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Marine Macroalgae Diversity at Bhuigaon Coast, District Palghar, Maharashtra

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Abstract: **Algal biodiversity is dynamic and varies a lot from region to region, coast to coast and time to time. This biodiversity and intertidal zonal distribution study was carried out at a small coastal area away from the regular tourist zones near metropolitan Mumbai area, at Bhuigaon in Palghar district of Maharashtra. The study gives input in the distribution pattern of different division of algae with respect to different intertidal zones of sea area. The study indicated that the high tide zone and the middle tide zones of the coastal rocky beach is the site of maximum algae occurrence with 35 % and 40 % occurrence percentage. The study also indicated this zone to be very rich in members of Rhodophyta as total 8 genera are found to be present here. *Enteromorpha,* a member of Chlorophyta was the only most frequent genera with a frequency of 75%. It was observed that algae are very specific in their occurrence at specific zones in the intertidal coastal area. As many as 11 genera of total 15 had least frequency of 25% and presence in only one of the zones specific for their growth and development.**

Index Terms: **Algal Diversity, Bhuigaon, Frequency Distribution, Intertidal zones, Marine Macroalgae.**

I. INTRODUCTION

India has over 8000 km of its coastal shoreline distributed among 9 coastal states, 2 union territories and 2 of its island territories. Total 11 % of this length constitutes rocky beaches which are considered as a rich biodiversity regions for marine macroalgae. Maharashtra being one of the coastal states has 720 km stretch of coastal land of which 37% constitutes the rocky beaches (Venkataraman & Wafar, 2005). Indian coastal region has around 865 species of marine algae from 217 reported genera. From this data Maharashtra contributes to around 159 species from 79 genera (Rao & Gupta, 2015).

Algal biodiversity is dynamic and varies a lot from region to region, coast to coast and time to time. Biodiversity of marine macroalgae at various coast in Konkan has been studied by different researchers in their studies. Raigadh coast shows 44 marine algae (Ambhore & Whankatte, 2016), Malvan and Kunkeshwar coast shows 40 genus (Rode & Sabale, 2015). Borli reportedly have 27 genus (Kurve, 2012), Dapoli had 34 genus (S.S. & Mishra, 2014), 16 genus of marine algae were found from Uran coast (Pawar & Al Tawaha, 2017). Sand dunes of Kokan coast shows presence of around 40 genus of marine algae reported by (Gole, 2007). Similar studies were also done on other beaches of India. On Dwarka coast a study revealed presence of 39 genus of marine algae (Kalasariya et al., 2020). In Tamilnadu 37 genus were reported (Sahayaraj et al., 2014). From Digha coast, West Bengal 5 genus were reported from green algae (Yadav & Majumdar, 2020). In another of such a study on Vishakhapatanam coast 31 genus of algae were reported (Lakshmi & Narasimha Rao, 2009). Their diversity varies from zone to zone. The algae found in coastal region is dominated by Rhodophyta (Waghmode, 2017).

It is also been observed that few of the regions have garnered attention of researchers more than compared to some lesser known and unapproachable areas which also need there mention in the good books of biodiversity (Mantri et al., 2020). One of these is a scenic and yet undisturbed beach of Bhuigaon, at Palghar district near the metropolitan shore of Mumbai. This small patch of rocky beach has been yet unexplored as far as macroalgae diversity is considered. The region also harbours many fresh water bodies and in a study of microalgae 23 species of microalgae were reported from this region (Pandey & Kejariwal, 2019). In our present study we have selected this site and have explored the diversification of macroalgae species with respect to their distribution along the vertical stretch of the beach and explored possibilities of the area to be a rich biodiversity hotspot for macroalgae commonly referred as seaweeds.

Fig. 1. Bhuigaon Beach: Red star mark indicating the rocky intertidal patch. Source: Google maps

Bhuigaon is in Vasai taluka of Palghar District, Maharashtra, on western coast of India around 70 km from Mumbai Central and 50 km from International airport. It lies between the coordinates 19.382627 N, 72.75408 E. It is mostly a sandy beach connecting between Vasai and Virar region of Palghar District with a small rocky patch in between. The width of the rocky patch is around 800 meters from sea front near the Rangaon area.

II. MATERIAL AND METHODS

A preliminary survey of the site were done before actually starting with the collection and statistical analysis. Tide time were analyzed and the lowest low tide during the daytime was selected as the preferred time of algal analysis.

A. Site of Study

The site selected is a rocky patch of Bhuigaon beach, Palghar district about 9 km from Vasai Road railway station which is a closest railway station on western railway. The site shows various rocky patches spread between Bhuigaon and Rangaon village area of Vasai Taluka. The time selected was the lowest low tide to get maximum intertidal zone available for collection. The red star mark indicates the rocky region of the beach in Fig.1. Time for lowest tidal zone was selected as median (Tide Times and Tide Chart for Mumbai).

The intertidal region is designated into 4 zones i.e. spray zone (Z1), high tide zone (Z2), middle tide zone (Z3) and low tide zone (Z4) (NOAA). All the 4 zone showed distinct variation in their topography due to exposure caused by tides and their geographical terrain. Spray zone has maximum sunlight and wind available while low tide zone has minimum. Sea front is always covered by ocean water. The zones were laid based on the time of tide. The time taken between consecutive high and low tide is about 6 hours and 12 minutes, hence the zones were divided by distance covered by tide in 1 hour and 33 minutes approximately. The intertidal zone could clearly be divided in the 4 zones and the differences in the terrain were quite

Fig. 2. The intertidal zones Spray Zone Z1, High Tide Zone Z2, Middle Tide Zone Z3, Low Tide zone Z4.

prominent due to the differential light intensity and effect of water current. Fig. 2 indicates the different zones at Bhuigaon beach.

B. Quadrat Analysis

The frequencies of various algae were calculated using frequency distribution method. The belt transect of about 50 m from seafront to sea beach were taken at the interval of time of tide i.e. 1 hour and 33 minutes, using transect method (McIntyre, 1953). Fig. 2 shows the 4 distinct zones and their geography. The google image clearly shows the distinct features varying from each zones. From each of the belt area three quadrats were taken for regeneration of better results. The area of quadrats and

Table I. Zonal Division of Intertidal Region at Bhuigaon Coast

Zone	Distance	Tide Time (Tidal Cycle)*	Belt Transect Quadrat (20 meters x Length)	Area Sampled (meter$^{2)}$	Land Form
Spray Zone	500-800 meters	6 hrs 12 min	Q1	20x300	Sandy
High Intertidal Zone	250-500 meters	4 hrs 39 min	Q2	20x250	Intermittent Rocky
Mean sea level (MSL)					
Middle Intertidal Zone	125-250 meters	3 hrs 06 min	Q3	20x125	Rocky with low gradient
Low Intertidal Zone	0-125 meters	1 hrs 33 min	Q4	20x125	Rocky with high gradient
Sea Front - 0 meter					

their terrain form is summarized in the Table No. I. The largest

area is under Z1 in spray zone hence the area of quadrats were taken accordingly as 20 m at whole length of the zone. Three quadrats were covered in each zone for result accuracy and to cover maximum area for study. Frequency distribution and percentage occurrence of individual algae were calculated by frequency distribution method (Gravetter & Wallnau, 2012).

C. Collection and Identification

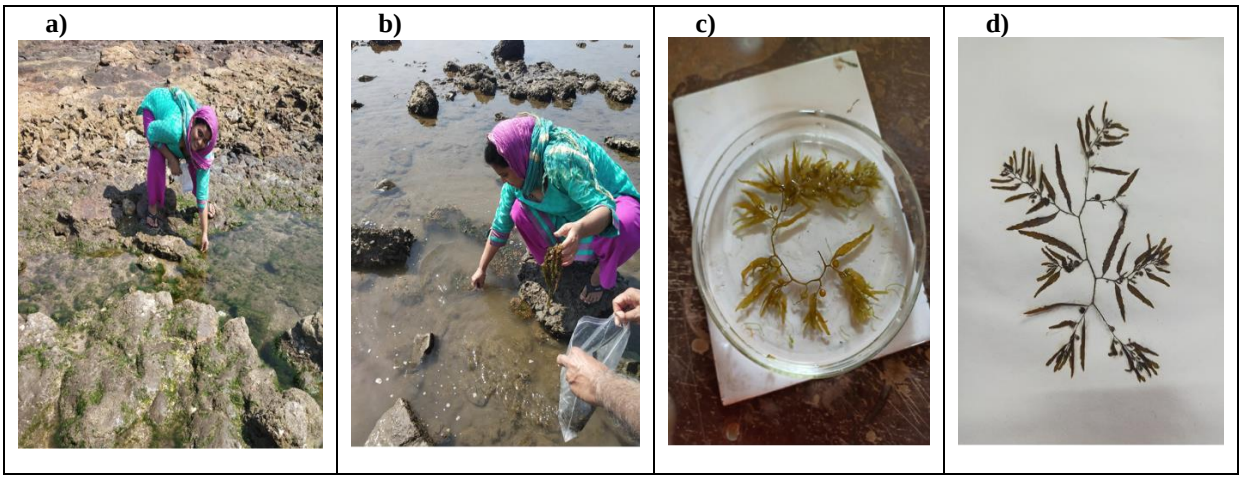

Fig. 3. The process of algae collection and preservation. a) Collection of macroalgae at Bhuigaon coast. b) Primary cleaning of collected algae at site with seawater. c) Final cleaning of macroalgae with distilled water at laboratory. d) Preparation of herbarium for preservation and identification purpose.

Macroalgae were collected manually during the month of February 2019.They were washed with seawater and stored in plastic polybags. They are stored in 4% formalin solution in plastic containers for further use. These were brought to the laboratory, cleaned and herbarium were prepared. The genus of algae were identified based on references and keys available(Ambhore & Whankatte, 2016), (Rao, 1987) and also from e-herbarium Common Seaweeds and Seagrasses of India Volume I & II by Central Marine Fisheries Research Institute (CMFRI), Kerala (Manisseri et al., 2012). The complete process is shown as photographs in each step in the Fig. 3.

III. RESULTS AND DISCUSSION

The current survey of marine algae at Bhuigaon shows presence of 15 genera of marine macroalgae distributed in 3 divisions of algae. Division Chlorophyta has 3 genera, division Phaeophyta 4 genera and division Rhodophyta showed presence of 8 genera. We can observe that number of genera for the members of Rhodophyta are double than compared with other two divisions as observed by (Dhargalkar & Deshmukhe, 1996; Waghmode & Deshmukh, 2019). The Table No. II. enlists the frequencies of algae found on various quadrats. We can observe that the pattern of distribution among the different types of algae varies significantly. *Enteromorpha*, from Chlorophyceae was found to be present in maximum number of quadrats with highest frequency (75%) recorded among all genera observed. Followed by *Chaetomorpha* in Chlorophyceae and *Spatoglossum* in Phaeophyceae and *Gracillaria* in Rhodophyceae members with 50 % frequency. Rest all of the algae were present only in any one of the quadrats hence indicating lowest of the frequency (25%).

Members of Chlorophyta were found in higher tidal zone (Z2) and middle tide zone (Z3). Phaeophyta members were observed in all zones except Z2 High tide zone whereas Rhodophyta members were seen in middle and low tide zone. Macroalgae show very specific intertidal zonal diversity. *Sargassum* was found only in spray zone. It was also noteworthy that most algae genera were found confined to any one particular zone in the coastal region. As many as 11 out of total 15 genera has frequency as low as 25 %. *Ulva* from green macroalgae, *Dictyota, Dilophus, Sargassum* from brown algae and *Acanthophora, Agardhiella, Amphiroa, Galaxaura, Gelidium, Portiera, Hypnea* belonging to red macroalgae were present only in any one quadrat each. Fig. 4 indicates zone wise distribution of different division of algae.

The occurrence of different genera according to their zones is depicted in Fig. 2. It was observed that the middle tidal zone showed maximum of the macroalgae occurrence with 40 % of total algae genera being present here. This zone could be termed as the zone with maximum biodiversity for macroalgae. High tide zone show presence of 35 % of total macroalgae appearing in these patches. Spray zone accounts for least number of algae presence with only 5 % occurrence shown in this zone.

According to the percentage of presence of the algal genera observed at different tidal zone, best time for biodiversity study to be conducted would be the lowest low tide where the high tide and middle tide areas will be approachable for biodiversity study. During this time the maximum algal biodiversity can be found.

Table II. Frequency Distribution of Marine Macroalgae at Bhuigaon coast in different intertidal zone

Sr. No.	**Name of Macroalgae**	**Name of Quadrat , species occurs**				**Total number of quadrat in which species occurs**	**Total number of quadrat sampled**	**Frequency (Q/S x 100)**
	Genus	Z1	Z2	Z3	Z4	(Q)	(S)	%
	Chlorophyceae							
1	*Chaetomorpha*		✓	✓		2	4	50
2	*Enteromorpha*		✓	✓	✓	3	4	75
3	*Ulva*				✓	1	4	25
	Phaeophyceae							
4	*Dictyota*				✓	1	4	25
5	*Dilophus*			✓		1	4	25
6	*Sargassum*	✓				1	4	25
7	*Spatoglossum*			✓	✓	2	4	50
	Rhodophyceae							
8	*Acanthophora*		✓			1	4	25
9	*Agardhiella*		✓			1	4	25
10	*Amphiroa*		✓			1	4	25
11	*Galaxaura*		✓			1	4	25
12	*Gelidium*			✓		1	4	25
13	*Gracillaria*		✓	✓		2	4	50
14	*Portiera*			✓		1	4	25
15	*Hypnea*			✓		1	4	25

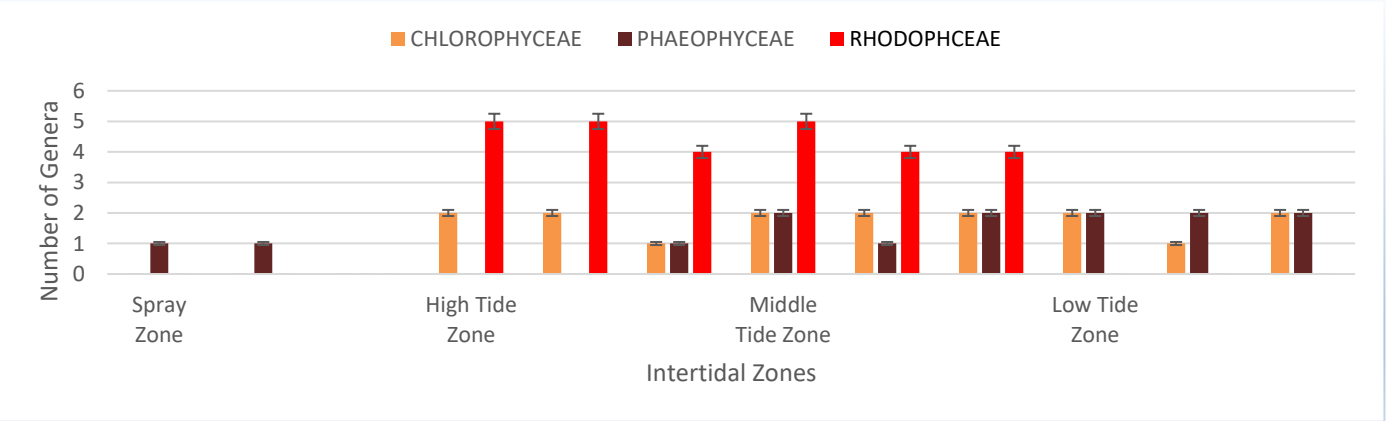

Fig. 4. Distribution of Macroalgae Genera in Different Intertidal Zones at Bhuigaon

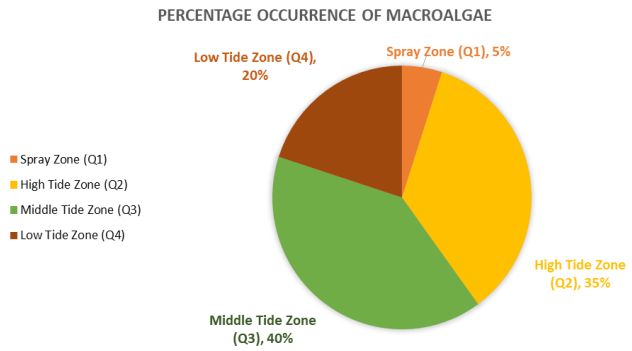

Fig. 5. Percentage Occurrence of Macroalgae at Bhuigaon

IV. CONCLUSION

In a preliminary checklist for macroalgae at Bhuigaon beach (Gupta, 2019) have found total of only 9 genus of macroalgae. In which 2 genus belonged to Phaeophyta, 3 genus belonged to Chlorophyta and 5 genus were from Rhodophyta. Here also it is evident that Rhodophyta members predominate the coastal region as found in our study also. We can see from the number of macroalgae reported from our study that the number have increased over the period. Bhuigaon comes under the rural area in Dstrict Palghar. Conservation and biodiversity preservation becomes utmost important for the local fisheries community as these macroalgae serve as primary producer of the ocean. (Falkowski & Knoll, 2007). Many of the macroalage we have identified are of immense economic importance and should be promoted for the better opportunity of the community. *Sargassum* and *Ulva* are used as animal feed. These two green macroalgae can be used as a nutritional boosters for animal husbandry and aquaculture in the area as they have been reported to have high protein and nutritional content. (Maehre et al., 2014). *Dictyota* and *Sargassum* are a good source of bio-fertilizers. Addition of these as either wet or dried biomass increases soil moisture and subsequently soil-fertility. (Zodape, 2001). Alginates, algin and agar are some important phycocolloids derived from red macroalgae like *Gellidium, Gracillaria, Acanthophora* which are extensively used in food industry as gelling and setting agents (Pangestuti & Kim, 2015).

Seaweeds have been reported to have various importance and uses for the purpose of human development. Since India has a large population residing and being dependent on its ocean, seaweed industry has very high potential for employment generation. Post covid being independent in raw material requirement becomes almost mandatory. Small areas like Bhuigaon need attention and could be developed as a raw material hub for such enterprises. There are various companies which are already in business of seaweed products. There are schemes and opportunity to encourage seaweed utilization and cultivation. We can conclude that with such areas under exploration, special focus will be on employment generation activities and being self-reliant.

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