



Diversity and Distribution of Seaweeds from the West Coast of Maharashtra

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Abstract

The purpose of this research is to introduce the diversity of algal flora along the west coast of Maharashtra. The present study of seaweeds was conducted at west coast of Maharashtra formed of different inter-tidal rock shores with rich algal vegetation. During the study period (Aug 2015 to Feb 2016), total 73 species of seaweeds were recorded. An updated species list has been compiled on the basis of fresh collections. Of these 21 species belong to Chlorophyta, 17 species to Phaeophyta and 33 species to Rhodophyta. Among them, Blue-green algae like *Lyngbya*, *Microcoleus* were found all over the west coast. Red algae were found more, then the green and brown from the west coast of Maharashtra. *Caulerpa spp* were observed only at Sindhudurgh and Raighad district. *S. ilicifolium* were found commonly throughout the west coast.

Keywords: Diversity, Seaweeds distribution, Maharashtra coast

Introduction

Algae are the most common marine vegetation commonly called “Seaweeds”. They are classified into Blue-green (Cyanophyta), Green (Chlorophyta), Brown (Phaeophyta) and Red (Rhodophyta). Seaweeds play important role in marine food chains. It is suggested that seaweeds could become a major food and energy resource in the 21st century. Biodiversity is the variety among living organisms and the ecological complexes in which they occur. Marine algal studies from Kokan region of Maharashtra was initiated in the late 19th century. The credit for the first report of marine algae from Maharashtra goes to Shri Kirtikar (1886) who read out a paper on marine algae collected by Hon. Justice Birdwood, from Ratnagiri coast (Deodhar, 1987). Biodiversity of marine algae along the east and west coast regions of India was studied by several authors (Srinivasan, 1946; Gopalkrishnan, 1970; Kalimuthu, 1995; Sahoo *et al.* 2003; James, 2004; Venkataraman, 2005; Rath and Adikary 2006 and 2007. Near about 624 species of seaweeds have been recorded from the Indian sea coast. Untawale and Dhargalkar, (1975) and Agadi and Untawale, (1978) surveyed the seaweeds from the Goa coast. Untawale, *et al.* (1979) reported 94 species of seaweeds from the entire coast of Maharashtra. The latest systematic account of seaweeds is of 844 species from the Indian coast have been recorded, at the same time, 159 species from Maharashtra (Oza & Zaidi, 2000). Dhargalkar *et al.* (2001) reported 91 species of macroalgae from entire west coast of Maharashtra. In present study, the diversity and distribution of marine macro algae study was carried out from Bombay, Thane (Palghar), Raighad, Ratnagiri and Sindhudurgh district along the west coast of Maharashtra was studied. Although, west coast is subjected to increasing industrial pollution and habitat destruction, there are some pockets wherein high macro algal diversity occurs. This may be because of the increased tolerance to the environmental changes. Hence occurrence, diversity and distribution were studied from the coastal region.

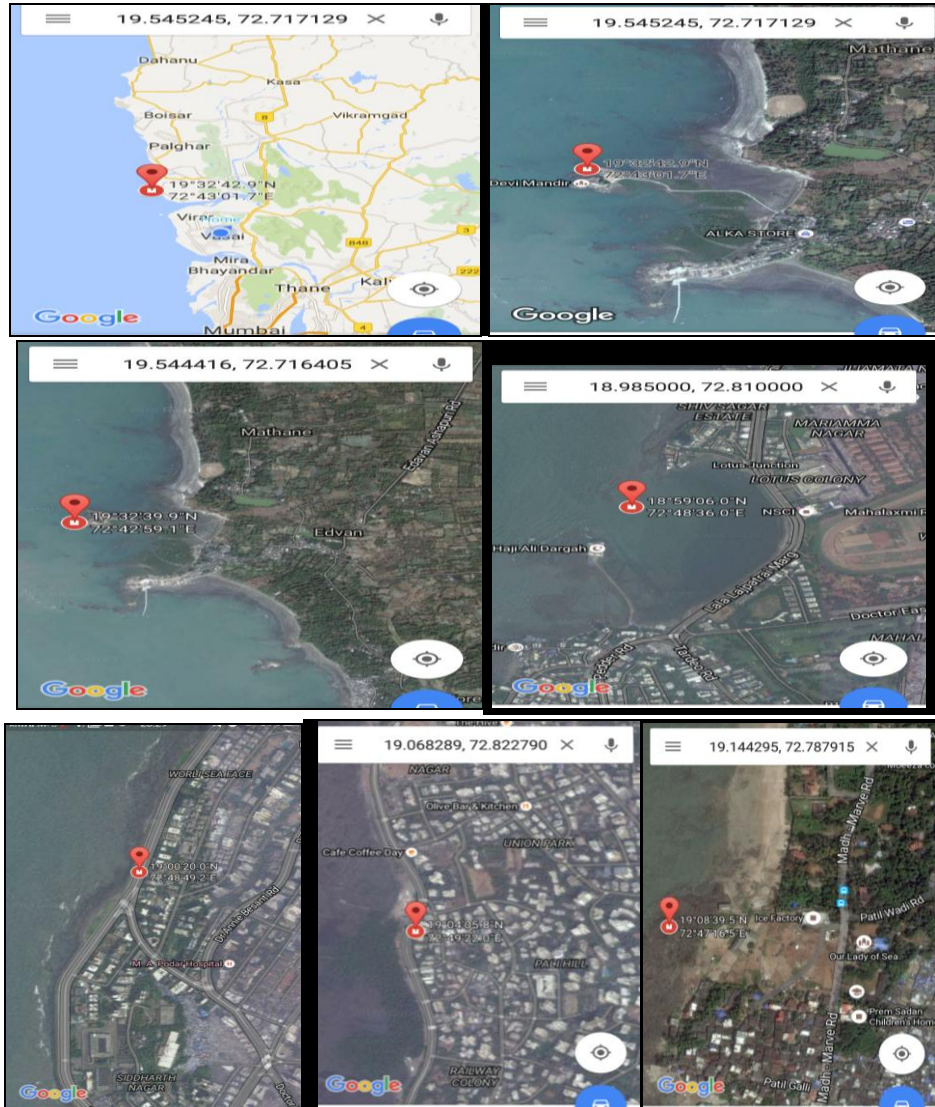


Fig 1. Geo-location of sampling sites in different regions of Bombay & Thane.

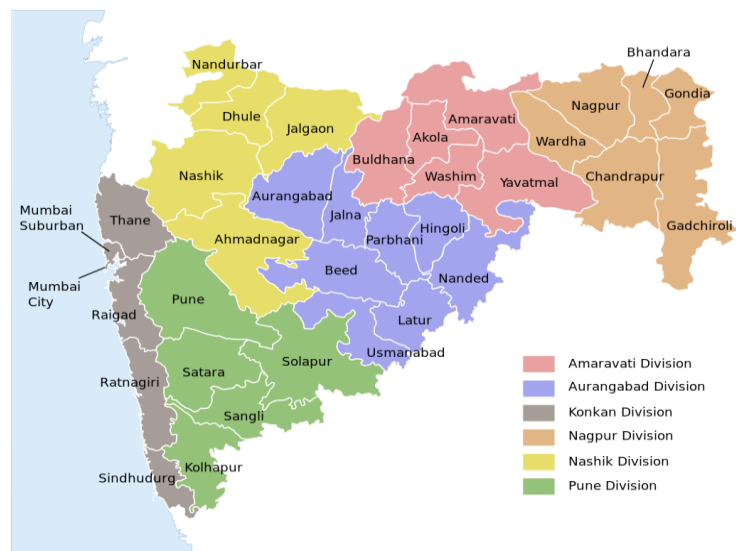


Fig 2. Map showing the study site west coast of Maharashtra.

Materials and Methods

The collection of seaweeds from the intertidal area is done during the low tide. Present survey includes entire Maharashtra coast, from Redy in the south to Dahnu in the north. Diverse habitat types at each collection site were surveyed in order to obtain a representative census of algal diversity. Since 2015 algal collections were made from west coast of Maharashtra. Herbarium specimens (Dry preservation) were prepared for each species and wet samples were preserved in 4% formalin solution, for identification and confirming their taxonomic position. Systematic identification of the species of marine algae found on the west coast was done.

Result and Discussion

Totally 73 species of seaweeds were reported from the coastal region of Maharashtra of these 28.77% species belong to Chlorophyta, 45.21% to Rhodophyta, 2.73% to Cyanophyta and 23.29% to Phaeophyta. Species of *Ulva*, *Chaetomorpha*, *Enteromorpha*, *Sargassum*, *Padina*, *Amphiroa*, *Jania*, and *Gracilaria* are common in this region. Species of *Porphyra*, *Gracilaria*, *Gelidium*, *Ulva*, *Sargassum* spp are the economically important algae occurring along this coast.

Total 74 seaweeds have been reported by Dhargalkar (1981) and Agadi (1986) from Goa coast. According to Untawale *et. al.* (1983), there are 624 species of marine algae belonging to 215 genera and 64 families. Out of these 60 species are commercially important. In the revised checklist of marine algae 844 species were reported from India, comprising 216 species of chlorophyta, 191 species of phaeophyta, 434 species of rhodophyta and 03 species of xanthophyta indicating a considerable increase in the species recorded from India (Oza and Zaidi, 2001). *Ulva fasciata*, *U. lactuca*, *Caulerpa* spp, *Chaetomorpha* spp, *Sargassum ilicifolium*, *Padina tetrastromatica*, *Gracilaria corticata*, *Hypnea*, *Acanthophora*, *Jania*, *Corallina*, *Ceramium* and *Amphiroa*, *Corallina* were present throughout the study period. Intertidal regions support rich growth of algae belonging to the genera *Ulva*, *Enteromorpha*, *Chaetomorpha*, Blue green algae like *Microcoleus* and *Lynbya*. Ditches and Rocks are observed at Redi, Malvan, Kunakeshwar, Vijaydurg, Ratnagiri near Harnai fort, Kurli-Kasop beach, Harihareshwar, Near Alibag fort, Murud-Janjira, Rocks between Shrivardhan & Divagar, Colaba, Arnala, Dhanu, Hagi-ali, Worli C-Link, Bandra (Kartar road), Palli hills (Mud island), Edwan, Kelva and Tokepada, Bordi (Narpad). Diversity of marine algae in the west coast showed that the members of Rhodophyta were dominant followed by Chlorophyta.

Table 1. Distribution of Blue-green algae/Cyanophyta.

Sr. No.	Name of the Marine Algae	Name of the Locality				
		Sindhudurgh	Ratnagiri	Bombay	Thane	Raighad
1.	<i>Microcoleus chthonoplastes</i> Thuret ex Gomont	√	√	√	√	√
2.	<i>Lyngbya majuscula</i> Harvey ex Gomont	√	√	√	√	√

Table 2. Distribution of Green algae/Chlorophyta.

Sr. No.	Name of the Marine Algae	Name of the Locality				
		Sindhudurgh	Ratnagiri	Bombay	Thane	Raighad
1.	<i>Monostroma oxyspermum</i> (Kützinger) Doty	√	-	-	-	√
2.	<i>Chaetomorpha antennina/media</i> Bory de Saint-Vincent) Kützinger	√	√	-	√	√
3.	<i>Chaetomorpha linum</i> (Muell.) Kützinger	√	√	√	√	√
4.	<i>Chaetomorpha crassa</i> (C. Agardh) Kützinger	√	√		√	√

5.	<i>Enteromorpha compressa/lingulata/flexuosa</i> (Linnaeus)Nees	√	√	√	√	√
6.	<i>Enteromorpha prolifera</i> (O.F.Muller)J.Agardh	√	√	√	-	√
7.	<i>Ulva fasciata</i> Delile	√			√	√
8.	<i>Ulva lactuca</i> Linnaeus	√	√	√	√	√
9.	<i>Ulva lactuca</i> var. <i>rigida</i> (Ag.)Le Jolis	-	-	-	√	-
10.	<i>Ulva/Enteromorpha intestinalis</i> (Linnaeus)Nees	√	-	-	√	-
11.	<i>Cladophora gracilis</i> Grif (ex Harvey)	√	√	-	-	-
12.	<i>Cladophora glomerata</i> (Linnaeus)Kutzing	-	√	-	√	-
13.	<i>Cladophora fascicularis</i> (Mert.)Kuetzing	-	√	-	√	-
14.	<i>Cladophoropsis zollingeri</i> (Kutz)Silva	-	√	-	-	-
15.	<i>Caulerpa racemosa</i> (Forsskal) J. Agardh	√	-	-	-	√
16.	<i>Caulerpa peltata</i> Lamouroux	√	-	-	-	-
17.	<i>Caulerpa sertularoides</i> (S.Gmelin)Howe	√	-	-	-	√
18.	<i>Caulerpa taxifolia</i> (M.Vahl)C.Agardh	√	-	-	-	-
19.	<i>Ulothrix flacca</i> (Dillwyn)Thuret	-	-	-	-	-
20.	<i>Bryopsis pennata</i> Lamouroux	√	-	√	√	-
21.	<i>Rhizoclonium grande</i> Boergesen	-	-	√	√	-

Table 3: Distribution of Brown algae/Phaeophyta.

Sr. No	Name of the Marine Algae	Name of the Locality				
		Sindhudurgh	Ratnagiri	Bombay	Thane/ Palghar	Raighad
1.	<i>Ectocarpus simpliciusculus</i> C.Agardh	√	-	-	-	-
2.	<i>Sphacelaria furcigera</i> kutzing	√	√	-	-	√
3.	<i>Dictyota bartayresiana</i> Lamouroux	√	-	√	√	-
4.	<i>Dictyota maxima</i> Zanardini	√	-	-	-	-
5.	<i>Dictyota dichotoma</i> (Hudson)Lamouroux	√	√	-	-	-

6.	<i>Lobophora variegata</i> (Lamouroux) Womersley ex Oliveira	√	-	-	-	√
7.	<i>Padina tetrastratica</i> Hauck	√	√	-	-	-
8.	<i>Padina gymnosperma</i> (Kutzing)Vickers	√	-	-	-	√
9.	<i>Spatoglossum asperum</i> J.Agardh	√	√	-	-	√
10.	<i>Stoechospermum marginatum</i> (C.Agardh) Kutzing	√	√	-	-	-
11.	<i>Sargassum cinereum</i> (J.G.Agardh)	√	√	-	-	-
12.	<i>Sargassum tenerrimum</i> (J.G.Agardh)	√	-	-	-	-
13.	<i>Sargassum wightii</i> (Greville mscr.)J. G. Agardh	√	-	√	-	-
14.	<i>Sargassum ilicifolium</i> (Turner) C. Agardh	√	√	√	√	√
15.	<i>Sargassum cristaefolium</i> C.Agardh	-	√	-	-	-
16.	<i>Dictyopteris woodwardia</i> (R.Brown ex Turner)C.Agardh	√	-	√	√	-
17.	<i>Rosenvingea orientalis</i> (J.Ag.)Boergesen	-	√	-	-	-

Table 4: Distribution of Red algae/Rhodophyta.

Sr. No.	Name of the Marine Algae	Name of the Locality				
		Sindhudurg	Ratnagiri	Bombay	Thane	Raighad
1.	<i>Porphyra vietnamensis</i> t.tanaka & Pham-Hoang Ho	√	-	√	-	-
2.	<i>Gelidiella acerosa</i> (Forsskal)J.Feldmann & G.Hamel)	√	√	√	√	√
3.	<i>Gelidium pusillum</i> (Stackhouse)Lee Jolis	√	-	-	√	√
4.	<i>Gracilaria corticata</i> (J.Agardh)J.Agardh	√	√	√	√	√
5.	<i>Gracilaria eucheumatoides</i> Harvey	-	-	√	√	-
6.	<i>Gracilaria edulis</i> (S.Gmelin)P.Silva	-	-	√	-	√

7.	<i>Gracilaria verrucosa</i> (Hudson)Papefuss	√	-	√	√	-
8.	<i>Gracilaria corticata</i> (J.Agardh)J.Agardh var. <i>cylindrica</i> Umamaheshwara Rao	√	√	√	-	-
9.	<i>Acanthophora spicifera</i> (Vahl)Borgesen	√	√	-	-	-
10.	<i>Acanthophora muscoides</i> (Linnaeus)Bory de Saint-Vincent	√				
11.	<i>Acanthophora dellei</i> Lamouroux	√				
12.	<i>Asparagopsis taxiformis</i> (Delile)Trevisan	√		√	√	
13.	<i>Grateloupia filicina</i> (Lamouroux) C.Agardh	√				√
14.	<i>Grateloupia lithophila</i> Borgesen	√				√
15.	<i>Amphiroa anceps</i> (Lamarck)Decaisne	√	√	√		
16.	<i>Amphiroa fragilissima</i> (Linnaeus)Lamouroux	√	√	√	-	-
17.	<i>Corallina berteroi</i> Montagne ex Kutzing	√		√		
18.	<i>Corallina officinalis</i> Linnaeus	√		√		
19.	<i>Jania rubens</i> (Linnaeus)Lamouroux	√				
20.	<i>Jania adhaerens</i> Lamouroux	√				
21.	<i>Hypnea musciformis</i> (Wulfen) Lamouroux	√	-	-	-	√
22.	<i>Hypnea valentiae</i> (Turner)Montagne	√	-	-	-	√
23.	<i>Hypnea spinella</i> (C.Agardh),Kutzing	√	-	-	√	√
24.	<i>Ceramium diaphanum</i> (Lightfoot)Roth	√	√	-	-	√

25.	<i>Griffithsia corallinoides</i> (Linnaeus) Trevisan	√	√	-	-	-
26.	<i>Polysiphonia platycarpa</i> Borgesen	√	√		√	√
27.	<i>Portieria hornemannii</i> (Lyngbye)P.Silva	√	-	√	√	-
28.	<i>Spyridia filamentosa</i> (Wulfen)Harvey	-	√	-	-	-
29.	<i>Laurencia obtuse</i> (Hudson)Lamouroux			√	√	
30.	<i>Sarconema filiforme</i> (Sonder)kylin			√	√	
31.	<i>Solieria robusta</i> (Greville)Kylin			√	√	
32.	<i>Champia compressa</i> Harvey			√	√	
33.	<i>Centroceras clavulatum</i> (C.Ag.)Mont.	√	√			√

Table 5: List of Blue-green marine algae/Cyanophyta.

Sr. No.	Name of Marine algae	Class	Order	Family
1.	<i>Microcoleus chthonoplastes</i> Thuret ex Gomont	Cyanophyta	Nostocales	Oscillatoriaceae
2.	<i>Lyngbya majuscula</i> Harvey ex Gomont	Cyanophyta	Oscillatoriales	Oscillatoriaceae

Table 6: List of Green algae/Chlorophyta.

Sr. No.	Name of Marine algae	Class	Order	Family
1.	<i>Monostroma oxyspermum</i> (Kutzing)Doty	Chlorophyta	Ulvaes	Monostromataceae
2.	<i>Enteromorpha compressa/lingulata/flexuosa</i> (Linnaeus)Nees	Chlorophyta	Ulvaes	Ulveaceae
3.	<i>Enteromorpha prolifera</i> (O.F.Muller)J.Agardh	Chlorophyta	Ulvaes	Ulveaceae
4.	<i>Ulva fasciata</i> Delile	Chlorophyta	Ulvaes	Ulveaceae
5.	<i>Ulva lactuca</i> Linnaeus	Chlorophyta	Ulvaes	Ulveaceae
6.	<i>Ulva lactuca</i> var. <i>rigida</i> (Ag.)Le Jolis	Chlorophyta	Ulvaes	Ulveaceae
7.	<i>Ulva/Enteromorpha intestinalis</i> (Linnaeus)Nees	Chlorophyta	Ulvaes	Ulveaceae
8.	<i>Chaetomorpha antennina</i> Bory de Saint-	Chlorophyta	Cladophorales	Cladophoraceae

	Vincent)Kutzing			
9.	<i>Chaetomorpha linum/crassa</i>	Chlorophyta	Cladophorales	Cladophoraceae
10.	<i>Chaetomorpha antennina/ media</i> (Bory de Saint-Vincent	Chlorophyta	Cladophorales	Cladophoraceae
11.	<i>Cladophora glomerata</i> (Linnaeus)Kutzing	Chlorophyta	Cladophorales	Cladophoraceae
12.	<i>Cladophora gracilis</i> Grif (ex Harvey)	Chlorophyta	Cladophorales	Cladophoraceae
13.	<i>Cladophora fascicularis</i> (Mert.)Kuetzing	Chlorophyta	Cladophorales	Cladophoraceae
14.	<i>Rhizoclonium grande</i> Boergesen	Chlorophyta	Cladophorales	Cladophoraceae
15.	<i>Cladophoropsis zollingeri</i> (Kutz)Silva	Chlorophyta	Cladophorales	Cladophoraceae
16.	<i>Caulerpa racemosa</i> (Forsskal) J. Agardh	Chlorophyta	Bryopsidales	Caulerpaceae
17.	<i>Caulerpa peltata</i> Lamouroux	Chlorophyta	Bryopsidales	Caulerpaceae
18.	<i>Caulerpa sertularioides</i> (S.Gmelin)Howe	Chlorophyta	Bryopsidales	Caulerpaceae
19.	<i>Caulerpa taxifolia</i> (M.Vahl)C.Agardh	Chlorophyta	Bryopsidales	Caulerpaceae
20.	<i>Bryopsis pennata</i> Lamouroux	Chlorophyta	Bryopsidales	Bryopsidaceae
21.	<i>Ulothrix flacca</i> (Dillwyn)Thuret	Chlorophyta	Ulotrichales	Ulvophyceae

Table 7: List of Brown algae/Phaeophyta.

Sr. No.	Name of Marine algae	Class	Order	Family
1.	<i>Ectocarpus simpliciusculus</i> C.Agardh	Phaeophyta	Ectocarpales	Ectocarpaceae
2.	<i>Sphacelaria furcigera</i> Kutzing	Phaeophyta	Sphacelariales	Sphacelariaceae
3.	<i>Dictyota bartayresiana</i> Lamouroux	Phaeophyta	Dictyotales	Dictyotaceae
4.	<i>Dictyota maxima</i> Zanardini	Phaeophyta	Dictyotales	Dictyotaceae
5.	<i>Dictyota dichotoma</i> (Hudson)Lamouroux	Phaeophyta	Dictyotales	Dictyotaceae
6.	<i>Lobophora variegata</i> (Lamouroux)Womersley ex Oliveira	Phaeophyta	Dictyotales	Dictyotaceae
7.	<i>Padina tetrastromatica</i> Hauck	Phaeophyta	Dictyotales	Dictyotaceae
8.	<i>Padina gymnosperma</i> (Kutzing)Vickers	Phaeophyta	Dictyotales	Dictyotaceae
9.	<i>Spatoglossum asperum</i> J.Agardh	Phaeophyta	Dictyotales	Dictyotaceae
10.	<i>Stoechospermum marginatum</i> (C.Agardh)Kutzing	Phaeophyta	Dictyotales	Dictyotaceae
11.	<i>Dictyopteris woodwardia</i> (R.Brown ex Turner)C.Agardh	Phaeophyta	Dictyotales	Dictyotaceae
12.	<i>Sargassum cinereum</i> (J.G.Agardh)	Phaeophyta	Fucales	Sargassaceae
13.	<i>Sargassum tenerrimum</i> (J.G.Agardh)	Phaeophyta	Fucales	Sargassaceae
14.	<i>Sargassum wightii</i> (Greville mscr.)J. G. Agardh	Phaeophyta	Fucales	Sargassaceae
15.	<i>Sargassum ilicifolium</i> (Turner) C. Agardh	Phaeophyta	Fucales	Sargassaceae
16.	<i>Sargassum cristaefolium</i> C.Agardh	Phaeophyta	Fucales	Sargassaceae
17.	<i>Rosenvingea orientalis</i> J.Ag.)Boergesen	Phaeophyta	Punctariales	Punctariaceae

Table 8: List of Red algae/Rhodophyta.

Sr. No.	Name of Marine algae	Class	Order	Family
1.	<i>Porphyra vietnamensis</i> t.tanaka & Pham-Hoang Ho	Rhodophyta	Bangiales	Bangiaceae
2.	<i>Gelidiella acerosa</i> (Forsskal)J.Feldmann & G.Hamel)	Rhodophyta	Gelidiales	Gelidiellaceae
3.	<i>Gelidium pusillum</i> (Stackhouse)Le Jolis	Rhodophyta	Gelidiales	Gelidiellaceae
4.	<i>Gracilaria corticata</i> (J.Agardh)J.Agardh	Rhodophyta	Gracilariales	Gracilariaceae
5.	<i>Gracilaria euchematooides</i> Harvey	Rhodophyta	Gracilariales	Gracilariaceae
6.	<i>Gracilaria edulis</i> (S.Gmelin)P.Silva	Rhodophyta	Gracilariales	Gracilariaceae
7.	<i>Gracilaria verrucosa</i> (Hudson)Papenfuss	Rhodophyta	Gracilariales	Gracilariaceae
8.	<i>Gracilaria corticata</i> (J.Agardh)J.Agardh var. <i>cylindrica</i> Umamaheshwara Rao	Rhodophyta	Gracilariales	Gracilariaceae
9.	<i>Acanthophora spicifera</i> (Vahl)Borgesen	Rhodophyta	Ceramiales	Rhodomelaceae
10.	<i>Acanthophora muscoides</i> (Linnaeus) Bory de Saint-Vincent	Rhodophyta	Ceramiales	Rhodomelaceae
11.	<i>Acanthophora delilei</i> Lamouroux	Rhodophyta	Ceramiales	Rhodomelaceae
12.	<i>Laurencia obtuse</i> (Hudson)Lamouroux	Rhodophyta	Ceramiales	Rhodomelaceae
13.	<i>Polysiphonia platycarpa</i> Borgesen	Rhodophyta	Ceramiales	Rhodomelaceae
14.	<i>Centroceras clavulatum</i> (C.Ag.)Mont.	Rhodophyta	Ceramiales	Ceramiaceae
15.	<i>Ceramium diaphanum</i> (Lightfoot)Roth	Rhodophyta	Ceramiales	Ceramiaceae
16.	<i>Griffithsia corallinoides</i> (Linnaeus)Trevisan	Rhodophyta	Ceramiales	Ceramiaceae
17.	<i>Spyridia filamentosa</i> (Wulfen)Harvey	Rhodophyta	Ceramiales	Ceramiaceae
18.	<i>Amphiroa anceps</i> (Lamarck)Decaisne	Rhodophyta	Corallinales	Corallinaceae
19.	<i>Amphiroa fragilissima</i> (Linnaeus)Lamouroux	Rhodophyta	Corallinales	Corallinaceae
20.	<i>Corallina berteroi</i> Montagne ex Kutzing	Rhodophyta	Corallinales	Corallinaceae
21.	<i>Corallina officinalis</i> Linnaeus	Rhodophyta	Corallinales	Corallinaceae
22.	<i>Jania rubens</i> (Linnaeus)Lamouroux	Rhodophyta	Corallinales	Corallinaceae
23.	<i>Jania adhaerens</i> Lamouroux	Rhodophyta	Corallinales	Corallinaceae
24.	<i>Hypnea musciformis</i> (Wulfen) Lamouroux	Rhodophyta	Gigartinales	Hypneaceae
25.	<i>Hypnea valentiae</i> (Turner)Montage	Rhodophyta	Gigartinales	Hypneaceae
26.	<i>Hypnea spinella</i> (C.Agardh),Kutzing	Rhodophyta	Gigartinales	Hypneaceae
27.	<i>Sarconema filiforme</i> (Sonder)kylin	Rhodophyta	Gigartinales	Solieriaceae
28.	<i>Solieria robusta</i> (Greville)Kylin	Rhodophyta	Gigartinales	Solieriaceae
29.	<i>Champia compressa</i> Harvey	Rhodophyta	Rhodymeniales	Champiaceae
30.	<i>Portieria hornemannii</i> (Lyngbye)P.Silva	Rhodophyta	Gigartinales	Rhizophyllidaceae
31.	<i>Asparagopsis taxiformis</i> (Delile)Trevisan	Rhodophyta	Bonnemaisoniales	Bonnemaisoniaceae
32.	<i>Grateloupia filicina</i> (Lamouroux) C.Agardh	Rhodophyta	Halymeniales	Halymeniaceae
33.	<i>Grateloupia lithophila</i> Borgesen	Rhodophyta	Halymeniales	Halymeniaceae

Table 9: Total list of seaweeds collected from west coast of Maharashtra.

Taxonomic groups	Chlorophyceae	Phaeophyceae	Rhodophyceae	Cyanophyceae	Total
Order	04	05	09	02	20
Families	06	05	11	01	24
Genera	10	10	23	02	43
Species	21	17	33	02	73

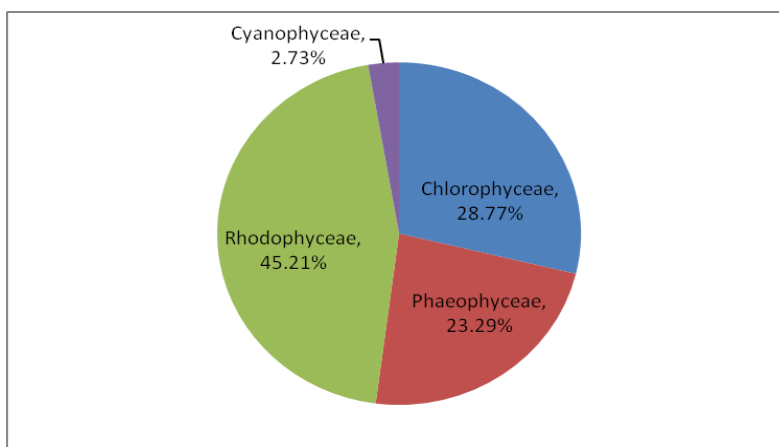


Fig 3. Class wise distribution percentage of seaweeds biodiversity in the study area.

Conclusion

Marine biodiversity needs systematic study. Thus adverse effect of pollution is observed more on the marine algal community of Bombay > Thane > Raighad > Ratanagiri > Sindhudurgh. Some economically important seaweeds like *Sargassum*, *Hypnea*, *Caulerpa*, *Graciliaria*, *Acanthophora*, *Corollina*, *Enteromorpha*, *Chaetomorpha* and *Ulva* are still common along west coast of Maharashtra. Some factors like industrial and commercial centres are responsible for dwindling down the algal flora. Thus the algal biodiversity is observed more in Sindhudurgh > Ratanagiri > Raighad > Thane > Bombay. However, corrective measures like conservation, research, education and public awareness are very necessary.

Acknowledgements

The author is thankful to Department of Science and technology (DST-SERB), New Delhi for financial support to carryout this research and Principal of Rajarshi Chh. Shahu College, Kolhapur for providing laboratory facilities.

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