host surface is another organism and also the relationship isn't parasitic. Biofouling is that the undesirable accumulation of microorganisms, plants, algae, and/or animals on wetted structures. It's one in all the foremost important problems currently facing marine technology. Within the marine environment any solid surface will become fouled. Marine biofouling is one in all the key unsolved problems currently affecting the shipping industry and industrial aquatic processes in Maharashtra. it's commonly refers to the adverse growth of marine organisms on immersed artificial structures like ship hulls, jetty pilings, navigational instruments, aquaculture net cages and seawater in taking pipes etc. Biofouling problem isn't only site

specific, but also are reported to vary for two different power plants drawing same source of cooling water. Coastal power station, is incredibly susceptible for biofouling problems (Ghouriet.al.,2011). Marine fouling may be a common but complex succession of processes which involves settling, interaction and subsequent accumulation of organic materials, both living and non-living on a submerged solid surface. Studies on different aspects of fouling like, biology, physiology, succession, recruitment, etc., (Oshurkov, 1992; Kocak, 2007; Litulo, 2007;Tremblay et al., 2007) are disbursed. In India, cage culture of marine finfish and shellfish has been initiated in 2007 by Central Marine Fisheries Research Institute and successfully cultured Asian sea bass. CMFRI has developed a Marine farm at, off Karwar bay for culturing Finishes and shellfishes. During the study period there have been 25 cages within the marine farm culturing Cobia (Rachycentroncanadum), Pompano (Trachinotusblochii), Seabass (Latescalcarifer) and redsnapper (Lutjanusargentimaculatus). little or no work has been allotted in India on macro-biofouling communities.
Therefore, this study has been allotted along Dahanu and Tarapur coast near thermal and nuclear energy plants to assess the macro-fouling pattern, monthly settlement and species dominance between two coastal areas of geographic region of India during the amount of 2016-2017. The key macrofouling organisms include algae, ascidians, barnacles, bryozoans, hydroids, mussels, and serpulids (Salta et al., 2009). A macrofouling community consisting of either 'soft fouling' or 'hard fouling' may develop and overgrow the microfouling. Macro- fouling is categorized as soft fouling comprises algae and invertebrates, like soft corals, sponges, anemones, tunicates and hydroids. Hard fouling comprises invertebrates like barnacles, mussels and tubeworms, bryazons and seaweeds (Callow and Callow 2002).

Area of Study

The present investigation has been carried out along Dahanu and Tarapur coast of Palghar district of Maharashtra during June 2016 to May 2017, total four sites were selected for the study of macrofoulers, out of which two sites were near Dahanu Thermal power station and two sites were near Tarapur atomic power plant because coastal power plant, is very susceptible for biofouling problems (Ghouri*et al*.2011).

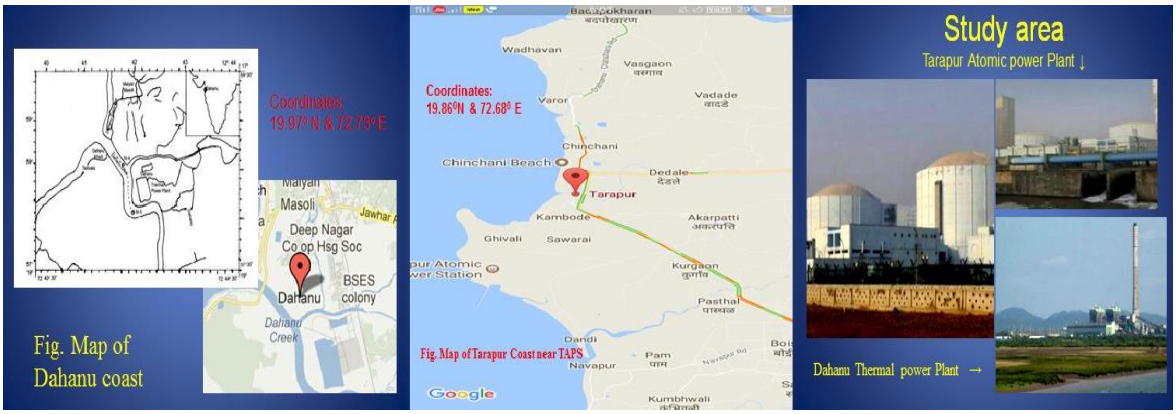

Fig.1- Map of macrofouler sampling sites

Materials and Methods

The study period was lasted for 13 months during this period water samples were collected for various physicochemical and biological parameters, analyses has been carried out by following standard methods. All nutrient including nitrate, nitrite, ammoniumnitrate, phosphate were analyzed calorimetrically Using UV- Vis spectrophotometer. Estimation of chlorophyll a and phyophytin was carried out by Strickland & Parson method(1972).Phytoplankton samples were collected from the surface water during low tide and high tide using plankton net(mesh size 20mm), the samples were subjected to qualitative and quantitative analyses. Fresh sample were collected on a month intervals to periodically record the macro fouling fauna in the coastal region along Dahanu and Tarapur coast. The samples were collected from the piers, jetty, boats, floating ropes, stones, shells, outboard motors and boats in the coastal zone near Thermal and atomic power plants. The collected samples were immediately transferred to laboratory. The animals were washed, sorted and examined fresh with a dissecting microscope, preserved in 5% seawater formalin. Identification of macrofoulers were done by following standard monograph and research papers. The identified macrofoulers were categorized according to their phylum and class.

Results

Abiotic features of Dahanu and Tarapur Coast were influence by tides and monsoon therefore physico-chemical and biological parameters showed significant variations. In the present investigation, a total of 16 species of macro fouling organisms were recorded from Dahanu and Tarapur coast near Thermal and Atomic power plant (Table 1). The identified species of macrofoulers including *Hydroideselegans, Pernaviridis, Modiolusmodiolus M odiolusstriatulus, Modiolus undulates, Balanus Amphitrite, Crassostreacuttackensis, Saccos treacuculata, Ilyanassaobsoleta\,\Chiton, Nassarius sp.,Mytilusgalloprovincialis , Myarenaria, Martesiastriata, Pholas sp.,Bankiasp.*,etc). Barnacles were found to be the most dominant group in the study followed by mussels, Tubicolouspolychaetes and oyster. Outboard motors like shafts and propellers. The biodiversity of an ecosystem is always influenced by its environmental and geographical factors, Dahanu and Tarapur ecosystem with rich marine diversity, especially the

coastal areas. The muddy and rocky area found along Dahanu and Tarapur coast are rich diversity of flora and fauna, most of which are fouling (sedentary) in nature. A lot of motile forms like crabs and amphipods are also found in concurrence with the macro fouling species. The biodiversity of macro biofoulers varies according to the certain physic-chemical factors like, temp, pH, DO, BOD, nutrients, salinity etc. The present study showed significant variation in the physiochemical and biological parameters of the selected sites along Dahanu and Tarapur coast near Thermal and Atomic power plant. (Table1).

Table1:Variation in different physic-chemical and biological parameters of surface and bottom water at Dahanu and Tarapur coast

Parameters	Dahanu Coast		Tarapur Coast	
	D1	D2	T1	T2
Temperature (^{0} C)	23.5 - 33.00 (aver.28.70)	24.5 to 32.5 (aver.27.79)	22.5-35.5 (aver.29.54)	21.0 -34.5 (aver.28.90)
pH	6.70 -8.60 (aver.7.86)	6.09-8.02 (aver.7.30)	5.70-9.45 (aver.8.42)	6.40-10.69 (aver.8.90)
Salinity %	29.4-32.8 (aver.30.20)	23.65 – 35.70 (aver.27.5)	21.50-39.62 (aver.24.20)	22.9-37.60 (26.42)
CO_2 (mg/l)	2.30-17.60 (aver.9.25)	1.69-15.60 Aver.7.85)	1.89-14.30 (aver.6.92)	2.50-18.30 (aver.8.62)
DO (mg/l)	2.50-6.58 (aver.4.56)	1.49-5.67 (aver.3.42)	1.90-3.52 (aver.2.60)	2.13-4.96 (aver.3.41)
BOD (mg/l)	0.35-4.70 (aver.2.73)	0.89-5.61 (aver.2.89)	0.70-5.79 (aver.2.42)	0.90-4.90 (aver.2.78)
Nitrite (µmol/L)	0.09-2.72 (aver.0.94)	0.03- 3.12 (aver. 1.69)	0.04-1.90 (aver.0.76)	0.02-2.86 (aver.0.89)
Nitrate (µmol/L)	16.20-51.66 (aver.34.50)	14.17-54.24 (aver. 29.13)	12.41-54.70 (aver.28.60)	15.82-49.3 (aver.26.8)
Ammonia (µmol/L)	0.20-21.5 (aver.7.9)	0.4- 23.60 (aver.8.13)	0.43-19.73 (aver.6.41)	0.19-21.62 (aver.7.81)
TN (µmol/L)	40.20-142.6 (aver.81.75)	36.60-90.13 (aver.76.30)	21.60-91.40 (aver.54.60)	32.41-96.30 (aver.66.81)
Phosphate (µmol/L)	1.20-8.70 (aver.4.90))	0.90-9.12 (aver.3.71)	0.69-6.71 (aver.2.89)	0.89-5.69 (aver.2.81)
TP (µmol/L)	2.70-18.66 (aver.9.26)	3.62-20.12 (aver.10.69)	1.90-16.30 (aver.8.42)	1.49-21.86 (aver.9.70)
Chlorophyll a (mg m^{-3})	2.45-7.50 (aver.4.65)	1.60-6.19 (aver.3.44)	1.86-5.61 (aver.3.90)	1.67-4.93 (aver.2.69)
Phyophytin (mg m^{-3})	0.69-2.15 (aver.1.49)	0.4-1.69 (aver.0.46)	0.29-1.63 (aver.0.67)	0.92-1.29 (aver.0.63)
Phytoplankton cell count(no.X10^3/l)	8.6-11412.6 (aver.1250.7)	7.9-12732.3 (aver.1345.8)	6.09-10416.7 (aver.945.9)	5.70-9724.3 (aver.820.8)

Macrofouler community along Palghar coast				
Hydroideselegans	16	29	13	16
Pernaviridis	09	07	54	22
Modiolusmodiolus	18	11	07	05
Modiolusstriatulus	05	02	29	12
Modiolusundulatus	21	82	22	12
Balanusamphitrite	166	176	182	120
Crassostreacuttackensis	26	28	82	38
Saccostreacuculata	10	07	82	28
Ilyanassaobsoleta	20	23	17	06
Chiton Sp.	07	05	98	31
Nassarius sp.,	22	19	38	29
Mytilusgalloprovincialis	02	06	66	23
Myaarenaria	26	30	02	03
Martesiastriata	55	21	11	22
Pholas sp.,	24	20	07	05
Bankia	24	27	49	41

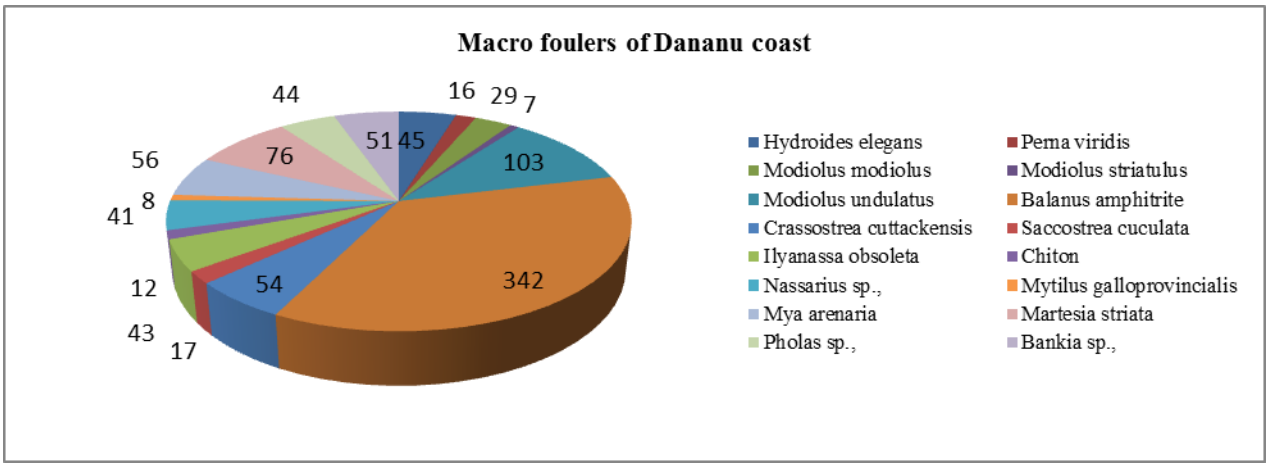

Fig.2: Diversity of Macrofoulers along Dahanu Coast

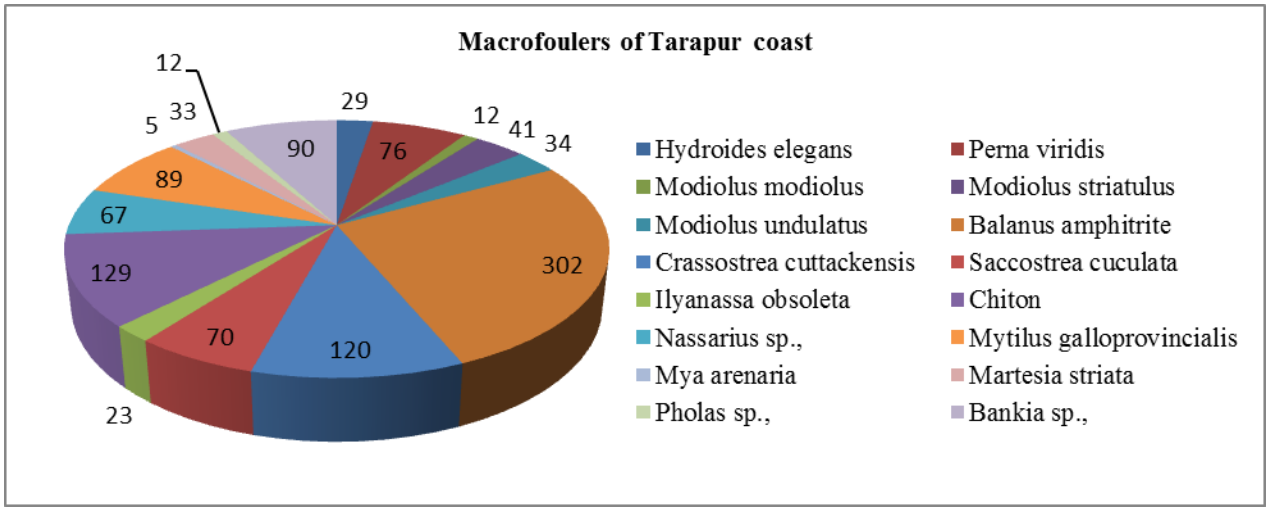

Fig.3: Diversity of Macrofoulers along Tarapur Coast

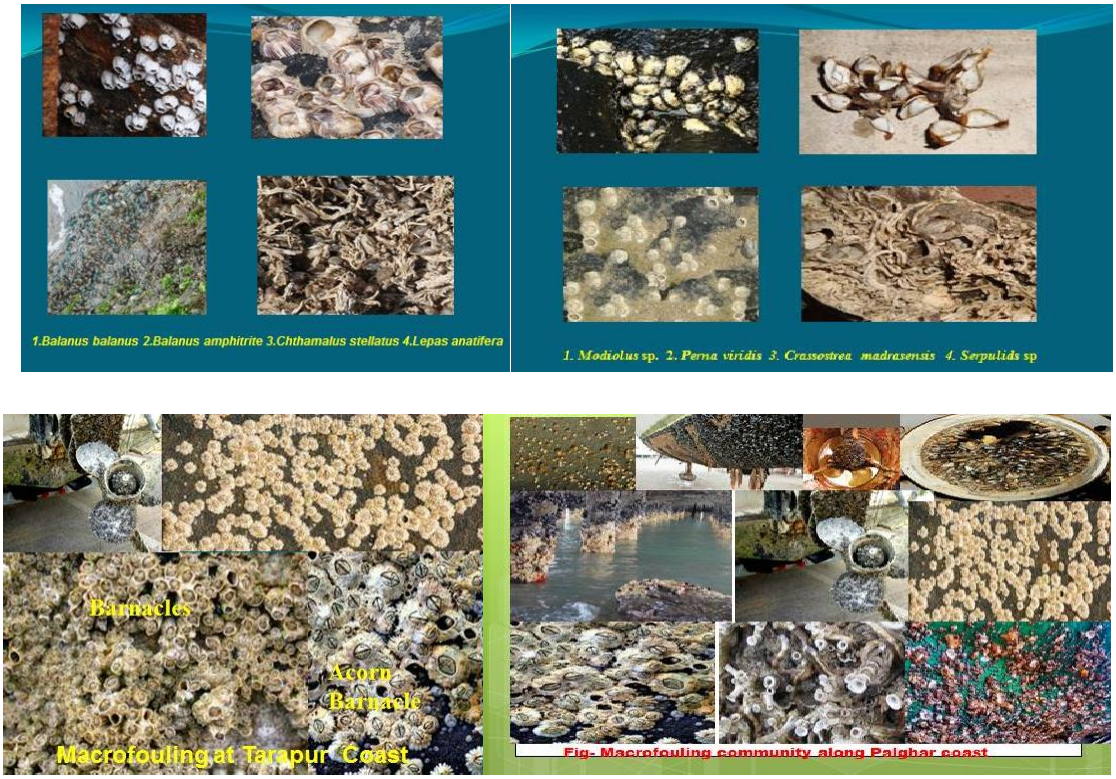

Fig.4: Macrofouler community along Palghar Coast

Control measures of biofouling

The simplest method for treatment of biofouling is simply to remove by mechanical cleaning e.g. by treatment of the fouled surface with high-pressure water jets (Granhag *et al.*, 2004). TBT, Copper, UV irritation, Chlorination, Titanium alloy (2m/sec) and Silicone elastomers (for fast vessels) .Several kinds of natural antifouling agents that inhibit growth of fouling organisms have been isolated from marine organisms like bacteria (Holrnstrom *et al.*, 1996), marine algae (Abarzua *et al.*, 1999).

Conclusion

Several coastal ecosystems along the west coast of India are now thushighly disturbed and threatened, encountering problems like pollution, siltation and erosion, flooding, saltwater intrusion, storm surges and other hazards. Marine biofouling is one of the major unsolved problems currently affecting the shipping industry and industrial aquatic processes in Maharashtra. It is commonly refers to the adverse growth of marine organisms on immersed artificial structures such as ship hulls, jetty pilings, navigational instruments, aquaculture net cages and seawater in taking pipes etc. Hence, appropriate management strategies are needed to ensure the sustainable development and management of coastal

areas and their resources. Land-based industrial and domestic effluents further impact the abundance and composition of marine communities in coastal areas. Very little work has been carried out in India on macro-biofouling communities. Therefore, the present study has been carried out along Dahanu and Tarapur coast near thermal and atomic power plants to assess the macro-fouling pattern, monthly settlement and species dominance between two coastal areas of Palghar, Maharashtra.

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