AMERICAN-EURASIAN JOURNAL OF SUSTAINABLE AGRICULTURE
ISSN: 1995-0748, EISSN: 1998-1074
2017, volume(11), issue(3): pages (20-28)
Published Online May 3 2017 in http://www.aensiweb.com/AEJSA/

Distribution pattern and species composition of the seaweeds at Uran, Maharashtra, the west coast of India

[1]Prabhakar R. Pawar and [2]Abdel Rahman Mohammad Said Al-Tawaha

[1]Veer Wajekar Arts, Science and Commerce College, Department of Zoology, Phunde (Uran), Raigad, Navi Mumbai - 400 702, India.
[2]Department of Biological Sciences, Al Hussein Bin Talal University, Ma'an, P.O. Box 20, Jordan.

Received 12 January 2016; Accepted 2 May 2017 Published Online 3 May

Address For Correspondence:
Prabhakar R. Pawar, Veer Wajekar Arts, Science and Commerce College, Department of Zoology, Phunde (Uran), Raigad, Navi Mumbai - 400 702, India.
E-mail: prpawar1962@gmail.com

Copyright © 2017 by authors and American-Eurasian Network for Scientific Information.
This work is licensed under the Creative Commons Attribution International License (CC BY).
http://creativecommons.org/licenses/by/4.0/

Open Access

ABSTRACT

Seaweeds were collected from along Sheva creek, Peerwadi coast and Dharamtar creek of Uran (Raigad), Navi Mumbai, west coast of India. Seaweeds attached to the boulders, jetties, rocks on the shores, stones, pebbles, fishing nets and pneumatophores of mangrove were removed by scrapping and collected monthly from June 2013 to May 2015 during spring low tides. 19 species of seaweeds representing 16 genera, 15 families and 13 orders were identified from Uran coast. Of these, 7 species belongs each to Chlorophyta and Rhodophyta, 2 each to Cyanobacteria and Ochrophyta and 1 to Charophyta. Maximum species diversity of seaweeds is recorded during pre-monsoon and post-monsoon than monsoon periods at all sites. Diverse species composition of seaweeds is recorded at Peerwadi coast than the Sheva creek and Dharamtar creek. Lower species diversity at Sheva creek and Dharamtar creek is attributed to the non-availability of rocky substratum for settlement and unregulated disposal of wastes and effluents and also to maritime activities of Jawaharlal Nehru Port Trust (JNPT). This study reveals that seaweeds from Uran coast are under stress due to industrial pollution and anthropogenic stresses like over-exploitation, reclamation and hazardous chemicals.

KEY WORDS
Seaweeds, Anthropogenic stresses, Jawaharlal Nehru Port, Uran, Coastal biodiversity

INTRODUCTION

'Seaweeds' are the larger algae that have a very complex differentiated thallus and when they are attached by a holdfast with upright stems are known as 'kelps'. They are multicellular and macrothallic [39]. Seaweeds are divided into brown algae (Phaeophyta), red algae (Rhodophyta), green algae (Chlorophyta), and blue-green algae (Cyanophyta) [22]. They constitute one of the important living resources of the ocean and were found attached to the bottom on solid substrates [36].

Seaweeds are ecologically important primary producers [13] and are with varied biodiversity [5]. Seaweeds are the main primary producers and form the base of the food chain in the oceans [10]. They play a key role in coastal biodiversity [1] and provide ecosystem goods and services to human like food, medicine and protection of coastal ecosystem from storm [35].

Quantification of nutritional aspects of edible seaweeds include polysaccharides (Celluloses, Hemicelluloses, Xylans, Carrageenans and Alginates), minerals (Calcium, Potassium, Magnesium, Sodium, Copper, Iron, Iodine and Zinc), polyunsaturated fatty acids (PUFA), vitamins (A, B, C and E), proteins (Biliproteins) and other major compounds (Alginic acid, Fucoidan, Laminarin, Mannitol, Porphyran, Floridoside, Pentoses and Xylose) [22].

Therapeutic benefits offered by seaweeds include use of algae in traditional medicines, antiviral effects, anticancer effects, immunity, and inflammation and to reduce plasma cholesterol and hypertension [11]. Marine algae produce variety of chemically active metabolites with pharmacological importance like antialgal, antimacrofouling and antifungal properties. The phytochemicals produced from seaweeds were used in food, pharmaceutical, confectionary, dairy, textiles, paper, paint, varnish industries [19].

A biodegradable polysaccharide extracted from seaweeds *Gracilaria dura*, *Gelidiella acerosa* and *Kappaphyucus alvarezi* is used for preparation of biodegradable ropes to replace synthetic ropes used in seaweed harvest and other applications. It can replace plastic in forms like packing material, cloths drying rope, bag handles and other home décor items [14]. Algae can also be used in the preparation of biodiesel, bioethanol, biobutanol and hydrogen gases [29].

Bioactive compounds derived from seaweeds show health-promoting properties and lower many chronic diseases [3]. Biological importance of the seaweeds as food, medicines, therapeutics, fodder, fertilizer and manure is also documented by Burtin [4], Dhargalkar and Pereira [7], Kandale et al. [11], Gupta [12], Raja et al. [30] and Krishnamurty et al. [21].

Study of diversity patterns of seaweeds is useful in planning the conservation strategies of coastal resources [41]. On the upper littoral zone, seaweeds are exposed to high temperatures, desiccation stress and on the lower littoral zone; they are limited by herbivores and competition with other animals and plants [10]. Though seaweeds provide trillions of dollars of ecosystem goods and services every year, impacts of human activities on seaweeds is not studied in detail [13].

In India, many of the rocky beaches, mudflats, estuaries, coral reefs and lagoons along the coast provide ideal habitats for the growth of marine algae. In all, 271 genera and 1153 species of marine algae have been enumerated till date from the Indian waters [39].

Maritime activities of Jawaharlal Nehru Port (JNP), reclamation, overexploitation of coastal resources, industrialization and habitat loss have affected the coastal ecosystem of Uran [26]. No scientific studies have been carried out on the species composition of seaweeds of Uran, Navi Mumbai; hence, the present study is undertaken. Objective of the study is to evaluate the distribution pattern and species composition of seaweeds from Uran coast.

MATERIALS AND METHODS

Study Area:

Uran (Lat. 18º 50'5" to 18º50'20" N and Long. 72º57'5" to 72º57'15" E) with the population of 28,620 is located along the eastern shore of Mumbai harbor opposite to Coloba. Uran, is bounded by Mumbai harbor to the northwest, the Thane creek to the north, Dharamtar creek and Karanja creek to the south, and the Arabian Sea to the west. Uran and Jawaharlal Nehru Port (JNP) is included in the planned metropolis of Navi Mumbai (Fig. 1).

The coast of Uran is tide-dominated and the tides are semidiuranal. The average tide amplitude is 2.28 m. The flood period lasts for about 6–7 h and the ebb period lasts for about 5 h. The average annual precipitation is about 3884 mm of which about 80% is received during July to September. The temperature range is 12–36ºC, whereas the relative humidity (61% to 86%) is highest in the month of August.

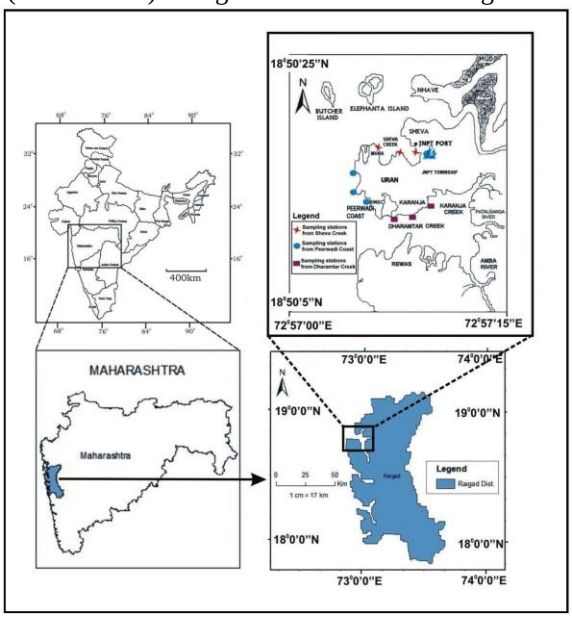


Fig. 1: Location map of study area representing sampling stations along Uran, Navi Mumbai

Sampling and identification:

The present study was carried out from June 2013 to May 2015. Three study sites namely Sheva Creek, site I, (Lat.18º50'20" N and Long. 72º 57' 5" E), Peerwadi coast, site II, (Lat.18º 50' 10" N and Long. 72º 57' 1" E) and Dharamtar Creek, site III, (Lat.18º 48' 03" N and Long. 72º 58' 31" E) separated approximately by 10 km were selected along the coast.

The study sites were visited monthly during spring low tides from June 2013 to May 2015 and the seaweed samples were collected from the intertidal region. As per seaweed collection procedures documented by Rath and Adhikary [32], seaweeds attached to the boulders, jetties, rocks on the shores, stones, pebbles, fishing nets and pneumatophores of mangrove were collected by scrapping and preserved in 4% formaldehyde-seawater solution. Microphotographs of the seaweeds were taken with Cannon EOS1100D digital camera and samples were identified following the standard taxonomic keys of Kaliaperumal et al [15], Dhargalkar and Kavlekar [6], Krieg [20], Bhavanath Jha et al. [2], Edwards et al [9], and Manisseri et al [23].

RESULTS AND DISCUSSION

19 species of seaweeds representing 16 genera, 15 families and 13 orders were recorded from Uran coast (Table 1) and (Fig. 3 and Fig. 4). Of these, 7 species belongs each to Chlorophyta and Rhodophyta, 2 each to Cyanobacteria and Ochrophyta and 1 to Charophyta. Varied diversity of seaweeds belonging to Charophyta, Chlorophyta, Cyanobacteria, Ochrophyta and the Rhodophyta is recorded from three sites. Of the recorded species, 36.84% belongs each to Chlorophyta and Rhodophyta, 10.53% each to Cyanobacteria and Ochrophyta, and 5.26% to Charophyta (Fig. 2).

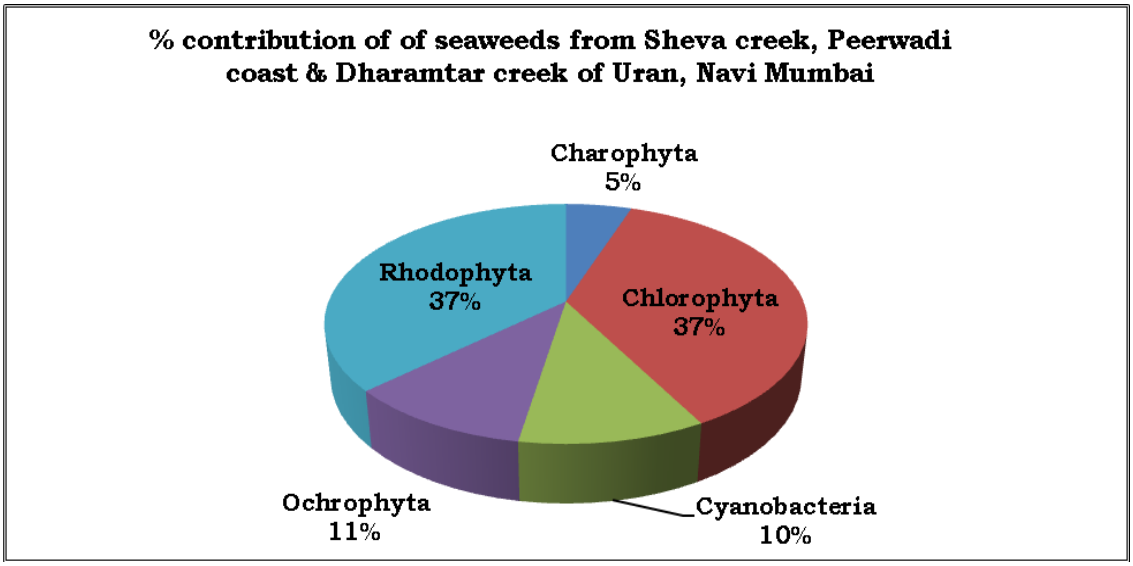


Fig. 2: Percentage representation of species of seaweeds from Uran, Navi Mumbai

Table 1: Species of seaweeds recorded from Sheva creek, Peerwadi coast and Dharamtar creek of Uran, Navi Mumbai.

Class	Order	Family	Binomial Name
Division: Charophyta			
Charophyceae	Charales	Characeae	*Chara baltica* (A. Bruzelius,1824)
Division: Chlorophyta			
Ulvophyceae	Cladophorales	Cladophoraceae	*Cladophora rupestris* (L.) Kutzing 1843)
		Valoniaceae	*Valonia aegagropila* (C. Agardh, 1823)
	Ulotrichales	Gomonticeae	*Monostroma nitidum* (Wittrock,1866)
	Ulvales	Ulvaceae	*Ulva fasciata* (Delile, 1813)
			Ulva lactuca (L.) 1753
			Enteromorpha intestinalis (L.) Nees, 1820
			Enteromorpha linza (L.) J. Agardh, 1883
Division: Cyanobacteria			
Cyanophyceae	Oscillatoriales	Oscillatoriaceae	*Lyngbya confervoides* (C. Agardh ex Gomont, 1893)

			Lyngbya majuscule (Harvey ex Gomont) 1892
Division: Ochrophyta			
Phaeophyceae	Ectocarapales	Scytosiphonaceae	*Colpomenia sinuosa* (Derbes and Solier, 1851)
	Sphacelariales	Sphacelariaceae	*Sphacelaria tribuloides* (Meneghini, 1840)
Division: Rhodophyta			
Florideophyceae	Corallinales	Corallinaceae	*Amphiroa tribuloides* (Meneghini, 1840)
	Nemaliales	Galaxauraceae	*Galaxaura oblongata* (J.V.Lamouroux, 1816)
	Gelidiales	Gelidiaceae	*Gelidium pusillum* (Stackhouse) Le Jolis, 1863
		Gelidiellaceae	*Gelidiella acerosa* (Fosskal) Feldmann and G. Hamel, 1934
	Gracilariales	Gracilariaceae	*Gracilaria verrucosa* (Hudson) Papenfuss, 1950
	Halymeniales	Halymeniaceae	*Grateloupia filicina* (C. Agardh, 1822)
	Ceramiales	Rhodomelaceae	*Acanthophora specifera* (M.Vahl)Borgesen,1910

At Uran coast, maximum species diversity of seaweeds was recorded during pre-monsoon and post-monsoon than monsoon periods. Higher species composition of seaweeds was also noted during post-monsoon than pre-monsoon and monsoon. Maximum diversity of seaweeds recorded during pre-monsoon and post-monsoon is attributed to favorable environmental conditions with respect to variables like temperature, salinity, dissolved oxygen and nutrients. Results of the study are in agreement to earlier reports of Rao et al [31], in the Bhimili coast, the east coast of India, Reddy et al [33], in seaweed resources of India, Pariera and Almeida [25] from the Goa coast, Naik et al [24], in Karwar Bay, and Rodde and Sable [34] from Malvan and Kunakeshwar in Sindhudurg District of Maharashtra.

During present study, the diverse species composition of seaweeds was recorded at Peerwadi coast than the Sheva creek and Dharamtar creek. This is correlated with the presence of rocky upper littoral zone which provide suitable substratum and appropriate habitat for the seaweeds. Also at site II, less number of Container Freight Stations and other port related establishments are present [27]. Similar results were reported by Barot et al [1] at Okha coast, western India.

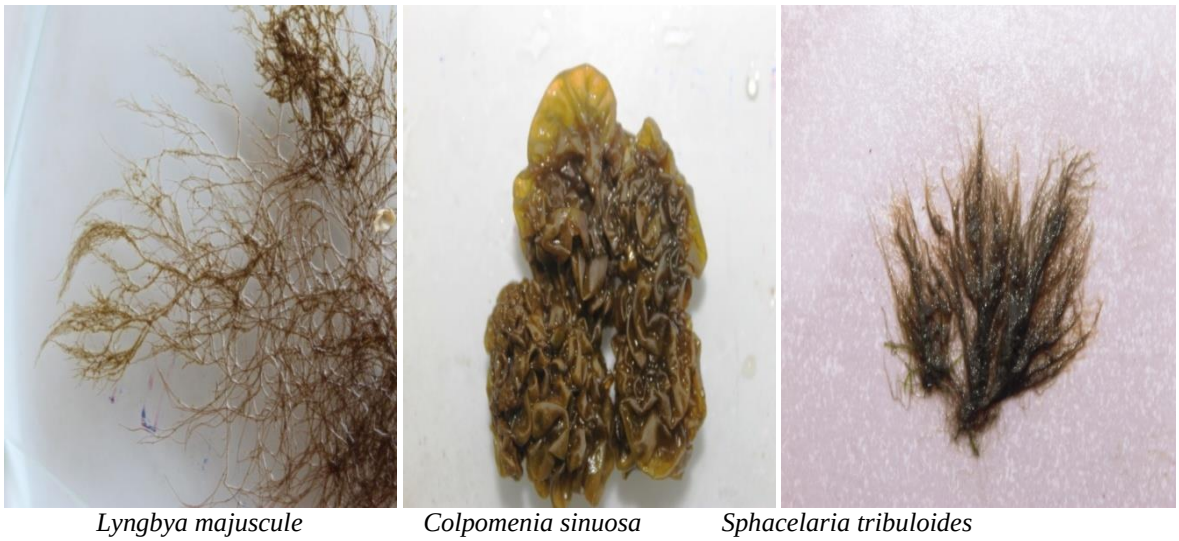
At Sheva creek, intertidal region has extensive mudflats with less rocky substratum. Establishments like an international port, Jawaharlal Nehru Port (JNP), DP WORLD, Naval Armament Depot (NAD), Grindwell Norton Ltd., Indian Oil Tanking (IOT), Container Freight Stations (CFS), Trawler building workshops etc. are located in the stretch of Sheva creek. Also, Gharapuri Island (Elephanta caves), is present on the north side of the creek. The creek receives wastes and effluents from Asia's largest industrialized zone namely Thane Belapur industrial area and Navi Mumbai Urban area. Maritime activities of JNP and non-availability of rocky and coral substratum might be related to minimum density of seaweeds at Sheva creek [26]. Similar results on species diversity of the seaweeds were reported by Rath and Adhikary [32] in Orissa, east coast of India and Satheesh and Wesley [38] in the Kudankulam coastal waters, the south-eastern coast of India.

Chara baltica

Cladophora rupestris

Valonia aegagropila

Fig. 3: Seaweeds from coastal waters of Sheva creek, Peerwadi coast and Dharamtar creek of Uran, Navi Mumbai



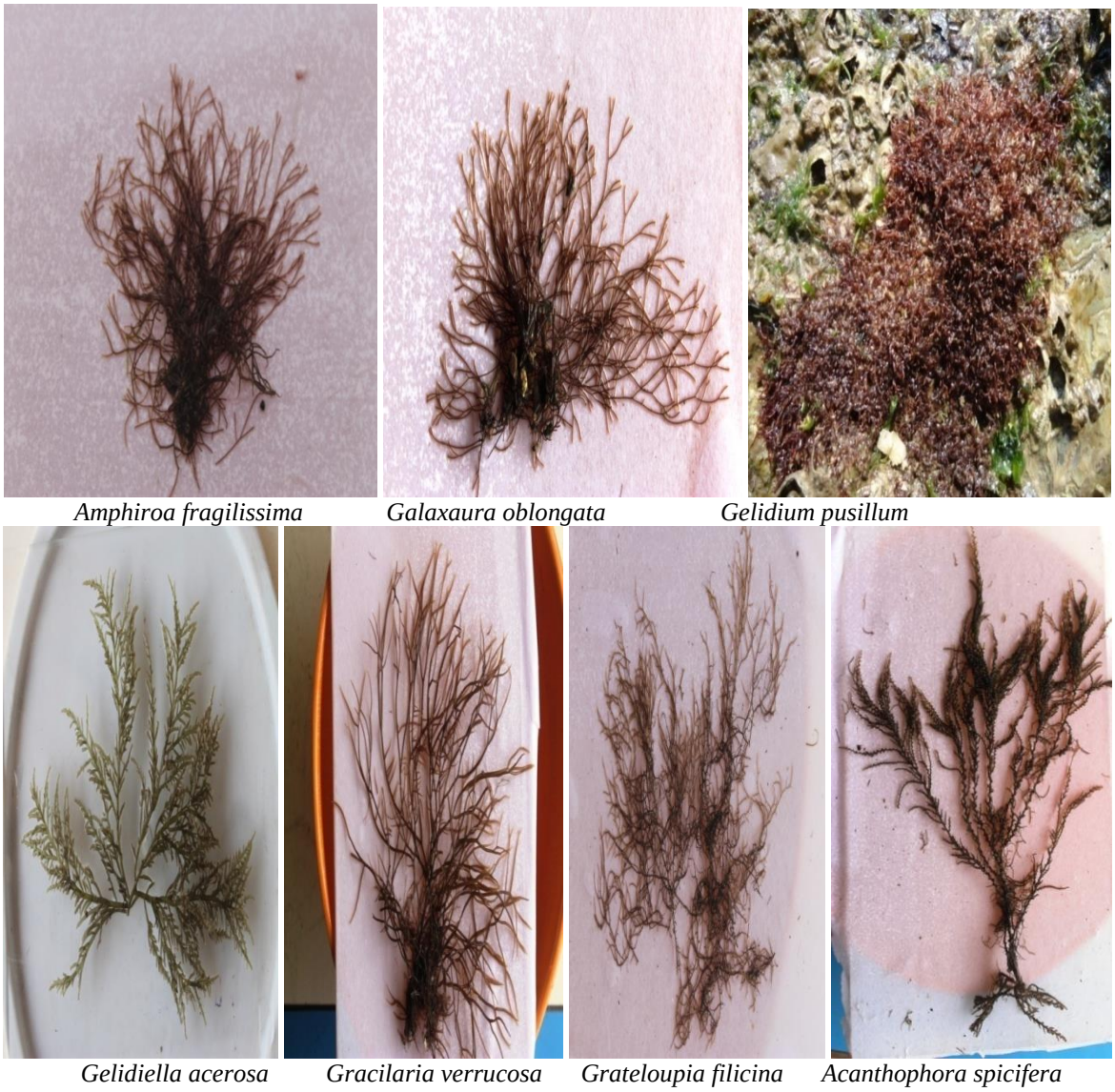


Fig. 4: Seaweeds from coastal waters of Sheva creek, Peerwadi coast and Dharamtar creek of Uran, Navi Mumbai

Table 2: Seasonal distribution of seaweeds from Uran, Navi Mumbai

Sr. No.	Species Name	Pre-monsoon	Monsoon	Post-monsoon
1	*Chara baltica* (A. Bruzelius,1824)	+	+	+
2	*Cladophora rupestris* (L.) Kutzing 1843)	-	-	+
3	*Valonia aegagropila* (C. Agardh, 1823)	+	-	-
4	*Monostroma nitidum* (Wittrock,1866)	-	+	+
5	*Ulva fasciata* (Delile, 1813)	-	+	+
6	*Ulva lactuca* (Linnaeus, 1753)	-	+	+
7	*Enteromorpha intestinalis* (L.) Nees, 1820	-	-	+
8	*Enteromorpha linza* (L.) J. Agardh, 1883	-	-	+
9	*Lyngbya confervoides* (C. Agardh ex Gomont, 1893)	+	+	+
10	*Lyngbya majuscule* (Harvey ex Gomont, 1892)	+	+	+
11	*Colpomenia sinuosa*	+	-	+

	(Derbes and Solier, 1851)			
12	*Sphacelaria tribuloides* (Meneghini, 1840)	+	+	+
13	*Amphiroa tribuloides* (Meneghini, 1840)	-	-	+
14	*Galaxaura oblongata* (J.V.Lamouroux, 1816)	+	-	+
15	*Gelidium pusillum* (Stackhouse) Le Jolis, 1863	+	+	+
16	*Gelidiella acerosa* (Fosskal) Feldmann and G. Hamel, 1934	+	-	+
17	*Gracilaria verrucosa* (Hudson) Papenfuss, 1950	-	-	+
18	*Grateloupia filicina* (C. Agardh, 1822)	-	+	+
19	*Acanthophora specifera* (M.Vahl)Borgesen,1910	+	+	+

Dharamtar creek is the confluence of Karanja creek, Patalganga River and Amba River, opening into southern part of Mumbai harbor. Intertidal region of Dharamtar creek is with rocky and the coral substratum towards the Dronagiri mountain and remaining part of the creek is dominated by the marshy areas with mud flats. Towards the Revas side, upper littoral zone is sandy whereas remaining part of the creek is marshy with mud flats. The rocky substratum of Dharamtar creek supports the moderate species diversity of seaweeds. This is attributed to the substantial amount of waste water received from the petrochemical complex and other industries that opens into Dharamtar creek [28].

At Uran coast, the species composition of Chlorophyta and Rhodophyta has dominated the Cyanobacteria, the Ochrophyta and the Charophyta. This is correlated with the topography of the coasts which is made up primarily of rocks of green basalt, and is covered by calcareous surfaces. Results of the present study are in agreement with work of Kerswell [18], Domettila et al [8], Karthick et al [17], Reddy et al [33], Sahayraj et al [36] and Valanju and Jamdhade [40].

Seaweeds are highly sensitive to the changes in the physico-chemical characteristics of the coastal ecosystem [13]. Sahoo et al [37] reported that large-scale aquacultural activities in Chilika Lake, Orissa have resulted in eutrophication which has changed its floristic composition. Satheesh and Wesley [38] noted that anthropogenic activities have affected the diversity of seaweeds in developing countries. Gradual disappearance of marine algae along Visakhapatnam coast by disturbances created by the discharge of effluents, environmental factors, tidal waves and the cyclones Krishnamurty et al [21].

Reclamation, overfishing, industrialization, habitat loss and maritime activities of Jawaharlal Nehru Port (JNP) have affected the water quality and diversity of macrobenthos from coastal ecosystem of Uran [26, 28]. Since no earlier reports are available on taxonomy and species diversity of seaweeds from Uran coast, data presented here can be taken as a baseline data in knowing the status of seaweeds from Uran coast and effect of industrial development on it and for a better management of marine algae.

Conclusion:

This study shows that the Uran coast harbors a diverse group of subtidal seaweeds. Species composition of seaweeds reveals that species of Chlorophyta and Rhodophyta have dominated the Cyanobacteria, Ochrophyta and Charophyta. Indiscriminate disposal of wastes along Uran coast and maritime activities of Jawaharlal Nehru Port (JNP) will affect the species diversity of seaweeds from Uran coast in near future. Present information on species diversity of seaweeds would be taken as baseline information for further monitoring of species diversity of seaweeds from Uran coast.

ACKNOWLEDGEMENTS

Financial support provided by University Grants Commission, New Delhi [File No: 42–546/2013 (SR) dated 22nd Mar 2013] is gratefully acknowledged. The author is thankful to The Principal, Veer Wajekar Arts, Science and Commerce College Mahalan Vibhag, Phunde (Uran), Navi Mumbai 400 702 for providing necessary facilities for the present study. Special thanks to Dr. Rahul B. Patil for providing healthy cooperation during field visits for photography of the study sites and seaweeds. Thanks are due to Mr. Sanket S. Shirgaonkar, who worked as a Project Fellow for the present study. Thanks to Dr. Atul G. Babar for the help during preparation of the location map of study area.

REFERENCES

[1] Barot, Megha., Nirmal Kumar J. I. and Rita N. Kumar, 2015. Seaweed Species Diversity in Relation to Hydro Chemical Characters of Okha Coast, Western India. Int. J. Recent Res. and Review., 3(3): 16-28.

[2] Bhavanath, Jha., C.R.K. Reddy, Mukund C. Thakur and M. Umamaheswara Rao, 2009. Seaweeds of India-The Diversity and Distribution of Seaweeds of the Gujarat Coast. DOI 10.1007/978-90-481-2488-6, Springer Dordrecht Heidelberg London New York pp: 216.
[3] Brown, Emma, M., Philip, J. Allsopp, Pamela, J. Magee, Chris, IR Gill, Sonja, Nitecki, Conall, R. Strain and Emeir, M. McSorley, 2014. Seaweed and human health, pp: 1-12. doi:10.1111/nure.12091
[4] Burtin, Patricia, 2003. Nutritional Value of Seaweeds. Electron. J. Environ. Agric. Food Chem., 2(4): 1-6.
[5] Christie, H., K.M. Norderhaug and S. Fredriksen, 2009. Macrophytes as habitat for fauna. Mar. Ecol. Prog. Ser., 396: 221-33.
[6] Dhargalkar, V.K. and Devanand Kavlekar, 2004. Seaweeds-a field manual. National Institute of Oceanography, Dona Paula, Goa – 403 004, pp: 42.
[7] Dhargalkar, V.K. and Neelam Pereira, 2005. Seaweed: Promising Plant of the Millennium. Science and Culture, pp: 60-66.
[8] Domettila, Cosman., Thankappan Sarasabai Shynin Brintha, Selvamony Sukumaran and Solomon Jeeva. 2013. Diversity and distribution of seaweeds in the Muttom coastal waters, south-west coast of India. Biodiversity Journal, 4(1): 105-110.
[9] Edwards, M., D. Hannifffy, S. Heesch, J. Hernandez-Kantun, M. Moniz, B. Queguineur, J. Ratcliff, Soler-A. Vila and A. Wan, 2012. Macroalgae Fact-sheets. Edited by: Soler-Vila, A. And Moniz, M., pp: 40.
[10] Figueiredo, M.A.O. and J.C. Creed, 2009. Marine Algae and Plants. In: Kleber Del Claro, Paulo S. Oliveira and Victor Rico-Gray (Eds), Tropical Biology and Conservation Management, Botany Vol. IV, Encyclopedia of Life Support Systems. Eolss Publishers Co. Ltd; Oxford, United States, pp: 1-7.
[11] Fitton, Helen J., 2003. Brown Marine Algae - A Survey of Therapeutic Potentials. Alternative and Complementary Therapies, pp: 29-33.
[12] Gupta, Rachita, 2012. Red Algae's and its Medicinal and Therapeutic Uses. Int. J. Sci. Inventions Today, 1(1): 27-31.
[13] Harley, Christopher, D.G., Kathryn M. Anderson, Kyle W. Demes, Jennifer P. Jorve, Rebecca L. Kordas and Theraesa A. Coyle, 2012. Effects of Climate Change on Global Seaweed Communities. J. Phycol., DOI: 10.1111/j.1529-8817.2012.01224.x
[14] Herlekar, Ipsita, 2015. Biodegradable ropes from seaweed extracts. Curr. Sci., 108(12): 2140.
[15] Kaliaperumal, N., S. Kalimuthu and J.R. Ramalingam, 1995. Economically Important Seaweeds. ICAR Special Publication No. 62, Central Marine Fisheries Research Institute, Indian Council of Agricultural Research, Post Box No. 1603, Cochin - 682014, India, pp: 44.
[16] Kandale, Ajit., A.K. Meena, M.M. Rao, P. Panda, A.K. Mangal, G. Reddy and Ramesh Babu, 2011. Marine algae: An Introduction, Food value and Medicinal uses. J. Pharmacy Research, 4(1): 219-221.
[17] Karthick, P., R. Mohanraju, C.H. Ramesh and Kada Narayan Murthy. 2013. Distribution and diversity of seaweeds in North and South Andaman Island. Seaweed Res. Utiln., 35(1 and 2): 8-16.
[18] Kerswell, Ailsa P., 2006. Global Biodiversity Patterns of Benthic Marine Algae. Ecology, 87(10): 2479-2488.
[19] Kolanjinathan, K., P. Ganesh and P. Saranraj, 2014. Pharmacological Importance of Seaweeds: A Review. World J. Fish and Marine Sci., 6(1): 01-15. DOI: 10.5829/idosi.wjfms.2014.06.01.76195
[20] Krieg, Kate, 2005. Field Guide to Oregon's Rocky Intertidal. PISCO's Online Taxonomic Database, pp: 126.
[21] Krishnamurty, V.S., K.S. Chennubhotla, Rao and N. Kaliaperumal, 2015. Effect of some adverse factors on the diversity and distribution of marine macro algae along the Indian coasts. Seaweed Res. Utiln., 36(1): 5-11.
[22] MacArtain, Paul., Christopher I.R. Gill, Mariel Brooks, Ross Campbell and Ian R. Rowland, 2007. Nutritional Value of Edible Seaweeds. Nutrition Reviews, 65(12): 535-543.
[23] Manisseri, Mary K., Geetha Antony and G. Syda Rao, 2012. Common Seaweeds and Seagrasses of India. Herbarium Vol.1. Central Marine Fisheries Research Institute (Indian Council of Agricultural Research) Kochi- 682 018, Kerala, India, pp: 47.
[24] Naik, Ulhas G., V. Beligiriranga and Shivakumar B. Haragi, 2015. Seaweeds of Karwar Bay, Arabian Sea, West Coast of India - a Diversity Profile. Int. J. Sci. Nat., 6(4): 728-732.
[25] Pariera, N. and M.R. Almeida, 2014. A preliminary checklist of marine algae from the coast of Goa. Indian J. Mar. Sci., 43(4): 655-665.
[26] Pawar, Prabhakar R., 2013. Monitoring of impact of anthropogenic inputs on water quality of mangrove ecosystem of Uran, Navi Mumbai, west coast of India. Mar. Poll. Bull., 75: 291-300. http://dx.doi.org/10.1016/j.marpolbul.2013.06.045
[27] Pawar, Prabhakar R., 2015. Monitoring of Pollution Using Density, Biomass and Diversity Indices of Macrobenthos from Mangrove Ecosystem of Uran, Navi Mumbai, west coast of India. J. Bioremed. Biodeg., 6:299. doi:10.4172/2155-6199.1000299.

[28] Pawar, Prabhakar R. and Balasaheb G. Kulkarni, 2007: Assessment of water quality in Karanja creek (Dist-Raigad), Maharashtra, West coast of India. J. Ecophysiol. Occup. Hlth., 7: 61-72.
[29] Pooja, S., 2014. Algae used as Medicine and Food-A Short Review. J. Pharm. Sci. and Res., 6(1): 33-35.
[30] Raja, A., C. Vipin and A. Aiyappan, 2013. Biological importance of Marine Algae- An overview. Int. J. Curr. Microbiol. App. Sci., 2(5): 222-227.
[31] Rao, K. Satya., Prayaga Murty P. and G.M. Narasimha Rao, 2011. Seasonal Studies on Marine algae of the Bhimili Coast, East Coast of India. J. Algal Biomass Utln., 2(2): 69-82.
[32] Rath, Jnanendra and Siba Prasad Adhikary, 2006. Marine Macro-algae of Orissa, East Coast of India. Algae, 21(1): 49-59.
[33] Reddy, C.R.K., P.V. Subba Rao, M. Ganesan, K. Eswaran, S.H. Zaidi and V.A. Mantri, 2014. The Seaweed Resources of India. In: A. T. Critchely, M. Ohno and D. B. Largo (eds.), World Seaweed Resources (in DVD format), ETI Information Services Ltd., Wokingham, Berkshire, U. K., pp: 25.
[34] Rode, Surekha and Anjali Sabale, 2015. Diversity of Seaweeds from Malvan and Kunakeshwar in Sindhudurg District of Maharashtra. Ind. J. Appl. Res., 5(9): 413-415.
[35] Ronnback, P., N. Kautsky, L. Pihl, M. Troell, T. Soderqvist and H. Wennhage, 2007. Ecosystem goods and services from Swedish coastal habitats: identification, valuation, and implications of ecosystem shifts. Ambio., 36: 534-44.
[36] Sahayaraj, K., S. Rajesh, A. Asha, J.M. Rathi and Patric Raja, 2014. Distribution and diversity assessment of the marine macroalgae at four southern districts of Tamil Nadu, India. Ind. J. Geo-Mar. Sci., 43(4): 607-617.
[37] Sahoo, Debasish, Nivedita Sahu and Dinabandhu Sahoo, 2003. A Critical Survey of Seaweed Diversity of Chilika Lake, India. Algae, 18(1): 1-12.
[38] Satheesh, Sathianeson and Samuel Godwin Wesley, 2012. Diversity and distribution of seaweeds in the Kudankulam coastal waters, South-Eastern coast of India. Biodiversity Journal, 3(1): 79-84.
[39] Subba Rao, P.V. and Vaibhav A. Mantri, 2006. Indian seaweed resources and sustainable utilization: Scenario at the dawn of a new century. Curr. Sci., 91(2): 164-174.
[40] Valanju, N.M. and V.M. Jamdhade, 2014. Study of Marinemacro-Algal Biodiversity at Kurli-Kasop Beach, Ratnagiri Dist of Maharashtra. Bionano Frontier, 7(1): 172-176.
[41] Van der Strate, H.J., S.A. Boele-Bos, J.L. Olsen, L. van de Zande and W.T. Stam, 2002. Phylogeographic studies in the tropical seaweed *Cladophoropsis membranacea* (Chlorophyta, Ulvophyceae) reveal a cryptic species complex. Journal of Phycology, 38: 572-582.