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Effect of grazers on seaweeds along the Shrivardhan and Alibag Coast, Mumbai, Maharashtra, India

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Abstract

Intertidal communities, at Shrivardhan and Alibag were studied to understand their inter-dependence and co-existence as well as food preferences of the grazer communities. The present study was conducted at rocky and sandy shore of Shrivardhan (18°02'00"N 73°01'00"E) and Alibag (18°38'29"N 72°52'20"E). The physico-chemical parameter of intertidal water varies significantly at both stations. 22 seaweed species were recorded from Shrivardhan, mostly filamentous seaweed and Rodophycae in more amounts (45%). Alibag contributes 6 varieties of Seaweed species mostly fleshy thallus and equal in number. The highest seaweed biomass (wet wt.) was recorded in (703.47 gm/m^2) and (174.6 gm/m^2) in January and lowest 30.2 and 3.11(g/m^2) in October at the sampling site of Shrivardhan and alibag respectively. Intertidal organism biodiversity at Shrivardhan was higher (34 sp.) compared to Alibag where 32 organisms were found. Organisms at Shrivardhan were observed more often grazing on seaweed turfs than at Alibag. Euchelus tricarinata has shown a preference towards mix diet consisting Enteromorpha sp., Ulva sp. and Sargassum sp. whereas Nerita oryzarum preferred for Ulva and Enteromorpha. Enteromorpha sp. was being graze much faster than any other seaweed species used for laboratory feeding purpose. Some of the other important grazers are Planaxis sp, Clanculus sp, Bursa sp and Trochus sp. This study may helps to investigate the factors contributing to herbivory and abundance/reduction of benthic macro algae and molluscans and vice-á- versa.

Keywords: Grazers, Seaweeds, Alibag, Shrivdhan and Mumbai coast.

Introduction

Intertidal ecosystems are the areas where different communities including plants and animals live between the low and high tide lines. Studies on these communities are essential since they form important food chain in this vibrant ecosystem. The vertical zonation as described by Stephanson[1] demarcates the population distribution and dominance.

Several marine biologists emphasize on biological interactions e. g. grazing, space competition, etc. as being significant factors in determining the vertical distribution of intertidal communities[2-5]. The distribution of the organisms in different tidal zones is mainly a result of species tolerance towards desiccation and biological interactions[6]. The effects of waves on elevating or lowering the vertical distributions of various intertidal organisms are well documented[7,8].

Seaweeds are important components of coastal ecosystems that grow mainly in the intertidal region. They are the food for small crustaceans, fish, grazers and other herbivores. Documenting their distribution and understanding the physical and biological processes is important. Seaweeds are ecologically as well economically important marine plants. Indian coast harbours around 844 seaweeds species belonging to Chlorophyta, Phaeophyta, and Rhodophyta[9]. Grazers are herbivorous animals that eat grass and other vegetation for nourishment. Some of them can eat any vegetation as long as it is green and are known as bulk grazers. Others are very selective and will eat only particular types of vegetation.

In view of the importance of the relation between the grazer community, seaweed biomass and its ecological balance, it is necessary to understand the grazing benthic community structure and its possible effect on the other community.

Materials and methods

Intertidal area of srivardhan and intertidal area of Alibaug are situated in Raigarh district of state of Maharashtra, the west coast of India.

The intertidal areas of both are exposed during lower tidal condition and filled during high tidal condition. Geographically srivardhan is located on Cordinates 18°02′00″N 73°01′00″E / 18.0333°N 73.0167°E / 18.0333; 73.0167 And Alibaug is located about 100 km south of Mumbai, at 18°38′29″N 72°52′20″E. The average elevation is 0 metres (0 feet) both the above intertidal areas are rocky and sandy (mix type). The distance between both beaches is 91km.

Findings: Study Site, Water Analysis, Intertidal Biodiversity, Grazing Experiment, Gut Content Analysis.

Water Analysis: Physical Parameters: i. Dissolved Oxygen (DO), ii. Salinity, iii. pH, iv. Temperature (air or water), v. Nutrient analysis, vi. Phosphate test, vii. Nitrate test.

Intertidal Biodiversity: i. Sampling along Intertidal Area, ii. 25 x 25 cm quadrats, iii. Three transect consisting nine quadrats in each, iv. Fresh and dry biomass were determined, v. Statistical analysis was carried out using, vi. Software-PRIMER v 6, vii. Microsoft Excel 2010.

Figure-1: Observe the salinity of sea water.

Results and discussion

The total biomass (wet wt.) of recorded seaweed species along Shrivardhan intertidal area during study period was found to be about 1981.51 gm/m^2 and in Alibag the total seaweed biomass (wet wt) was recorded around 330.62 gm/m^2 during the sampling period.

The present study along Shrivardhan and Alibag intertidal area on total seaweed biomass shown distinct patterns of distribution. In Shrivardhan the highest biomass (wet wt) was recorded in the month of January (703.46 gm/m^2) and lowest (29.2 gm/m^2) in the month of October. In Alibag intertidal area the maximum total biomass (wet wt) was recorded in January (174.6 gm/m^2) and minimum was recorded in the month of October (3.11 gm/^{2}).

Inter-relationship between seaweed and the faunal species: There is marked appearance of seaweed assemblages along mid and low shore area in the sampling site. MDS Distribution of the organism along the site was prepared to evaluate the inter-relationship in natural habitat. The Dendrogram has brought out the co-existence of the intertidal benthic fauna and flora in the habitat.

Table-1: Cumulative occurrence of fauna at both sampling station.

Species	Shrivardhan	Alibagh
Aplysia benedicti	9	0
Astrea stellata	7	8
Barnacle	117	114
Bursa granularis	32	0
Bursa verrucosa	4	0
Bursa tuberculata	55	6
Cantharus spiralis	0	6
Cellana radiate	48	10
Cerithidea cingulate	65	94
Cerithium morus	38	109
C. rubus	89	28
Clanculus sp.depticus	22	60
Conus figulinus	3	0
Copepoda	100	52
Small crab	8	0
Drupa konkanensis	32	0
Drupa subnodulosa	54	32
Drupa tuberculata	35	50
Euchelus Tricarinata	23	8
Foraminifera	295	498
Gastropods juvenile	50	87
Gafrarium divaricatum	0	9
Hermit crab	0	33
Insect larvae	171	188
Melampus fasciatus	0	6
Nerita oryzarum	91	81
Oyster	148	111
Oliva nebulosa	0	27
Planaxis sulcatus	138	62
Planaxis similis	9	0
Prawn larvae	571	442
Pyrene atrata	33	57
Sea anemone	54	0
Oyster spat	851	203
Star fish	5	0
Thias blanfordi	2	3
Thais bufo	12	0
Thais lacera	0	19
Thias rudolphi	15	0
Thias tissoti	68	39
Trochus radiates	0	27
U. vestiarum	0	17

Table-2: Month wise occurrence of seaweed along Shrivardhan intertidal area.

Species	Oct.	Nov.	Dec.	Jan.	Mar.	Apr.
Rhodophyta						
Amphiroa fragilissima	+	+	+	+	+	+
Centroceras clavulatum	-	-	+	-	-	-
Ceramium sp.	-	-	-	+	-	-
Cheliosporum sp.	-	-	-	+	-	-
Chondria armata	-	-	-	+	+	+
Gelidium sp. sp.	+	+	+	+	-	-
Heterosiphonia crispella	+	-	-	+	-	-
Laurencian flageliformis	+	-	-	-	-	-
Polysiphonia sp.	-	-	-	+	-	-
Rhodymenia sp.	-	-	+	-	-	-
Phaeophyta						
Colpomenia sinuosa	-	-	+	+	-	-
Dictyota dichotoma	-	+	+	+	-	-
Padina tetrastromatica	+	+	+	+	+	+
Sargassum cinectum	+	+	+	+	+	+
Sargassum cinereum	+	+	+	+	+	+
Stoechospermum marginatum	-	+	+	+	+	+
Sphacelaria sp.	-	-	-	-	+	+
Chlorophyta						
Cladophora	-	-	-	-	+	+
Enteromorpha sp.	+	+	+	+	-	-
Rhizoclonium sp.	-	-	+	+	+	-
Ulva lactuca	+	+	+	+	+	+

Note: Sampling was not done in February month.

Table-3: Month wise water quality parameter in the intertidal water at Shrivardhan.

Month	DO,	Salinity,	Ph	Air temp.	Water temp.	Nitrate	Phosphate
Oct.	2.6	36	7.5	31.5	30.5	0.52	1.16
Nov.	2.8	34	7.7	33	30	0.45	1.19
Dec.	3.2	36	7.8	30	27	0.48	1.23
Jan.	2.8	35	7.6	27	24	0.51	0.81
March	2.4	35	8	32	30	0.41	1.17
Apr.	2.4	36	7.9	30	31	0.38	0.78

Table-4: Month wise occurrence of seaweed along Alibag intertidal area.

Species	Oct	Nov	Dec	Jan	Mar	Apr
Rhodophyta						
Ahnfeltia plicata	-	-	-	-	+	-
Gelidium sp.	-	-	-	-	-	+
Phaeophyta						
Padina tetrastromatica	-	-	-	+	-	-
Sargassum cinereum	-	-	+	+	-	-
Chlorophyta						
Enteromorpha flexuosa	+	+	+	+	+	+
Ulva lactuca	+	+	+	+	+	+

Table-5: Month wise water quality parameter in the intertidal water at Alibag.

Month	Physical Parameter					Nutrients	
	AT(^{o}C)	WT(^{o}C)	Salinity (‰)	pH	DO(mg/l)	Nitrate (NO3-N)	Phosphate (PO4-)
Oct.	31	31	35	7.8	2.6	0.44	1.12
Nov	32	30	34	7.6	2.4	0.39	1.15
Dec	29.5	28	35	7.8	3.2	0.40	1.33
Jan	28	27	35	7.9	3.0	0.43	0.97
Mar	28	29	36	7.8	2.8	0.36	1.02
Apr	29	31	35	7.7	2.8	0.33	0.72

Table-6: Occurrence of seaweed fragments in the gut of experimental organism.

Treatment	No. of *N. oryzarum*			No. of *E. tricherinata*		
	Sem. Digt	Digested	Empty	Sem. Digt	Digested	Empty
T-1(Ulva sp.)	5	3	12	10	2	8
T-2(Enteromorpha sp.)	5	0	15	15	0	5
T-3(Sargassum)	3	2	15	6	0	14
T-4(Ulva sp.+Ent+Sarg)	7	0	13	16	0	4

Table-7: Seaweed preferences of *Euchelus tricarinata.*

Preference Ranking	Chlorophyceae	Phaeophyceae
High	*Enteromorpha sp.*	-
Medium	*Ulva sp.*	-
Low	-	*Sargassum sp.*

MDS Distribution of the organism along the site was prepared to evaluate the interrelationship in natural habitat (Figure-2). The Dendrogram has brought out the co-existence of the intertidal benthic fauna and flora in the habitat (Figure-3).

The results of the MDS shows that Grazers and seaweed were found to scatered at the site of Shrivardhan but all they are related to the preference or choice basis of the grazers, the result shows that green seaweed was the most preffered by the grazers followed by brown and red seaweed.

Results of the MDS show that all seaweed are closely related to the grazers, At Shrivardhan site grazers are preferred all seaweed as a food, here C1, C2, P1 and R1 which are coded the name of seaweed Enteromorpha sp., Ulva lactuca, Padina tetrastromatica and Amphiroa fragilissima are closely related to grazers.

Discussion: Effect of Grazers on Seaweed distribution and biomass issue has been acknowledged worldwide by most of the professionals and institutions. In ultimate applications, the issue is about maintaining ecological or environmental health or balance between grazers and seaweed biomass while producing necessary renewable resources. This inter-relationship studies and distribution pattern have become an essential component of ecological studies because the earth's species are disappearing or coming close to extinction at an alarming rate and there is a real possibility of entire ecosystem being disappear. In developing countries like India, These issues have gained momentum in the recent years, but very few attempts have been made to assess the effect of grazers and present status of seaweed distribution and this marine renewable resource assessment is essential for future planning for its conservation ecosystem.

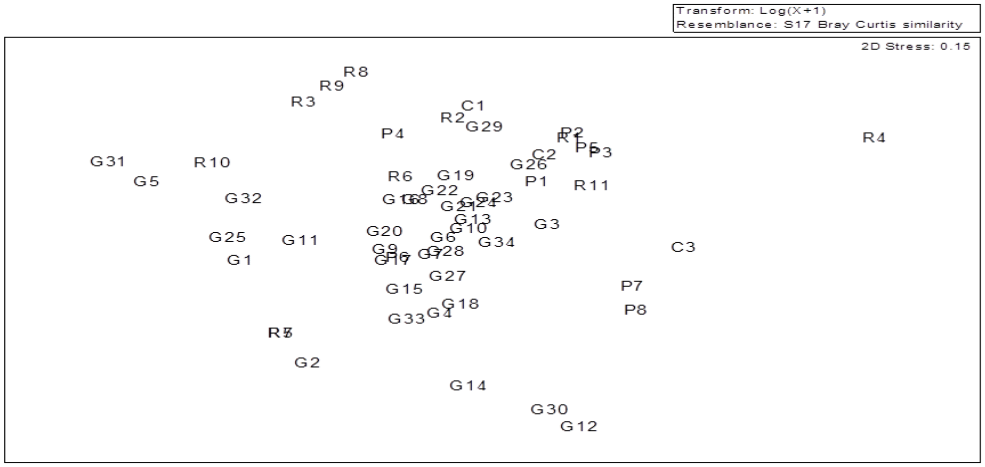
The present study results on abundance and diversity of Intertidal fauna showed that the sampling site at Shrivardhan is richer in abundance and diversity (Figure-5). This might be because of more number of grazing fauna and also the food preferences of them are different (Figure-4). The grazing fauna prefer ephemeral and tender seaweed species such as *Enteromorpha sp.* and *Sargassum* which are in abundant at Shrivardhan.

Grazer diversity can be a primary estimator of Seaweed diversity and vice versa[10]. Gradual changes in Seaweed communities have been recorded following exclusion of grazers[3].

Table-8: Loss of seaweed weight during grazing experiment.

Seaweed Species	Weight Loss of Seaweed (g)				
	7 Days	8-14 Days	15-21 Days	22- 28 Days	29- 35 Days
Ulva sp.	2.184	2.734	2.658	2.479	2.139
Enteromorpha sp.	2.347	2.483	2.326	1.937	1.627
Sargassum sp.	2.259	2.891	2.704	2.582	2.206
Ulva sp. + Ent + Sarg	2.305	2.647	2.511	2.391	1.849

Sem. Digt-Semi digested, Ent- *Enteromorpha sp.,* Sar-*Sargassum*



R =Rhodophyceae; P=Phaeophyceae; C =Chlorophyceae (seaweed); G=gragers
Figure-2: MDS for Grazers and Seaweed Relaionship at Shrivardhan.

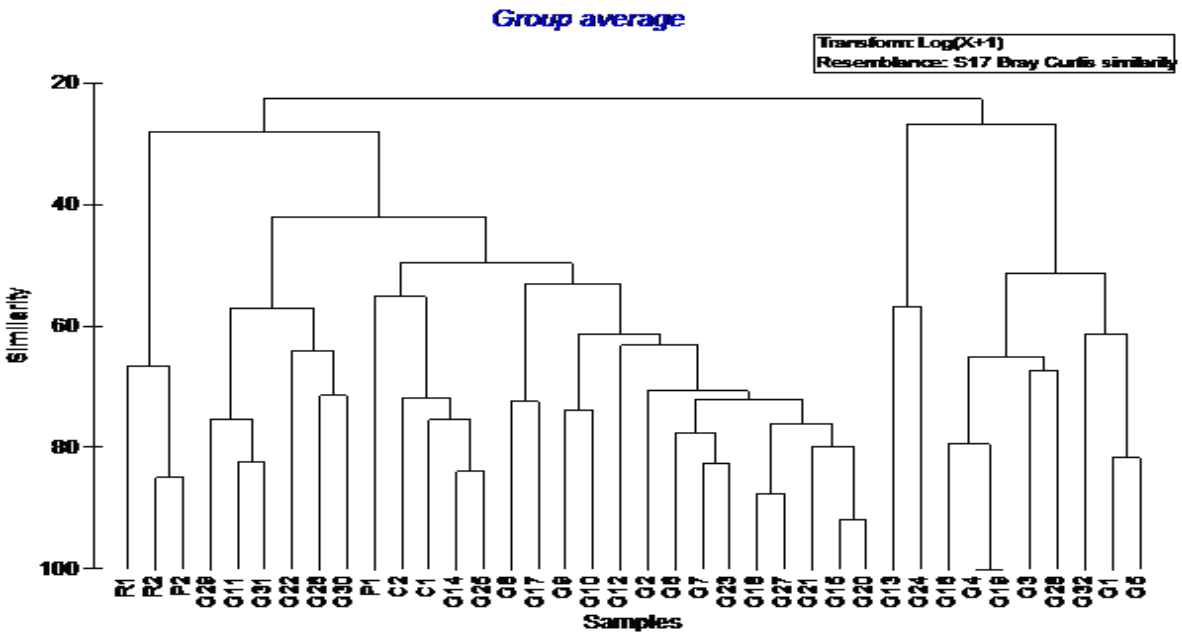


Figure-3: Dendrogram Based on relaionship between grazers and seaweed at Alibag.

Figure-4: Barnacles and other Grazers associated with seaweed.

Figure-5: Seaweed Density at Shrivardhan.

Conclusion

The present study pursues interaction between grazing Fauna and intertidal seaweed to determine the factors contributing to the successful domination of the low levels of the shore by Seaweed and the lack or reduced density of grazing limpets at this low level, decline the abundance of intertidal grazers at the low shore level. This hypothesis also supported by Underwood and Jernakoff[11].

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