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## **Biodiversity of marine algae along the Raigad coast of Konkan, Maharashtra**

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### **ABSTRACT**

*Raigad coast line of konkan are plentiful natural resources like marine algae, colourful fishes, various crabs, beautiful corals, marine mammals, sea grasses and various organisms. It shows various types of marine algae like caulerpa, ulva, chaetomorpha, sargassium, gracilaria, gelidiopsis, hypna, codium, stoechospermum, padina, cladophora, enteromorpha, porphyra, jania rubens etc. found in large quantity. Biodiversity of macro marine algae plays an important role as a source of food, feed, fodder, fertilizer and medicines throughout the world, since ancient times. Raigad coast line shows various types of chlorophyta, phaeophyta, and rhodophyta. In this investigation total 45 species were found, out of that 13 species belonging to green algae, 14 species belonging to brown algae and 18 species belonging to red algae. The 44 algal species belonging to 34 Genera and distributed in 24 different families. Macro Marine algal species like green algae, brown algae, and red algae found abundantly at coast line of Raigad of konkan, Maharashtra.*

**Keywords:** Biodiversity, Macro Marine Algae, Raigad Coast line.

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### **INTRODUCTION**

Marine algae, popularly known as Seaweeds, one of the most beautiful group of photosynthetic organisms which grow under the sea water. There are three major groups of seaweed which can be identified on the basis of their colour as Green algae [*Chloroohyta*], Brown algae [*Phaeophyta*], and Red algae [*Rhodophyta*]. Marine algae are rich source of Protein, carbohydrates, vitamins, and minerals (Black 1957). Marine algae are important living resource, these are source of food, feed, fodder and medicine etc, since ancient times. (Chapman 1981). Marine algae are photosynthetic, non-vascular aquatic plants containing chlorophyll and having simple reproductive structure. Algae are considered to be evolved early on earth based on fossil records from Precambrian periods (Chapman and Chapman, 1981) and also from Proterozoic and Cambrian periods (Vidal and Moczydlowska – Vidal 1977). These are the primary producers and major player of the entire ocean ecosystem. Marine algae are found in the form of unicellular, colonial, filamentous, heterotrichous and parenchymatous tissue. The size of marine algae varies from microscopic cell to huge plant more than 700 feet as in the case of *Laminaria* and *Macrocystis*. (Hoyt 1970). Seaweeds are used for the consumptions compared to the vegetable because of high contain in essential amino acid and high level of unsaturated fatty acids and these are the good source of vitamin A, Vitamin B-12, Vitamin C, Vitamin D, and Vitamin E, protein and lipids.

The ocean covers about 70% of earth surface and therefore marine algae are primary producer, sustain the entire ecosystem. They work as primary producer. The minerals which are found abundance in marine algae are potash and iodine, which are commercially extracted. They are used as good source of fertilizer for the plant growth, Chapman (1970).

Along the coast line of Maharashtra, Dixit, (1940) presented a historical account of algal investigations in Bombay presidency from 1847-1940. He also reported 9 *Chlorophyta*, 11 *Phaeophyta* and 10 *Rhodophyta* species along the Malvan coast. Biswas and Mitra, (1943) made certain observations on marine algae from the sea shore of Mumbai. Survey of marine algae of Mumbai was carried by Deodhar (1987) and reported 60 different species of marine algae. Dhargalkar et al, (2001) studied macro marine algal diversity along the Maharashtra coast and reported 91 algal species distributed in 51 genera and 30 families.

Dhargalkar and Komar pant (2003) carried out work on 'Impact on the distribution, abundance and community of rock intertidal macro algae of colaba coast 'and reported 41 macro algal species. Oza and Zaidi (2001) studied coastal and marine biodiversity of India and reported 844 algal species and out of that 97 algal species from coast line of Maharashtra. Dhargalkar and Pereira (2005) carried out work on Importance of seaweeds. Jagtap et al, (2001) reported more than 100 marine algal species from central west coast of India by using LANDSAT data.

Along the Indian coast line about 624 algal species have been recorded. The major species of economic importance are *Gracilaria*, *Saragassum*, *Gelidieum*, *Ulva*, *Caulerpa* etc. Untawale .et.al, (1983). Untawale and Dhargalkar, (1975) surveyed the along the coast line of Goa. Rao et al(2006) carried out work on Indian seaweed resources and sustainable utilization: Scenario at the dawn of a new century.

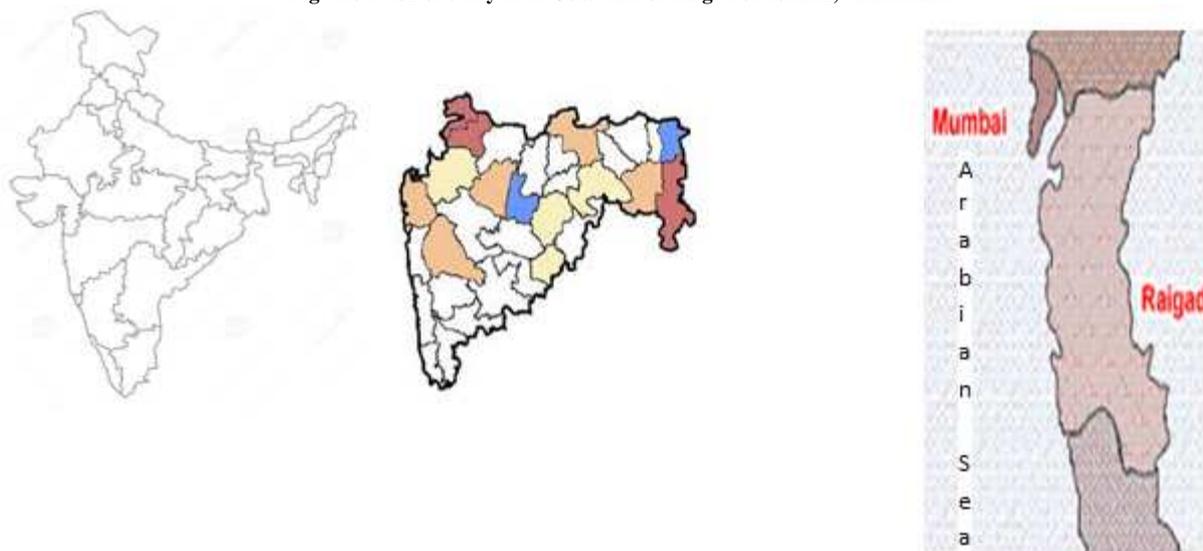
The first record of utilization of seaweeds is found in Chinese herbaria, since seaweeds are still used as source of food, feed, fodder and manure throughout the world. In India, manure from brown algae directly used as compost or as dried seaweed meal in Coconut plantations and for Orchid trees. (Black and Woodward, 1957).

The main objective of the present investigation deals with "Biodiversity of marine algae along the Raigad coast line of Konkan, Maharashtra", with special focus on occurrence of marine algal species, species variation, and ecosystem and to know and record the biodiversity of marine algae along the Raigad coast of Konkan, Maharashtra.

## MATERIALS AND METHODS

For the present investigation, collection of Macro marine algae carried out with selected sites of Raigad coast of konkan, during the low tides. The collected macro marine algae were washed in sea water and fresh water thoroughly to remove the epiphytes and other contamination. Then the washed algae samples were immediately transferred into a polythene bag. Then these bags were labeled and brought to the laboratory. Collected species of macro marine algae were preserved in 4 % formalin solution for identification. Herbarium specimens were prepared for each species for identification and to confirm their taxonomic position. Identification of macro marine algal species were done by referring Taylor (1960), Deodhar(1987), and Dinabandhu sahuo (2009) and other previous publications

Fig : Location of study area-Coast line of Raigad of konkan, Maharashtra



## RESULTS

Raigad coast which included in Konkan region of Maharashtra shows large no. of macro marine algal species. The brief information about these algal species is as follows,

**I. Class –Chlorophyta (Green algae)****1. *Acetabularia calyculus* ( Family – Dasycladaceae )**

**Occurrence:** This alga species grows on the shells, coral stones and other substratum in brackish water in intertidal zone.

**Characters:** These algae are clustered and grows up to 3 – 5 cm. uppermost part a shallow basin shaped disc present, rhizomestous base, stipe towards upper end with deciduous hair branches, superior corona is cylindrical or irregular.

**Uses:** It used as animal feed.

**2. *Caulerpa , microphysa*, ( Family – Caulerpaceae )**

**Occurrence :** This alga found in low tide pools, shallow rock pools and hard substances

**Characters :** It is greenish in colour small, forming dense clusters on corals and rocks and grow up to 12- 15 cm. The plants have slender creeping rhizomes; thalli are bright dark in colour, bearing descending branches, filiform rhizoides at the ends, stolon shortly stipulated, simple.

**Uses:** It used as food and animal fodder.

**3. *Caulerpa recemosa* ( Family – Caulerpaceae )**

**Occurrence:** This algae found in shallow rock pools, on sandy floors.

**Characters:** It is green in colour and attached to old colonies with stolons with erect branches, cylindrical and unbranched.

**Uses:** It is Used as food and animal feed.

**4. *Caulerpa sertulariodes* ( Family – Caulerpaceae )**

**Occurrence:** This alga found in surface of the sea to a few meter depths.

**Character:** It is light green to yellow green in colour plants with prostrate branched, cylindrical rhizome, stolons creeping on substrate. These are naked with a number of upright, delicate and flexible. Cylindrical axis with lateral outgrowth. Base of pinnules slightly larger than the apex. Assimilators are flattened and feather like with lateral in two rows.

**Uses:** It is used as animal feed.

**5. *Caulerpa scealpelliformis* ( Family – Caulerpaceae )**

**Occurrence :** This alga found on rocky substances in low tide pools.

**Character:** Thallus is dark green with extensive stoloniferous prostrate axis bearing upright frond. It is grows Up to 8 to 10 cm. in height. Upright fronds are teeter near the base, bearing closely flattened.

**Uses:** It is used as animal feed.

**6. *Caulerpa peltata* ( Family – Caulerpaceae )**

**Occurrence:** This alga found in low tide pools, shallow rock pool, on rocky shores .

**Character:** It is light green colour, it shows various branches, and rhizoid is below, cylindrical and colorless. Erect axis is vertical, variation in length, shows short branch lets, and terminating in a peltate assimilating disc. Plant with develop stolons which is naked, horizontal and creeping over substratum.

**Uses:** It is used as food and animal fodder.

**7. *Chaetomorpha antennina* ( Family -Cladophoraceae)**

**Occurrence:** This alga found on rocky substances and in intertidal sublittoral zone. **Characters:** It is dark green in colour, unbranched, filamentous, rigid below and flexuous above, it grow up to 4-10 cm and attached with hard rocks. Filament end are colourless. It grows at high water mark on all rocky coasts.

**Uses:** It is used as source of Alginate, food, and animal fodder.

**8. *Cladophora glomerata* ( Family -Cladophoraceae)**

**Occurrence:** It is firmly attached to the substratum under low tide pools.

**Characters :** Thallus is yellowish green in colour and grows up to 2-3 m in length. The filaments are rough to touch, filaments are highly branched, and it gives a more bushy appearance. These algae grow in association with various seaweeds and sea grasses.

**Uses:** It used as raw materials in paper industry.

**9. *Codium dwarkense* ( Family - Codiaceae )**

**Occurrence :** This alga species found in low tide level, shallow rock pool on slit covers in a intertidal zone.

**Characters:** These algae green in colour and it is tall up to 12-20 cm. Thallus is attached with a disc like holdfast. Its texture is soft and spongy. Thallus is dichotomously branched, vesicles are of two types slender and border.

**Uses :** It is used as source of alginate.

#### 10. *Enteromorpha intestinalis* ( Family – Ulvaceae )

**Occurrence:** This alga found in mid littoral zone in brackish water habitats.

**Characters:** Plants simple or branched, light to green in colour and up to 15 cm. Longs attached by rhizoidal portion and later become freely floating. Matured specimen often flattened at intervals giving an intestine like appearance contorted and irregularly constricted.

**Uses:** It is used as food in Japan, and Korea.

#### 11. *Monostroma oxyspermum* (Family - Monostromataceae )

**Occurrence:** This alga grows on rocks, in lagoons and in sub littoral belts.

**Characters:** It is light green in colour, membranous, gelatinous in appearance. It grows up to 3-10 cm in height. Thalli initially saccate, later split into irregular membranous. Thallus arising as a sac from a prostrate discoid portion and rupturing at maturity to form monostromatic blade.

**Uses:** It is used as source of alginate.

#### 12. *Ulva fasciata* (Family -Ulvaceae)

**Occurrence:** It is found in deep water and on the rocky substances.

**Characters:** It is light green in colour, plants frond is large, longer and attached to the substratum by holdfast. Thallus is divided into many small parts, lobes are flat and linear.

**Uses:** It is used as animal feed and in medicine.

#### 13. *Ulva lactuca* (Family -Ulvaceae)

**Occurrence:** It is growing on the rocky substances, on other plants and attached to the substratum.

**Characters:** It is light green in colour. Plants grow on other substratum, it is very small and thallus is foliaceous, margin of thallus is folded and thallus lobe is thick.

**Uses:** It is used as sea lettuce, vegetable and animal feed.

### II. Class- Phaeophyta (Brown algae)

#### 1. *Cystoseira indica* (Family –Cystoseiraceae )

**Occurrence:** This algal species found in the rock pools of the intertidal regions and at low tide level.

**Characters:** This alga is brown in colour, perennial, bushy, and shows differentiation into holdfast. Main axis shows extensive branches. Thallus is attached to the substratum by a cup like disc; air bladder is prominent and occurs on short laterals.

**Uses:** It used as fertilizer.

#### 2. *Dictyopteris woodwardia* (Family - Dictyotaceae )

**Occurrence:** This algal species found in low tide level, and in shallow rock pool.

**Characters:** Thallus is pale brown in colour, and erect with defined holdfast. Fronds height is more than 15 cm, flat, 5-7mm broad, and linear. Surface of fronds perforated on both sides by minute pores.

**Uses:** It used as animal feed.

#### 3. *Dictyota bartayresiana* ( Family - Dictyotaceae )

**Occurrence:** This algal species grows in low tide level, and in an intertidal zone.

**Characters:** Plants are erect variable, and bushy. Thallus is branched when young later becomes bent. Margin entire; apex acute, thallus is three celled and thick.

**Uses:** It is used as animal feed and source of alginate.

#### 4. *Dictyota dichotama* ( Family –Dictyotaceae )

**Occurrence:** This algal species found in low tide level, in shallow rock pools, on slit covered stones, and on hard substances.

**Characters:** This alga is tall, bushy, forking at angles, with little decrease in width, lower segment is broader below each fork and internodes are long.

**Uses:** It used as animal feed and source of alginate.

#### 5. *Dictyota pinnatifida* (Family - Dictyotaceae )

**Occurrence:** This alga found in a surface of the sea to a few meter depths.

**Characters:** It is brown in colour , grows up to 10-30 cm long dichotomously branched, branches more profuse towards upper side .fronds is narrow and twisted.

**Uses:** It is used as animal feed.

**6. *Hydroclathrus clathratus*** (Family –Scytosiphonaceae )

**Occurrence:** This alga grow well in the under surface rocks or coralline pieces, it can also grow on neighboring plants.

**Characters:** This alga is yellow to brown in colour, size and shape is irregular. Thallus is loosely attached by the undersurface rocks, thallus is fragile.

**7. *Lobaphora variegata*** (Family – Dictyotaceae )

**Occurrence:** This alga found in the low intertidal, on coral debris in lagoons, and deep subtidal rocks.

**Characters:** This alga is orange to dark brown in colour. Prostrate thallus is attached by moniform rhizoids; they are small, thick, prostrate plants with irregularly lobed blades.

**Uses:** It is used as food by aquatic animals.

**8. *Padina tetrastromatica*** (Family – Dictyotaceae )

**Occurrence:** This alga found in low water level and in rock pools.

**Characters :** Plant is erect, rhizome is prostrate which is attached to substratum, fronds is varying in size, it is thin, flat, blades split into narrow and hairs present in younger thallus and in older thallus hairs absent.

**Uses:** It is used as animal feed and in a antibacterial activity.

***Spatoglossum asperum*** ( Family – Dictyotaceae )

**Occurrence:** This alga found on rocks in the subtidal area of seashore exposed to strong waves of sea water.

**Characters:** Plant is dark brown to dirty green in colour. Thallus is 20-40 cm or more in height. The branches are strap like, dichotomously divided with large and small lobes, are elongate, linear, apex is rounded or acute.

**Uses:** It used as animal feed.

**9. *Sphacelaria frucigera*** ( family –Sphacelariaceae )

**Occurrence:** This alga found in a low tide level in a intertidal zone, and estuaries .

**Characters:** This alga is stoloniferous, erect and branched. Segments are longitudinally divided and without secondary transverse divisions. Rhizoids are descending and stalk is tapering to the base and it is cylindrical.

**Uses:** It used as animal feed.

**10. *Stoechospermum marginatum*** (family – Dictyotaceae )

**Occurrence:** This alga grows in low water level, in intertidal lagoons, rocky pools at mid tide level and in tranquil bays.

**Characters:** This alga is tall, thallus is flat, erect and dichotomously branched, apex is flatly truncate, Thallus is without midrib and fertile plant shows marginal dark line of crowded sporangia.

**Uses:** It used as animal feed and fertilizer.

**11. *Saragassum cinerum*** (family –Saragassaceae )

**Occurrence:** This alga grows on rocks, in lagoons and in sub littoral belts.

**Characters:** This alga is short in length, smooth, stout main axis, primary branches at upper part, leaves are long membranaceous , and round at the apices, branch lets of leaves are lanceolate and vesicles are rounded

**Uses:** It is used as fertilizer, medicine and source of alginates.

**12. *Saragassum tenerrimum*** (family – Saragassaceae )

**Occurrence:** This alga grows in lagoons and rocks in sub littoral belts and on rocks dashed by waves.

**Characters:** Plants are light green to yellowish in colour, pyramidal in shape with basal disc from which several branches arises. Secondary branches fork repeatedly. Leaves are wide and tapering at the end, thin, linear-lanceolate and translucent, with toothed margin, and receptacles are freely-branched structures.

**Uses:** It used as source of alginates and fertilizer.

**13. *Saragassum wightii*** ( Family – Saragassaceae )

**Occurrence:** This alga grows on the rocky substratum, in sub tidal zone.

**Characters:** plants is yellowish brown in colour, it grows up to 20-30cm,leaves are 4-8cm long and 2-8mm broad with tapering at the ends. It bears large spherical vesicles. Receptacles in clusters and repeatedly branched.

**Uses:** It is used as animal feed.

**III. Class : Rhodophyta (Red algae )****1. *Acanthophoria specifera*** ( Family -Rhodomelaceae )

**Occurrence:** It is growing on sub tidal dead corals, on the rock or hard substances.

**Characters:** It is purple brown in colour. Thallus is attached by holdfast which produces many rhizomatous branches. Main axis is cylindrical, with proliferous spinous outgrowths ramuli on determinate branches.

**Uses:** It is used as fertilizer.

**2. *Ahnfeltia plicata*** ( Family – Ahnfeltiaceae )

**Occurrence:** It grows on the sandy shores and sub littoral belts.

**Characters:** Thallus is dark red to purple black in colour. It grows up to 10 cm, cylindrical in structure, and dichotomously branched. It shows occasional proliferations.

**Uses:** It is used as animal feed.

**3. *Asparagopsis taxiformis*** ( Family- Bonnemaisoniaceae )

**Occurrence:** It grows in a shallow sub tidal habitats with heavy water motion.

**Characters:** Plant is red to bluish violet in colour, bearing with a creeping rhizomatous portion. The creeping part usually much branched, densely covered with branches.

**Uses:** It is used as animal feed.

**4. *Amphiora anceps*** ( Family - Corallinaceae )

**Occurrence:** It grows on the rocky substratum in low tide level with other algae.

**Characters:** It is red to bright purple in colour, and sub-compressed below and flattened above, 6-10 cm high, dichotomously branched. Due to complete calcification of some node no articulation is visible.

**Uses:** It is used as animal feed.

**5. *Centroceras clavalatum*** ( Family -Ceramiaceae )

**Occurrence:** This alga species grows on rocks and in a low tide level mark.

**Characters:** Thallus is purple red in colour, it grows by an apical cell and 1-3 cm in height. The axis consists of nodes and internodes, the spines are present in each node. Rhizoids are colourless, unbranched and helps in anchorage of plants to substratum.

**Uses:** It is used as animal feed.

**6. *Chondria armata*** ( Family -Rhodomelaceae )

**Occurrence:** This alga grows on rocks and in intertidal zone.

**Characters:** This alga is light red in colour. It is attached by discoid holdfast, branchlets are opposite, upper branchlets are short and curved at the base. When algae become dry, then colour changes from Red to Green.

**7. *Champia compressa*** ( Family - Champiaceae )

**Occurrence:** It grows in the lower intertidal to subtidal zone of shores exposed to moderate wave actions.

**Characters :** This alga is red in colour, grows up to 2-4 cm, the branches are slightly compressed irregularly, branched alternately, and highly mucilaginous.

**8. *Corallina berteroi*** ( Family- Corallinaceae )

**Occurrence:** It grows well on mollusk shells and other macro algae.

**Characters:** Thallus is variable in colour such as pink, purple, yellowish and red. It is 8-12 cm in height, calcareous branched, segmented fronds. Thallus contains disc shaped holdfast, branches are opposite with like appearance.

**Uses:** It is used as animal feed.

**9. *Gelidium pusillum*** ( Family- Gelidiaceae )

**Occurrence:** It grows on sandy rocks in the subtidal zone, shells etc.

**Characters:** It is red in colour, plant is small 6 – 7 mm height horizontal stolons are prostrate portion irregularly branched without midrib, attached by rhizoids, erect fronds simple or rarely branched.

**Uses:** It is used as source as agar.

**10. *Gracillaria corticata*** ( Family- Gracillariaceae )

**Occurrence:** It grows on the rocky substratum in low tide level.

**Characters:** The thallus is violet red in colour it is attached firmly to rocky surface. Thallus grows up to 10 – 15 cm in length both male and female plants are morphologically different.

**Uses:** It is used as animal feed.

**11. *Gracillaria edulis*** ( Family -Gracillariceae )

**Occurrence:** It is grow on the rocky substances with other macro algae like Enteromorpha species and Ulva reticulata .

**Characters :** Thallus is redish brown in colour, cylindrical, 20-25 cm in height and branching pattern is 3- 4 order, subdichotomus in nature they attached to coral stone or substratum with discoid holdfast.

**Uses:** It is used as animal feed.

**12. *Gracilaria verrucosa*** ( Family - Gracilariaceae )

**Occurrence:** This algal species grows on rocks, shells, sandy shores in brackish water.

**Characters:** Plant is dull purple to grayish in colour. Plant is bushy, mature thalli of attached type plants and grows up to 50-60 cm, branching is profuse and sub-dichotomous.

**Uses:** It is used as salad, cooked with vegetables, and animal feed.

**13. *Grateloupia filicina*** ( Family- Halymeniaceae )

**Occurrence:** It is grow on the rocky substances in intertidal zone.

**Characters:** These algae are deep redish brown in colour. Thallus is highly branched with several upright branches, arising from common discoid holdfast it is a rounded at the basal region, branches are long linear and short in height.

**14. *Hypnea musciformis*** ( Family- Hypneaceae )

**Occurrence:** This algal species grows on rocks , stones, shells in intertidal zone.

**Characters:** plants are purple red in colour with 12-25 cm height. Thallus exists in clumps, cartilaginous and highly branched. Branches are cylindrical, irregular, twisted, and flattened with broad hooks. Holdfast is small, and inconspicuous.

**Uses:** It is used as animal feed.

**15. *Hypnea valentiae*** ( Family –Hypneaceae )

**Occurrence:** This algal species grows on rocky surface, shells, in intertidal zone.

**Characters:** Plant is purple red in colour, bushy, large and grow up to 15 cm in height, branching irregularly and cylindrical, long, slender, posseses short rumuli which curved towards axis.

**Uses:** It is commonly used in salad.

**16. *Jania rubens*** ( Family –Corallinaceae )

**Occurrence:** This algal species grows on rocks, on sandy shores, and in brackish water.

**Characters :** Plant is light green to pale yellow in colour. Plant is small, erect, 2-5 cm high, forming closely bunched on the substratum, all branches with an erect posture, and tapering or acute at the apices.

**Uses:** It is used as medicine.

**17. *Porphyra sp.*** ( Family –Bangiaceae )

**Occurrence:** This algal species grows on rocky coast.

**Characters:** It is green to yellowish or grayish in colour. Plant is very thin, cylindrical, and slightly rough, its life period is short. (3 months).

**Uses:** It is used as animal feed.

**18. *Sarconema filiforme*** ( Family-Solieriaceae )

**Occurrence :** This algal species found in low water level and in rock pools.

**Characters :** This algae is greenish yellow to purple in colour. Thallus is thin and filamentous, dichotomously forked, grows up to 15-20 cm in height.

## DISCUSSION

The present investigation deals with the biodiversity of marine algae along the coast line of Raigad District of konkan, Maharashtra. The macro marine algal species were collected at coast line of Raigad, during low tides except rainy season. The macro marine algal biodiversity of Indian coast line were studied by different peoples at different sites mainly, Dixit (1940), Biswas and Mitra (1943), Deodhar (1989) ,Dhargalkar (2001), Untawale (1979), Sahoo (2001) etc. Sahoo et al (2001), reported 770 algal species of seaweeds from the coast line of India. Oza and Zaidi (2001) reported 844 algal species from sea coast of India and out of that 197 species from Maharashtra .Dhargalkar et al (2001), reported 91 species of macro marine algae from the coast of konkan. According to their studies, the information about biodiversity of marine algae, their occurrence and knowledge about algal variations of Indian coast line can be known to us.

In present study, 44 marine algal species were found, out of these 44 algal species, 12 species are belonging to Green algae (class – Chlorophyta), 14 algal species belonging to Brown algae (class- Phaeophyta), and 18 algal species belonging to Red algae (class – Rhodophyta). These 44 algal species belonging to 33 Genera and distributed in a 24 different families.

During this study it is observed that the coast line of Raigad of konkan is rich in macro marine algal species, their abundance, and algal variations. The availability of algal species was increased after September to December and decreased from January to March and again increased from April. It is also observed that, along the Raigad coast line Red algae species found in large quantity, while the quantity of Green algae and brown algae species found less in quantity as compared with Red algae.

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