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Studies on Anthropogenic Stresses Effecting Diversity of Rocky Intertidal Communities of Sindhudurg Coast

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ABSTRACT: Rocky intertidal zone of Sindhudurg district is under continuous anthropogenic pressure due to various activities like overfishing, eutrophication, dumping of waste, incineration of waste, mining, trampling, collection etc. The present study focused on the impact of this anthropogenic forces on diversity of intertidal zone of Kunkeshwar, Malvan and Redi rocky shore. Intertidal diversity of Redi rocky shore was severely disturbed followed by Malvan and Kunkeshwar.

KEYWORDS: Anthropogenic, Malvan, Redi, Kunkeshwar, Diversity, Intertidal

I. INTRODUCTION

Rocky shores are present all over throughout the world's coastline. These are the most comprehensive littoral habitat on coast which are constantly exposed to waves. The term rocky shore is commonly used for shores made up of hard materials such as basalt, granite or limestone due to exposure of the rocky shores to water movements, keeps the rocks free from sediment. The rocky beaches are continuously hit by strong waves which creates holes on rocks. It is biologically rich environment which includes different type of habitat such as steep rocky cliffs, rock pools. This environment has very extreme and fluctuating environmental conditions (Satyam and Thiruchitrabalam. G. 2018).

Interface between sea and terrestrial environment is known as intertidal zone and it is the most productive and dynamic zone of marine ecosystem. Waves and presence of sunlight plays an important role in influencing the life of organisms present in intertidal zone (Datta, et al., 2010). Microenvironment in rocky shores such as cracks, crevices, tide exposed area serve for propagation of species (Benedetti, 2001). Rocky region referred to as intertidal zone of sea coast in which solid rocks are dominant, this type of ecosystem is biologically rich and are natural home of number of marine fauna (Deshmukh, 2013). Several studies are conducted of structural analyse of flora and fauna in intertidal rocky shores (Colman, 1933; Fischer-pipette, 1936). Various species of intertidal organisms in natural rocky shores and artificial sea walls were documented in Sydney Harbour of Australia by many researchers (Chapman, 2003., Wendt, *et al.*, 1989; Whorf, *et al.*, 1995; Bulleri, *et al.*, 2000; Glasby and Connell, 1998; Glasby, 1999).

This original natural habitat is further extended by artificial manmade structures such as jetties, docks, sea walls, dykes etc. These artificial shores generally occur in densely populated areas, industrialised areas as well as in remote rural areas. Different terms are used today to describe disruption of environment and their effect. Continuous input of manmade substances contaminates the environment, but pollution is said to have occurred only if the biological components are affected by the contaminant. Hence anthropogenic stress is referred to as response of biological community to anthropogenic interference. Due to extreme conditions of the intertidal region such as varying salinity, wave action, limitation of space, predation the organisms are tolerant to stress therefore they have ability to withstand stress except under unusual conditions (Light *et al.*, 1975). Even though natural distress can impact the diversity of intertidal community, manmade disturbance can cause imbalance resulting in reduction of diversity of species. Different types of human induced activities such as overfishing, pollution, eutrophication, temperature rise, global warming, mining which impact the open sea are also responsible to disturb the intertidal zone. In addition to these stresses the activities such as trampling and collection of intertidal species such as bivalves, gastropods sea weeds etc. The ecological health of a particular habitat can be determined by biodiversity of that habitat (Vaselli, *et al.*, 2008). Due to human developmental activities and severe climatic changes as well as anthropogenic stress the rocky shore fauna is under threat day by day, therefore it is important to monitor them constantly. The present study was undertaken to study the diversity of intertidal species on Sindhudurg coast and anthropogenic stresses impacting them.

II. MATERIALS AND METHODS

For current study three spots Kunkeshwar, Malvan and Redi Rocky shore were considered (Plate1). Kunkeshwar (Fig-1.1) is a small village located in Devgad taluka of Sindhudurg district along the southward of mumbri creek. It is located at 16.3319⁰ N and 73.3959⁰ E. Kunkeshwar has open type of coastal ecosystem which is composed of sedimentary rocks. The coast has both rocky and sandy shores. Malvan (Fig-1.2) is surrounded by three small creeks viz., Karli, Kolamb and Kanlivali. From Malvan bay the rocky shore extends towards the South up to 16° 00' 00' N 16° 05' 00' N Latitude and 73° 25' 00' E 73° 30' 00' E Longitude. Redi rocky shore (Fig-1.3) is located in Redi village. It lies to the northern part of Goa and southern part of Shiroda. It is located at 15.7402346⁰ N and 73.6769342⁰ E (Parasnis, *et al.*, 2013).

The study was conducted from May 2021 to December 2022. Each site was visited alternately in every two months. sampling was done during morning and evening sessions depending upon the occurrence of low tide. Study was done based on field visits and observations.

PLATE.1

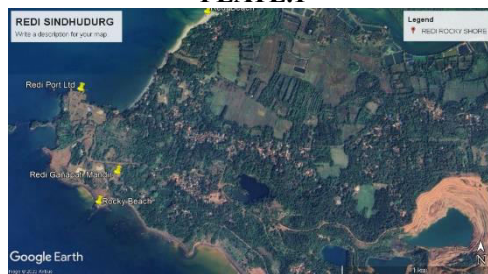


Fig 1.1-site 1 - Redi



Fig 1.2- site 2 - Malvan



Fig 1.3 site 3 -Kunkeshwar



Fig 1.4&1.5 Dead species of intertidal organisms observed along rocky shore



Fig 1.6- Incineration of waste on rocky shore



Fig 1.7- Mining activities in coastal region

OBSERVATIONS

Table. 1- Check list of Intertidal organisms observed in rocky shore

| SR.NO | SCIENTIFIC NAME | COMMON NAME | FAMILY |
|-------|--------------------------------|------------------------------|---------------|
| 1 | <i>Amphiora anceps</i> | red algae | Corallinaceae |
| 2 | <i>Acropora cervicornis</i> | Staghorn coral | Acroporidae |
| 3 | <i>Favia speciosa</i> | Moon coral | Merulinidae |
| 4 | <i>Padina pavonica</i> | Peacock's tail | Dictyotaceaa |
| 5 | <i>Sargassum Sps</i> | Gulf weed /sea holly | Sargassaceae |
| 6 | <i>Green algae Sps</i> | Green algae | |
| 7 | <i>Abudedefduf vaigiensis</i> | Indo-pacific sergeant | Pomacentridae |
| 8 | <i>Oligocottus maculosus</i> | Tidepool sculpin | Cottidae |
| 9 | <i>Grapsus grapsus</i> | Red rock crab | Grapsidae |
| 10 | <i>Pachygrapsus crassipes</i> | Striped shore crab | Grapsidae |
| 11 | <i>Sea anemone Sps</i> | Sea anemone | |
| 12 | <i>Grapsus Sps</i> | Lightfoot crabs | Grapsidae |
| 13 | <i>Pseudominolia Sps</i> | Sea snails | Trochidae |
| 14 | <i>Trochus Sps</i> | Top shaped sea snails | Trochidae |
| 15 | <i>Clypidin notata</i> | Black ribbed false limpet | Fissurellidae |
| 16 | <i>Clypepmorus Sps</i> | Sea snails | Cerithiidae |
| 17 | <i>Turbo bruneus</i> | Brown dwarf turban | Turbinidae |
| 18 | <i>Telescopium telescopium</i> | Telescope snail | Potamididae |
| 19 | <i>Natica Sps</i> | Moon snails | Naticidae |
| 20 | <i>Monodonta lineata</i> | Lined top shell | Trochidae |
| 21 | <i>Planaxis sulcatus</i> | Tropical periwinkle | Planaxidae |
| 22 | <i>Bursa granularis</i> | Granular frog shell | Bursidae |
| 23 | <i>Barnacle Sps</i> | Barnacle | Balanidae |
| 24 | <i>Gafrarium divericatum</i> | Forked venus clam | Veneridae |
| 25 | <i>Nassarius acutus</i> | Sharp nassa mud snails | Nassariidae |
| 26 | <i>Turritella duplicata</i> | Seasnail (gastropod mollusk) | Turritellidae |
| 27 | <i>Monodonta australis</i> | Toothed topshell | Trochidae |
| 28 | <i>Holothuria pardalis</i> | Sea cucumber | Holothuriidae |

| | | | |
|----|---------------------------------|---------------------|--------------|
| 29 | <i>Arenaria interpres</i> | Ruddy turnstone | Charadriidae |
| 30 | <i>Charadrius leschenaultia</i> | Greater sand plover | Charadriidae |

Table. 2- Intertidal species observed in Kunkeshwar, Malvan, Redi

| SR.NO | SCIENTIFIC NAME | KUNKESHWAR | MALVAN | REDI |
|-------|---------------------------------|------------|--------|------|
| 1 | <i>Amphiora anceps</i> | + | - | - |
| 2 | <i>Acropora cervicornis</i> | + | - | - |
| 3 | <i>Favia speciosa</i> | + | - | - |
| 4 | <i>Padina pavonica</i> | + | - | - |
| 5 | <i>Sargassum Sps</i> | + | - | - |
| 6 | <i>Green algae Sps</i> | + | + | + |
| 7 | <i>Abudedefduf vaigiensis</i> | + | + | - |
| 8 | <i>Oligocottus maculosus</i> | + | + | - |
| 9 | <i>Grapsus grapsus</i> | + | + | + |
| 10 | <i>Pachygrapsus crassipes</i> | + | + | + |
| 11 | <i>Sea anemone Sps</i> | + | + | - |
| 12 | <i>Grapsus Sps</i> | + | + | - |
| 13 | <i>Pseudominolia Sps</i> | + | - | - |
| 14 | <i>Trochus Sps</i> | + | + | - |
| 15 | <i>Clypidin notata</i> | + | + | + |
| 16 | <i>Clypepmorus Sps</i> | + | - | - |
| 17 | <i>Turbo bruneus</i> | + | + | - |
| 18 | <i>Telescopium telescopium</i> | + | + | + |
| 19 | <i>Natica Sps</i> | + | + | + |
| 20 | <i>Monodonta lineata</i> | + | + | - |
| 21 | <i>Planaxis sulcatus</i> | + | + | + |
| 22 | <i>Bursa granularis</i> | + | - | - |
| 23 | <i>Barnacle Sps</i> | + | + | + |
| 24 | <i>Gafrarium divericatum</i> | + | - | - |
| 25 | <i>Nassarius acutus</i> | + | + | - |
| 26 | <i>Turritella duplicata</i> | + | + | - |
| 27 | <i>Monodonta australis</i> | + | - | - |
| 28 | <i>Sea cucumber</i> | + | + | - |
| 29 | <i>Arenaria interpres</i> | - | + | - |
| 30 | <i>Charadrius leschenaultia</i> | - | + | + |

OCCURANCE (+) ABSENCE (-)

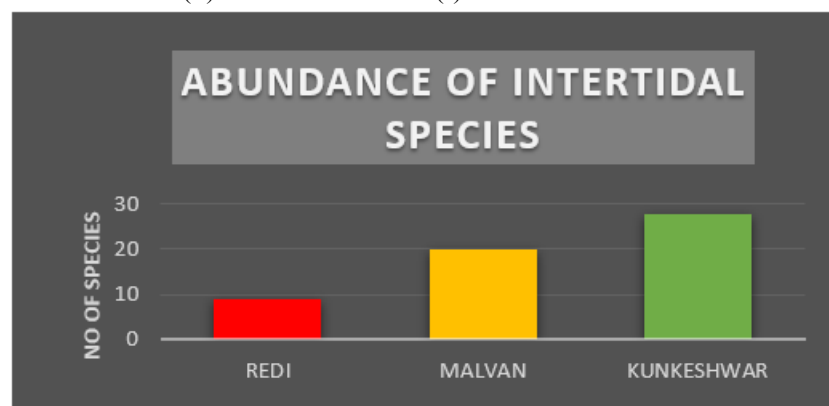


Fig-1.8 Abundance of intertidal species at 3 selected study sites

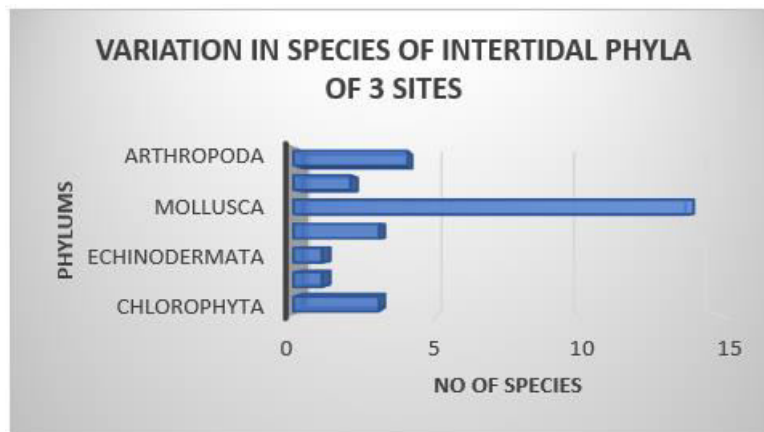


Fig 1.9-variation in species of intertidal phyla of 3 sites

III. RESULTS AND DISCUSSION

Sindhudurg district has vast coast line and it is rich with various types of habitats such as rocky, sandy, marshy etc. Diverse floral and faunal species inhabit this habitat. Current study was done to study the diversity of intertidal rocky shore organisms at Kunkeshwar, Malvan and Redi rocky shore and impact of anthropogenic stresses on diversity of intertidal biota. Variation in number of intertidal species was observed in all three sites.

Total 30 intertidal species belonging to 23 families and 7 phyla (Chlorophyta, Rodophyta, Arthropoda, Echinodermata, Chordata, Mollusca, Coelentrata) were recorded during the study which consisted of 4 algal species, 2 coral species, 1 species of sea anemone, 1 species of sea cucumber, 2 species of birds, 2 species of fish, 3 crab species, barnacle species, 2 bivalve species, 12 gastropods (Table 1 and 2). Phylum Mollusca was most dominant followed by Arthropoda, Coelentrata, Chlorophyta, Rodophyta, Echinodermata and Chordata (Fig 1.9). Kunkeshwar rocky shore had good diversity of species as compared to Malvan and Redi.

Total 28 species of intertidal organisms along with algal species were documented at Kunkeshwar rocky shore. At Malvan rocky shore total 20 species were recorded and at Redi site only 9 intertidal species were observed (Table 2 & Fig 1.8).

Site selection was done on the basis of dominance of human induced forces in areas. The coastal shore of Redi has undergone extreme mining activities (Fig-1.7), which has led to erosion of the coastal area. Mining has also critically disturbed the intertidal zone. The rock pools were distinctly observed which are the major habitat of intertidal species. The zone is mostly seen to be under water during high and low tide. Coastal area of Redi is accommodated with temple where several devotees visit every day. Therefore, this region is under constant pressure of tourist activities which makes the rarely available intertidal species susceptible to trampling by humans. Area is also dumped with plastic waste such as wrappers, bottles etc. Number of fishing net debris were also observed in this region. Number of dead species of hermit crabs and a turtle species was observed during the visit (Fig 1.4, 1.5). This region was dominated with barnacle species. Thus, least species of intertidal organisms were observed in this site. Malvan which is major spot of tourist attraction of Sindhudurg is also under immense stress of human encroachment. The area is also dumped with plastic waste, nets and other materials like bags, sandals, cans etc. Incineration of solid waste was observed in this region which can also cause destruction of intertidal zone (Fig 1.6). Collection of intertidal species such as molluscan shells, algal species as a memento was commonly observed in this region. Collection of intertidal species for using them as a fishing bait by local people was also observed. This activity also has adverse impact on abundance of species. Abundance of algal species such as sargassum, Padina, has also declined in this region. Kunkeshwar rocky shore is also under human pressure due to religious activities performed at Kunkeshwar temple which is situated at the edge of the rocky shore. Construction of roads, dykes, small shops has led to destruction of this region. Observations suggest that among the three selected spots Kunkeshwar rocky shore was moderately affected by human induced forces as compared to Malvan and Redi. These observations indicate that all three sites selected for the study purpose are under anthropogenic pressure. Thus, immediate attention is required to conserve the intertidal biodiversity and protect it from further deterioration.

Similar studies were conducted on intertidal zones of various regions by number of researchers. Bhadja, *et al.*, (2014) studied the impact of anthropogenic activities on intertidal organisms of Kathiawar peninsula coast of India. He documented 60 species intertidal macrofauna which included 3 species of Porifera, 8 species of Coelentrata, 5 species of



Annelida, 6 species of Arthropoda, 35 species of Mollusca and 3 species of Echinodermata. In his study Mollusca were dominant and Coelenterate was least observed. The values of richness, Diversity, and evenness indices were low in this study site. Deshmukh, (2013), has studied the biodiversity of rocky shore at Kunkeshwar region of Sindhudurg, this study stated that Kunkeshwar region was rich in marine invertebrates before 2011 but due to various construction activities the diversity has reduced to some extent. Anthropogenic pressures can affect the physiological state of animal it may cause changes in several life process like growth rate, mortality, reproduction therefore impact of this can easily be identified as there is difference in number and types of animals in disturbed and undisturbed areas (Tablado, *et al.*, 1994; Ng and Keough, 2003; Johnston and Keough, 2000; Bryan, *et al.*, 1986). Sarojini *et al.*, 1989; Lundebye *et al.*, 1997, have studied the impact of pesticides such as organochlorides on intertidal organisms. Beauchamp and Gowing (1982) studied the impact of human trampling on intertidal organisms. His study concluded that the sites having less human attendance showed abundance of intertidal species. Impact of collection on intertidal species was studied by (Murray *et al.*, 1999). Studies on rocky shore fauna of Andaman and Nicobar region showed that there was decline in abundance and diversity of rocky shore fauna due to tourist activities, Aquaculture effluents (Satyam and Thiruchitrabalam. G. 2018). Collection of mussels, crabs, clams and other molluscs from the intertidal region of Andapather, Burmanallah, Science centre and Kodiyaghat by visitors resulted in disturbance of intertidal community. These regions showed variation in diversity, richness and evenness of intertidal species due to human pressure. Science centre and Kodiyaghat were severely affected as compared to other two areas. (Satyam and Thiruchitrabalam. G. 2018).

IV. CONCLUSION

Sindhudurg coastline now is a major point for tourist attraction. Various organizations are setting up to develop the tourism industry in this region. On one hand it is of great benefit as it is providing employment opportunities and it is also supporting the revenue economy of the country. But on the other hand, due to expansion of this industry number of developments are being made along the coastal regions, mainly construction of hotels, guest houses for residence, development of various aqua sport for tourist entertainment, roads constructions. Along with all this infrastructural development, lot of pollution is caused due to various commodities such as plastic bags, bottles, food wrappers used by tourist as well as the local people residing in these areas. This is severely impacting the coastal zone by degrading its habitats and the biota residing this habitat. Proper measures should be taken to conserve this ecosystem.

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