PHYCOLOGIA INDICA

(Icones of Indian Marine Algae)

K. S. SRINIVASAN

Vol. 1

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TO

LATE PROF. DR. M. O. P. IYENGAR

M.A., Ph.D., F.L.S., F.B.S., F.N.I.

AN EMINENT BOTANIST AND AUTHORITY ON INDIAN ALGAE

THIS HUMBLE WORK IS DEDICATED
BY THE AUTHOR
AS A MARK OF DEEP RESPECT AND GRATITUDE
TO HIS ILLUSTRIOUS TEACHER WHO INITIATED HIM
IN THE FIELD OF MARINE ALGAE

PREFACE

Late Prof. M. O. P. Iyengar realised as early as the thirties of the present Century the wealth of knowledge that still remained to be unravelled in the field of Algology and particularly in the Marine Algae of the Indian coasts. As a student and later as a research worker under this eminent Botanist, I had the good fortune to be initiated into the field of Marine Algae, visiting with him several places of algal interest in South India, for field collections and studies. Prof. Iyengar's profound knowledge and deep insight into the mysteries of these fascinating groups of plants and his passion for algae, naturally had an abiding influence on his pupils who were accompanying him in his tours and camp life, benefiting considerably by his discourses, practical demonstrations on the life-activities of the various groups of sea-weeds, their methods of propagation, reproduction, structure, ecological and morphological peculiarities etc.,—lessons which have left an indelible impression. That being so, the sea-weeds of Indian coasts continued to attract the attention of his students even after their leaving the research department under the Professor's charge. Naturally, my independent collections and study of marine algae extended to more wider areas than hitherto covered by me with Prof. Iyengar, including several newer areas which Prof. Iyengar could not visit. The number of years of active search for algae from these new surroundings brought forth a rich and representative collection of Green, Brown, Red and Blue-green algae of our shores, which for their variety and representation, is well worth all the efforts put in their collections and field studies.

It was the desire of Prof. Iyengar that I should prepare a handbook on Indian Sea-weeds fully illustrated. Some of the colour illustrations prepared on the basis of the collections made by me attracted him so much that he strongly advocated for the publication of these Icones. For various reasons this did not materialise during all these years, and more especially the financial outlay involved therein tended to thwart any attempt in this direction. However, it is with the great determination and zeal of Rev. Fr. Dr. H. Santapau, S.J., former Director of the Botanical Survey of India, Calcutta, that this humble work of mine has come to see the light of the day. My grateful thanks are then due to Prof. Iyengar for all the knowledge he imparted me and the zeal and enthusiasm he had to initiate this work, and to Rev. Fr. Santapau for his encouragements for arranging the financial support, to bring to concrete shape this long felt treatise.

To Shri D. P. Deb, my artist, I am particularly grateful for his ungrudging help in the preparation of these Icones from the original specimens, quite true to them; to Shri B. P. Roy Chowdhury, my erstwhile artist, for similar help earlier. To M/s. N. K. Gossain & Co. (P). Ltd., Calcutta, I am deeply indebted for the excellent manner in which they have executed the job. I cannot adequately express my gratitude to the Trustees, Indian Museum, Calcutta, and to the Government of India for the funds and facilities they provided to make collections of these algae which form the basis for this publication. I hope that this little effort will go a long way to create greater interest in among our younger generations of botanists and scientists to bring to light more and more of these fascinating groups of marine algae of which little is so far known and much less is appreciated or understood in our country.

Botanical Survey of India
14, Madan Street
Calcutta
1st. January, 1969

K. S. SRINIVASAN

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INTRODUCTION

"Full many a gem of purest ray serene
The dark unfathom'd caves of ocean bear;
Full many a flower is born to blush unseen
And waste its sweetness on the desert air."

—*Thomas Gray*

Nothing on the face of the earth is more beautiful than the green verdure that covers the earth's crust. The fascinating forms of the flowers with the infinite variety of their colours, the splendour and elegance of their shapes and their alluring fragrance have all a charm and influence to gain the greatest of wide human appeal and attraction. While this is true of the land-flora it is equally true of the marine vegetation that bedecks the ocean floors and the long stretches of sea-coasts of the continents bathed by the ceaseless roaring breakers. For the extreme fineness and delicate nature, for the extreme range of their sizes and shapes and for the variety of combinations of all conceivable colours, the sea-weeds are no less attractive than their counter-parts on the land. But then, as most appropriately inscribed in the oft-quoted quotables as in the famous verses of Thomas Gray which opens this chapter, notwithstanding all the attractive features, the sea-weeds constituting the "Sea-Gardens" are very little known and least appreciated by the great majority—nay even condemned as detestable. The reasons are not far to seek. The too obscure natural places of their growth, the hazards and risks involved in reaching those natural habitats, to see, to understand and enjoy the innumerable species of plant life in their natural vigour, luxuriance and beauty, forming an amazing admixture and assemblage of plant communities of different kinds, incessantly and violently agitated by the turbulent sea with swift, swirling, sweeping currents, and mighty roaring breakers, or reposing during low tides, in clear, calm and quiet waters in the inter-tidal rock-pools and lagoons, disturbed only very mildly by the gentle ripples in the water-sheets, are perhaps some of the contributory factors for their being not appreciated. Further, the rapid deterioration they are liable to on being detached from their original places of growth is again a factor detracting attention; and the heaps of these plants often stranded on the beach above high-tide-mark are more often objects detested by the general visitors to the beaches, and they coming to be branded as "sea-weeds", are least cared for or even avoided for the obnoxious odour they emanate, to the association of carrion flies and insects of various sorts, infesting or humming over the cast-ashore litter.

Factors influencing marine algal growth

The more important factors influencing the growth of sea-weeds are (1) *the nature of the substratum*, (2) *effect of tides*, (3) *surf or wave action*, (4) *clearness of sea-water* and (5) *biotic and seasonal changes*.

A purely sandy beach harbours practically no alga. In striking contrast to this, a rocky coast supports quite an innumerable variety of algal vegetation. The rocky nature of the coast may be due to the naturally occurring rocks, huge boulders and stones or to the artificial masonry and similar structures, or again to the extensive formations of coralline beds and reefs. In such situations where the wave action is strong and is attended with swell and swift currents bathing the hard substrata, different kinds of algae grow in profusion. If the coast happens to be somewhat flat and extensive and gradually sloping towards the sea with marked tidal effects of complete submergence during high-tides and successive exposure during low-tides, that offers the best and most favourable fields for an infinite variety of algal population, occurring as open shore formations or in inter-tidal lagoons, bays, rock-pools and puddles, or in creeks and inlets. Beyond the low-tide mark, and in the sub-littoral regions of the coast, deep water forms flourish, some species descending down to several fathoms. Great many of the sea-weeds are susceptible to turbidity and pollution of sea-water, and only a few marine algae tolerate such environments. The sea-weeds, however, attain their luxuriance, both in growth and number where the sea-water is very clear with good penetration of sun-light to greater or lesser depths. Seasons have also a marked effect

on the growth of several species, particularly those flourishing on the upper limits of the littoral belts. The cool winter months about December or January support a climax of littoral marine vegetation in many places under different situations, which for their abundance, variety, density, and distribution, surpasses any imagination, while the hot summer months of March-May, inhibit the growth of several species, resulting in a remarkable poverty of vegetation or complete depletion and disappearance of most of the forms, striking thus a disappointment.

Animal populations in the sea have also great influence on marine algal growth. While many sea-weeds are nibbled by fishes, crabs, lobsters, prawns etc., several other forms of animal life exert such an influence as to preclude the growth of algae in many places. For example, the *Balanus*, *Tectorius*, *Littorina* etc. growing firmly attached to rocky substrata, covering extensive surfaces, preclude any algal vegetation. In rock-pools sponges such as *Tetillia* are not uncommon, and in various other places, Hydroids, Polyzoons, *Astrea* etc. populate to the elimination of algae. Several species of Molluscs, however, aid the growth of a few species, as their dead-and-broken shells offer very good substrata and anchorage.

Nature of Indian Coasts

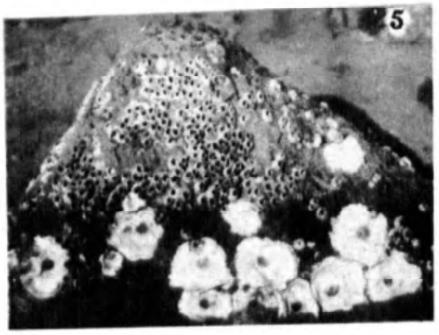
India has a coastal stretch of about 5689 km. On the West, the Arabian Sea washes the shores of the Gujarat, Maharashtra, Bombay, Mysore, and the Kerala States. On the East, the Bay of Bengal washes the coasts of Sundribans, portion of West Bengal, Orissa, Andhra Pradesh and Madras States, and the southern promontory of Indian Peninsula is bathed by the Gulf of Manaar and Indian Ocean, along the coasts of southern portions of Madras State. On the Arabian Sea side, the Gulf of Cutch and the Gulf of Cambay are the more important gulfs. On the Bay of Bengal coast, the Chilka Lake at Orissa and the creeks and inlets of Sundribans are the more important features of the coastal strip.

The Geology of the coast is very varied. At Cutch, recent deposits of newer Alluvium is characteristic. The Gujarat coast is composed of Deccan traps and Tertiary rocks and in places, newer Alluvium with limestones with Miliolite fossil forms, known as Porbandar stones, which are of Pleistocene age. At Gulf of Cambay, newer alluvium is met with. Bombay coast is primarily of Deccan trap and rocks of green basalt, which are glossy black above and covered by calcareous surfaces. Further south, along the west coast up to Cape Comorin, Archaean Gneiss and Schists, laterites, and Tertiary sedimentary formations are seen. On the East, along the Madras, Andhra and part of Orissa coasts, Archaean Gneiss schists and cretaceous sediments, overlain by Tertiary formations are seen, the latter at Cuddalore and Pondichery in S. India, with newer Alluvium here and there. The Sundribans consists of recent alluvial beds. Pure sandy stretches are frequent for greater or lesser distances along the entire east & west coasts.

Besides the main land, there are a few islands of which the Andamans, the Nicobars, (in the Bay of Bengal) the Laccadives and the Minicoy (in the Arabian Sea) are the more important. In the Gulf of Manaar, there are quite a number of small islands of interest of which Pamban, Rameswarm, Krusadai, Shingle, Dhanushkodi, and Hare islands are the more important. Many of these islands are ring-reefs and composed of boulders and coral lime-stones and coralline rocky conglomerates with great activities of living corals.

Along the coasts, the more important places of Algal interest are the Okha Port, Dwaraka, and several places along the Gujarat coast, Bombay, Karwar, Travancore, Cape Comorin, the various islands in the Gulf of Manaar, Tuticorin, Madras, Mahabalipuram, Waltair, Chilka Lake and Sundribans. Among the Archipelagoes, the Andamans, the Nicobars, the Laccadives and the Minicoy are of great interest for marine algae. For an enormous assemblage of variety of most interesting forms, the Gujarat coast and the island stretches in the Gulf of Manaar are of special interest, the former perhaps excelling all other areas in India for the luxuriance, variety, abundance and occurrence of several species not usually to be found in the tropical seas. The Cape Comorin has a distinctive algal flora which also for its variety and luxuriance, is noteworthy.

Tidal effects and the nature of substrata in the littoral belts have great influence in the luxuriance of the algal vegetation. In some areas, the difference between the high tides and the low tides is great, while in other stations, though that may not be considerable, yet



1. Aspect of an open rocky coast, with Granite and Charnokite, naturally occurring or artificial rocks and huge boulders at Mahabalipuram, Seven Pagodas, near Madras. 2. Aspect of rocky coast with huge rocks in the sea at Cape Comorin, South India. 3. Inter-tidal pools during low tide at Okha Port. 4. Aspect of coast at Dwaraka and Okha, with hard, sharp edged, corrugated basaltic rocks and limestones. 5. A small boulder at the shore heavily colonised by barnacles (*Balanus amphitrite*) and other shell-forming animals. 6. An aspect of coral reef with inter-tidal lagoons and pools, interspersed with coralline rocks of various types and sizes at Krusadai Island, during low tide.

is very appreciable. Where the inter-tidal zone is gently sloping towards the sea, and has a vast stretch of sea-floor exposed and flooded during the low tides and high tides respectively, several species of algae flourish in various situations, either as open shore formations, or in puddles, pools, lagoons, crevices, creeks etc. In these situations, the algae get completely exposed during low tides, and again completely submerged during high tides, as the case may be, according to the situations. A pure sandy or muddy sea-floor harbours very little or few forms, while hard substratum, either rocky or coralline in nature, supports quite a variety of species.

Collection and preservation of marine algae

A good knowledge of the tidal conditions of the area from where collection of sea-weeds is intended, is essential. High and low tidal points are reached twice each day, and the hours of such incidents vary from day to day. The tide tables should be consulted to choose the best time for collection, and the local conditions should also be best ascertained. Strong winds are not advisable. Choose a fine day with the low tides quite appreciable. One should not venture, and one should also be not over-enthusiastic. Greatest caution is to be taken while going out into the sea for collection. With the receding tide, it is better to set out for collection, and reach straight the lowest point of the low-water mark, as far as tide would admit on the particular day. With the advancing tide, work gradually up from the low water mark to the shore, retreating with the advancing tides.

The inter tidal zones are the best for work when the tide is lowest. Go steadily about the tidal flats, or down the rocks, as water recedes, and examine very closely pools, rocks, crevices, overhanging rocks and boulders, cliffs, large silted lagoons, coralline beds, creeks and reefs. It would be advisable to make first a preliminary rapid survey of the places to acquaint with the areas of collection before intensive collections are started. At nights, if low tides are favourable, on reef-flats and other safer places, one could go out with Petromax lamps and make collections.

Care should be taken against possible injuries from jelly-fish, star-fish, ray-fish, sea-scorpion, sea-snake etc. It would be advisable to probe a long stick in crevices and clefts in rocky beds and coral reefs, before collecting the algae from there to ward off possible hiding animal populations which may be injurious. The delicate sea-weeds which might be covered over by larger algae, should also be looked for by carefully lifting the larger sea-weeds.

Sheltered areas where large accumulation of sea-weeds occur, floating or suspended in the body of water and brought by the current or strong wind, should also be visited for collection. One can stand in amidst such huge accumulated sea-weeds, and by gently clearing a small area and floating the good ones and separating them from the lot, very good collection of rarer and deep water forms can be made. Deep water forms may be collected either by means of a dredging apparatus or by engaging professional or experienced divers. The huge mass of algae washed ashore during hightides should also be turned over and examined for possible new finds, from deeper areas, which cannot be easily reached or from where collections are difficult or impossible, under normal conditions.

To prevent from slipping, and to protect the feet from injuries and cuts from barnacles, corroded shells, reefs, shell-limestones, and knife-like edges of traps, heavy canvass or rubber shoes with thick and deeply corrugated soles should be worn. Loose flying shawls and clothings are to be avoided as they may, not only interfere with comfortable collecting and examination of specimens, but also lead to accidents.

The following may be recommended as general equipments for collections and preservation of algae. Convenient sized water-proof bags, or flexible plastic pails, or baskets; wide mouthed jars of two or more sizes; specimen tubes with corks; small tools for scraping and breaking rocks; knife, scissors, mounted needles, brushes; large quantity of newspaper cut to convenient sizes; good paper for labels; soft grade black-lead pencil; loose note books; field books with field numbers, if available; waxed paper; white paper with good rag content or drawing paper cut to convenient sizes; good washed linen or cloth pieces; herbarium blotters; herbarium press; wooden forceps; large, medium and small sized photographic developing trays; plywood pieces cut to convenient sizes; pipettes; measuring cylinder; 40% formaldehyde in quantity, rectified spirit in quantity; and if kerosene tins with lid

sealed except for one corner opened could be procured they may also be included in the collection kit.

While making collections, it is necessary to examine and study the local places of growth, ecology and associations of several sea-weeds that are met with. Critical notes on them should be made in the field. Larger and coarser forms such as *Sargassum, Turbinaria, Codium, Gracilaria* etc. may be kept rolled up in wetted thin sack-pieces or newspapers and kept in the basket. The delicate forms, soon after collection deteriorate and they need immediate preservation. Species of *Polysiphonia, Griffithsia, Dasya, Spathoglossum* and a few filmy and delicate filamentous red algae require immediate attention after collection for their preservation. Small quantities of these delicate forms may be kept loose in plenty of sea-water in tubes or jars, till they are finally preserved.

Individual collection should be kept separate with their respective field numbers and labels, and corresponding specimens of the same be also kept in alcohol or formalin preservatives with the appropriate labels. Some species like *Dictyota, Dictyopteris, Spathoglossum* etc., on being collected and kept long, change their natural brown colour and become dirty green. To avoid this, the specimens should be thickly packed in roll of wet paper and at the time of preservation spread out and best portions selected. Several hard, or calcareous algae as *Jania, Chielosporum, Amphiroa* and *Lithothamnia* need no special attention.

One should try to collect and bring as much as possible. The rarer and delicate, microscopic and epiphytic forms should not be overlooked. It is always desirable to pick from a spot only as much of algae as are absolutely needed and depletion of the forms is to be rigidly avoided. Every specimen collected should bear a field number and sufficient notes recorded as to the range of variations, condition of growth, associations, and any other factor of interest. For large museum specimens, good samples, complete with 'root' and holdfast should be selected and on being placed in paper-bags with labels, be dropped in kerosene tin with 4% sea-water formalin, to be later on separated and preserved in suitable containers or Museum Jars. The tin, when sufficiently packed with such collections may be sealed tight and despatched to headquarters.

Always make as many surveys and collections as possible from the same areas for a few successive days as this will reveal forms which might have been overlooked earlier. By experience one will be able to chalk out a programme with necessary equipments to make a profitable collection.

On bringing the collections to the shore, it is necessary to attend to them on the same day of collection for their preservation as herbarium or fluid specimens. Otherwise, they would decay, emanating a foul smell if kept in stagnant water. If, however, observations on fresh specimens are desired for any interesting life processes, etc., small portions of the fresh alga may be kept in a large tray with plenty of sea-water, but the water should be changed carefully as often as practicable.

For preparing herbarium specimens, the most delicate ones should be attended to first. The process is briefly described below. Keep sufficient quantity of sea-water or fresh-water in a large enamel tray of the type used for photographic developing work. From the collections, select out portions and wash them well in the water in this tray, to remove debris, sand particles, small animals attached to the plants, etc. Take another tray, smaller in size, about the size to take in a foolscap paper. Keep clean sea-water and float on it a cut piece of plywood. Over the floating plywood piece, place a clean, white mounting paper or drawing paper or any good quality paper with good rag content. Wet the paper thoroughly. Over this paper, on the floating plywood piece, place the selected specimen, after rinsing a few times in clean water and work up the specimen gently first by slightly immersing the plywood with paper and specimen, so that the specimen may spread out without much of overlapping of its parts. In case of finely filamentous and much divided thalli, the still overcrowded or overlapping portions can be spread out by pouring water over the portion by means of a sponge or wet cloth and also by working the specimens with a fine camel-hair brush. When the specimen is satisfactorily spread out, allow the plywood to float, when practically all the water on the paper would drain except perhaps for a thin film. Now, take a piece of cloth sufficient to cover the entire specimen. Wet it, and after squeezing out the water, and stroking it a few times to make it free from wrinkles, place it over the specimen to cover the same. The specimen will thus be in between the paper and the cloth. Gradually lift the nearer side of the paper and the cloth with the specimen, and remove it from the plywood piece, and holding

by the fingers of both the hands, the excess water can be drained. Keep the specimen then with the paper and the cloth, on drying blotters and when sufficient number of specimens are brought to the blotters to form a convenient sized bundle, keep the herbarium presses on either side of the bundle and tie them rather lightly and allow the bundle to dry in shade under moderate pressure. It is absolutely necessary to change the wet blotters in the initial stages as frequently as possible, preferably the first change after six or eight hours. If possible, the specimens in the press should be dried over hot air because the algae retain their natural colour if dried within 12 to 24 hrs. While changing the blotters, it is advisable also to gently remove without affecting the specimens the cloth piece over the mounted specimen, and again replace the same if it is not too damp, or by replacing with a fresh one, till the specimens are perfectly dry. When completely dry, the mounted specimens on the paper, may be kept together, now without cloth pieces covering them, in dry folders. The same wet blotters and the wet cloth, on being dried can be over and over again used. The algal specimens will stick to the mounting paper because of their own adhesiveness. Keep with each and every mounted alga, the field number relating to the specimen, and ultimately, the mounted sheets, which may be of different sizes should be affixed to standard sized (44.5 × 28.5 cm) herbarium mounts, by their corners.

Very robust and coarse forms such as *Turbinaria*, *Sargassum* etc. may be dried by spreading them loose on sheets of paper in shade, and frequently turning them. When they are thus dried, they may be rolled gently in paper with the labels and kept for future study and use.

Documentation of the specimens is very necessary and it should be as complete and detailed as possible, particularly to indicate the date of collection, the locality, habit, geological nature of substrata (sandy, clayey, chalky, coralline, rocky, etc., as the case may be), epiphytic, parasitic etc., ecological notes, (occurrence in rock-pools, surf-beaten faces, swamps, exposed or sheltered habitats, etc.), associated species, collector's name, and where possible, notes may be made on the stage, condition, appearance and properties of the specimen, and the local names if known.

If any specimen is suspected to become mouldy, the specimen may be kept in 50% alcohol and 5% formalin for two or three days, and then mounted afterwards and gently coated with 1% Mercuric chloride in alcohol or dipped in 1% 8-hydroxyquinoline sulphate and redried and preserved in the herbarium. Para-dichlorobenzene may be used as insecticide in the Herbarium cup-boards.

For critical studies, liquid preserved specimens of algae are also required. While there are various special fixatives and preservatives used, for general purposes, the specimens may be preserved in 4 to 5% formalin in sea-water or even half of that strength, in very hot localities. The specimens should not be crowded, but kept with plenty of the preservatives. Care should be taken to keep the correct labels, written in good drawing paper with Indian-ink.

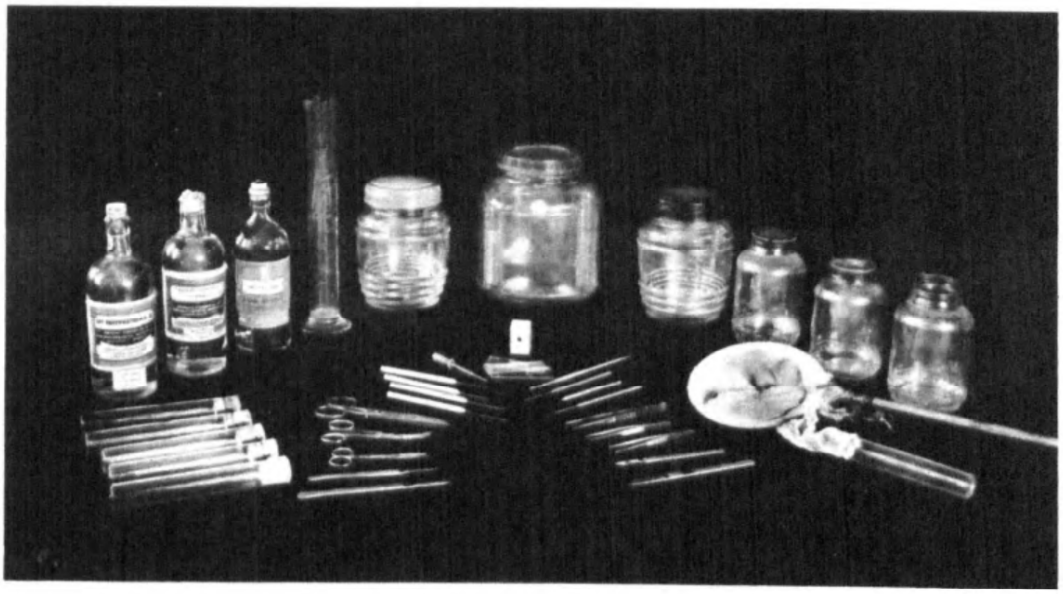
In the study of the algae, sectioning will have to be resorted to. For general purposes, the simple method is by keeping tight two safety-razor blades together, and holding the piece of the alga to be cut between the thumb and the forefinger of the left hand, stroke the portion of the alga in several close sequences with the razor-blades in the right hand to give sections of the alga. Select the proper ones for study and mount. By teasing and crushing the specimens also, microscopical preparations for study can be made. Freezing microtome is also used wherever found necessary. In case of rigid and hard and dried specimens, if the sections do not expand in water to disclose structures, treat the sections with a drop of muriatic acid. For quick examinations, sections may be stained with Iodine in aqueous solution for Green algae, with Methyline blue for Brown, and Congo-red followed by weak Caustic potash for red-algae. With a little experience, one will be able to develop his own technique to suit particular purposes.

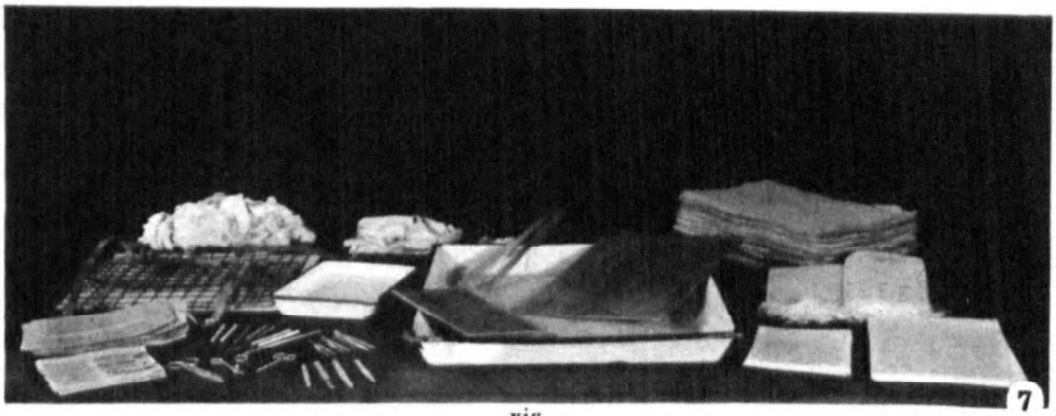
Need for ICONES of Indian Algae

Valuable publications with excellent colour illustrations of Marine Algae of the Australian, British, European, American, Japanese and Red-Sea coasts are available which have added considerably to the knowledge and wider appreciation of these flora throughout the world. Among the more important in these are the works of Turner, D. on *Fuci*, 4 vols., 1808-1819 ; Kutzing, F. T. *Tabulae phycologicae*, 20 vols., 1845-1871; Harvey, W. H. *Nereis*

boreali-Americana, 3 vols., 1846-1851 ; *Nereis australis*, 2 vols., 1847-1849 ; *Phycologia Australica*, 5 vols., 1858-1863; *Phycologia Britannica*, 4 vols., 1846-1851 ; Vickers, A. *Phycologia Barbadensis*, 1908 ; Alfred Gatty, *British Sea-weeds*, 2 vols., 1872 ; Johnstone, W. G. and Croall, A. *Nature Printed Sea-weeds*, 4 vols., 1859; Okamura, K. *Incones of Japanese Algae*, 7 vols., 1907-1942 ; Zanardini, G. *Phycological monographs*, 1860-1876 and several others.

Practically no illustrated account of Indian algae is available as on the above lines. Boergesen, F. published in a series, systematic account of the Marine Algae of South India (1932-1935), of the Northern part of the Arabian Sea and Okhamandal Sea (1929-1935). In these, Boergesen has given valuable illustrations, to help in understanding the structures of algae of diagnostic value. Anand, P. L. published a small account of the marine algae of the Karachi Coast during 1940 and 1943. While these works are valuable in their own way, there has so far been no attempt made to publish an illustrated book on Indian Marine Algae comparable to the foreign literature in these respects. The present attempt, in a humble way, is to meet this need, and it is hoped to carry the series to a few more volumes to cover as many of the Indian Sea-Weeds as possible. To make the publication useful for the research workers and others interested in Marine algae, original and authentic illustrations of diagnostic value and anatomical interest are also adapted in this work after the valuable published works of Boergesen, Desikachary, Balakrishnan and others.





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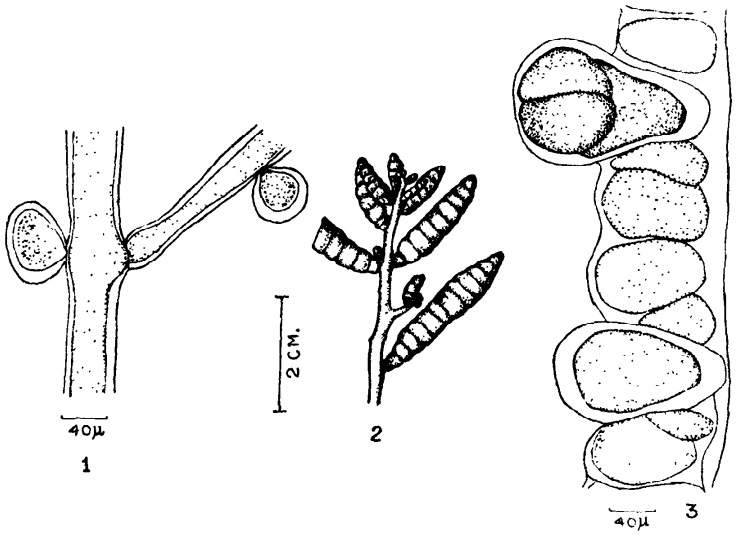
GASTROCLONIUM IYENGARII Srinivasan

Frond cartilaginous, erect, cylindrical, 10-12 cm or more in height, 2 cm thick ; older parts dark brown ; younger parts light green to light red ; branching pseudo-dichotomous. *Ramuli* numerous, lateral in acropetal succession on frond, inflated, linear-oblong, segmented, 15-20 mm long and 2.5-3.5 mm broad ; number of segments 11-20 in each ramulus ; mid-segments longer than the basal and distal segments. Cavity inside the ramulus intercepted by diaphragm at intervals. *Axial filaments* of ramuli 16.5-30μ across; *bulb-cells* 23-33 $\times$20-26μ. *Tetrasporangia* pyriform 100 $\times$ 50μ. *Tetraspores* by tetrahedral division. Sexual plants not seen.

Habitat : On Rocks below low water mark ; on coralline substrate ; Okha Port.

The red alga illustrated here is a very rare sea-weed of the Indian coast. This genus is newly reported for India with the discovery of *Gastroclonium iyengarii* Srinivasan, from Okha Port, the other species of *Gastroclonium* viz. *G. clavatum* (Roth.) Ardiss., *G. ovale* (Huds.) Kütz., and *G. coulteri* (Harv.) Kylin being earlier known only from the Atlantic, the Meditteranean and the Pacific coasts. The Indian alga grows in submerged situations, below low water mark, though in open bays, wherein there is much disturbance due to currents and swell during high tides. During heavy storms and high tides, when violent breakers are frequent, this alga with several others may be brought by the waves and cast ashore as ejectamenta. But, because of its rarity, this alga is not generally to be found with the huge mass of other sea weeds that get stranded on the shore. The alga attains its best and luxuriant growth during the colder months of January and February.

This sea weed can be very easily recognised by its general habit with an erect shoot, bearing large number of linear oblong articulated structures in tufts near the extremeties of the shoots bearing them. Their colour varies from red to pink while young and light red or purple with shades of light green when old.



1. Bulb cells. 2. Ramuli showing the number of segments. 3. A portion of the wall of the ramuli showing single layer of cells and tetrasporangia.

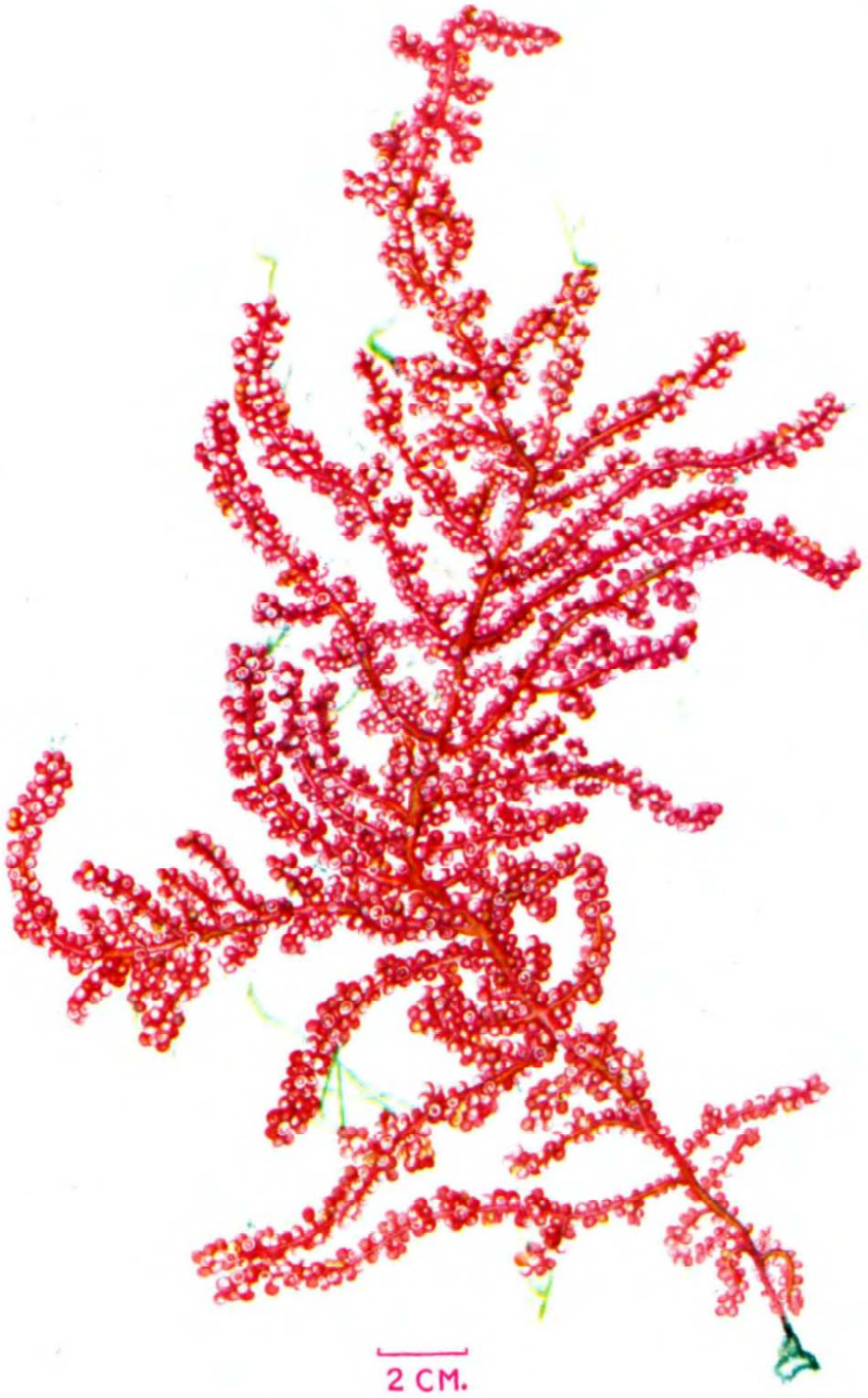
GASTROCLONIUM IYENGARII Srinivasan

BOTRYOCLADIA LEPTOPODA (J.Ag.) Kylin

Plants attaining 30-50 cm height, purplish red, attached to substratum by well defined holdfast ; much branched, axes and branches cartilaginous, terete to subterete. *Branches* covered entirely with numerous bladder-like vesicles. *Vesicles* numerous, generally radially disposed on branches, pyriform, globose, shortly pedicillate, varying much in size from 1-2 mm broad to 4-5 mm in diameter, mostly smaller in size, and generally with rather large vesicles intermingled ; younger vesicles occurring in between the older ones. Cavity inside the vesicles filled with clear mucilage. *Wall layer* of vesicles 60-65μ thick, 2-3 layered. *Innermost layer* of large cells covered near periphery by a cortical layer. *Cortical layer* of one or two cells thick made up of a large number of small cells of variable size forming a dense cover. *Gland cells* on the innermost large cells and facing the cavity inside the vesicles, globular, regularly distributed, generally single gland cell on each large cell, very rarely 2 or 3 on the same cell. *Substance* membranaceous, firm in the stem. Plants adhere well to paper on drying.

Habitat : Dwaraka; in lowest littoral zone or sublittoral zone ; in large and deep intertidal rock-pools, towards the bottom regions; completely submerged under water even in low tide. Dhanushkodi; Pamban coast; Cast ashore ; Cape Comorin, on the sides of rocks violently dashed by waves and swept by strong swell and gushing currents.

The present red-sea-weed is one of the many stately marine plants of the Indian coast. The plants growing at Cape Comorin are comparatively shorter, but more rigid and firm and the vesicles are also more densely set on the branches. They occur also in open situations, though always submerged under water, and subjected to violent wave action, swell and currents. A sort of algal zonation in these situations is seen at Cape Comorin. Thus, on the sides of rocks, the upper zone is populated by *Caulerpa racemosa* var. *uvifera*, *Caulerpa peltata*, *Corynomorpha prismatica*, *Neurymenia fraxinifolia* and *Botryocladia leptopoda* as one proceeds from top downwards ; below this no plant growth is seen. In their stature, height, more robust nature etc., the Cape Comorin alga suggests the plants found in the Mediterranean, which are known to reach only 5-6 cm height, but the latter are shallow water forms. At Dwaraka, the alga reaches very good dimensions, and good number of plants flourish even in deep and large intertidal rock-pools. Here they are seen at the bottom regions of the rock-pools firmly attached to coralline or rocky substratum and with fine silt also, the alga always occurring submerged under large sheets of water of more than 10 m at places.



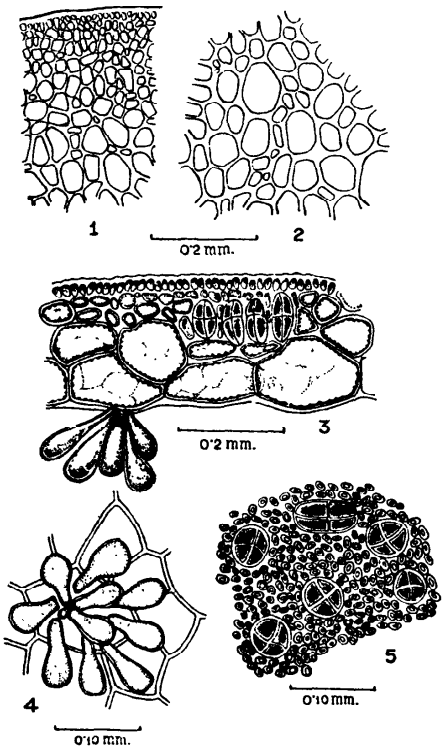
BOTRYOCLADIA LEPTOPODA (J.Ag.) Kylin

BOTRYOCLADIA SKOTTSBERGII (Boergs.) Levr.

Plants small, reaching a height of about 2.5 cm, dark purple, slimy, with a flat disc-like holdfast. *Erect shoots* terete, thin, tough, 1-2 mm in diameter. *Stem* solid, simple or branched, branching irregularly alternate or dichotomous, thus resulting in plants being simple or sparsely tufted. *Branches* ending in vesicular structures, up to 15 or more vesicles. *Vesicles* spherical to pyriform, and in older plants obovate to pyriform, 10 mm long, 6 mm broad, hollow inside. Cavity filled with slimy clear thick mucilage. Wall layer of vesicles with 3-5 layers of cells. Glandular structures present, projecting into the cavity of vesicles, occurring in clusters numbering as many as 20 gland cells. *Tetrasporangia* spherical to ellipsoidal 22-33μ × 19-22μ, occurring in the wall layer of vesicles.

Habitat : Kavarathy Island; Laccadives, on rocks in open situations, dashed by violent breakers.

The red alga represented here is a very rare one for our coast, and is newly reported from the Laccadives for the Indian region. The alga grows in small patches firmly attached to substratum which is rocky, and is found to prefer situations which are not exposed to direct sun light, on the under sides of rocky outcrops. Because of its small size, and the open situation where it grows, being in the surf-beaten areas, the collection is somewhat difficult, and several scrapings alone could yield a fair number of plants.



1. Transverse section of stem, peripheral portion showing small cells.
2. Transverse section of stem, central portion showing large cells.
3. Section through a portion of the wall of the vesicles. Note gland cells from lower portion and tetrasporangia in the wall layer.
4. Group of gland cells.
5. Tetrasporangia in optical section.

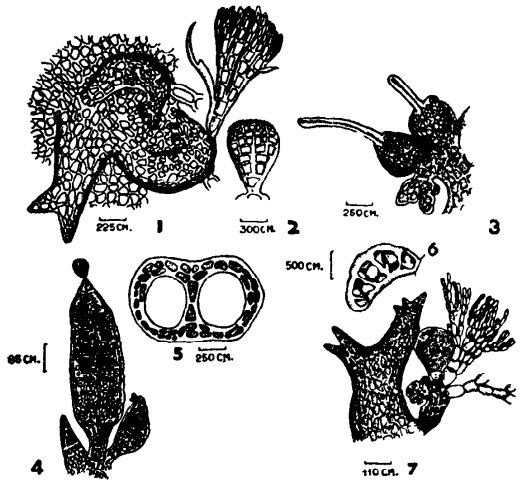
BOTRYOCLADIA SKOTTSBERGII (Boergs.) Levr.

NEURYMENIA FRAXINIFOLIA (Mert.) J. Ag.

Frond flat, membranous, leaf-like with distinct midrib and parallel veins. *Stem* cylindrical, simple or branched, being the thickened and denuded midrib of primordial leaf-like structures, very rigid, hard when dry. *Leaves* simple or pinnately lobed, linear oblong, membranous, lamina in older plants decayed and midrib serving as a stipe. *Lamina* 8-15 cm or more long, 10-25 cm broad, obtuse at base, emarginate and rounded at apices, slightly undulate, serrated throughout. Younger leaves starting from the midrib of older lamina. *Veins* patent with proliferations. *Proliferations* repeatedly arising from both surfaces of midrib. *Teeth* along margins of lamina, spinose with subulate and recurved ramuli; similar processes arising from veins and midrib also. *Fructifications* in secondary adventitious branchlets. *Stichidia* elongated, ovate or oblong, apex rounded, shortly stipitate, containing double ro ws of tetrasporangia. *Tetrasporangia* 100μ long, 70μ broad. *Androphore* spherical, 120μ in diameter. *Procarp* obovate, urn-shaped, 60μ broad, 70μ long. *Cystocarp* solitary. *Colour* deep red, purplish, becoming reddish-brown on drying. *Substance* very crisp and rigid. The alga does not adhere well to paper on drying.

Habitat : Tuticorin; Hare Is. ; Cape Comorin ; Krusadai Is. ; Shingle Is.

This red-alga is one of the beautiful species with its bright red leaf with prominent veins and is an inhabitant of deeper waters and situations, well protected from the direct action of waves or sunlight. At Cape Comorin, the alga grows forming an interesting community well below the surface level on the vertical faces or inwardly scooped out portions of rocks, which are only strongly agitated by the swell and swift currents. The higher regions in the habitat are colonised by *Corynomorpha prismatica*, *Caulerpa peltata*, *Caulerpa racemosa* as one proceeds from below upwards. Another alga associated with *Neurymenia* is *Enantiocladia* in certain environments. In the Coralline beds at Hare Is., Krusadai Is., Shingle Is. etc., the alga is to be seen in deeper waters, and dredgings bring some specimens from these areas. The alga is cast ashore also. Epiphytes are frequent on the flat expanded lamina, practically covering and masking the beauty of this alga. *Leveillea jungermannioides*, *Melobesia*, and even such larger forms as *Hypnea musciformis* are not un-common epiphytes.



1. Portion of thallus with adventitious branchlets and trichoblast.
2. Young Trichoblast.
3. Fertile branchlet with two procarps.
4. Stichidia.
5. Stichidium in transverse section.
6. Androphore.
7. Branchlet with trichoblasts and globular androphore.

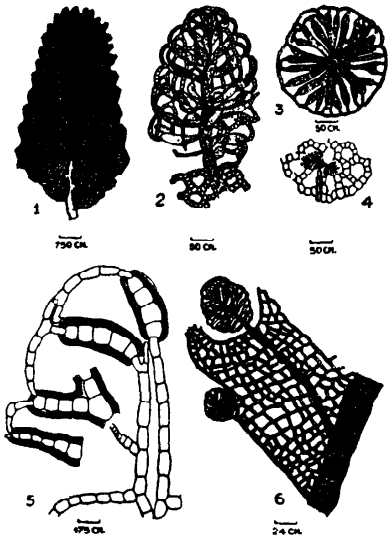
NEURYMENIA FRAXINIFOLIA (Mert.) J. Ag.

DICTYURUS PURPURASCENS Bory

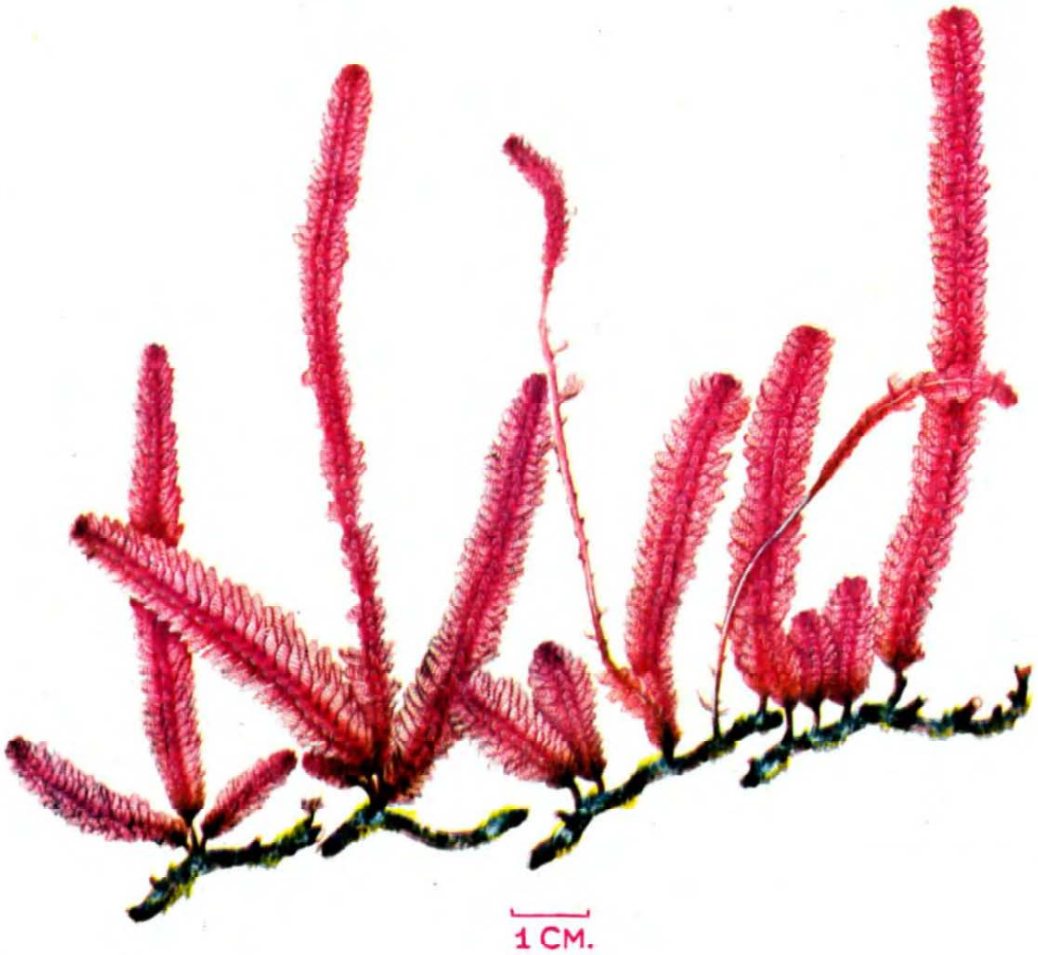
Plants with pretty articulated mantle-like thallus forming a sac-like net-work around the central main stem. *Main stem* erect, unbranched or only seldom branched until 6 cm high. Main axis bear transversal sympodial side branches and monosiphonous side branches, which grow together forming fine reticulate net-work around the main axis. *Side branches* distichously arranged, finally forming a closed continuous net-work. Thallus quadrangular in cross section or in older plants, tending to be octangular. *Tetraspores* in tetrasporic plants in stichidia at upper ends of transversal side-branches. *Stichidia* exposed outside the net-work when ripe. *Spermatangia* in complicated branch system of spermatangial branches. *Spermatangial branch system* in 4 rows along the quadrangular shoots or in 8 rows in octangular shoots. *Compound spermatangial branch system* 1-17 mm or more in length. *Spermatangial branch cells* up to 10-15μ or 30-40μ across or more. *Connecting filaments* of spermatangial branch 18-25μ across. *Cystocarps* in female plants producing carpospores.

Habitat : Cape Comorin ; Tuticorin ; Hare Is.

For the most complicated structure of the thallus as well as for the mere attractive nature of the same, the present red alga is, perhaps, unique among Indian sea-weeds. The alga occurs in clumps, several plants growing together, attached to the hard substratum by means of a well defined hold fast. Where it grows, the alga is seen to form good formations of close-mats. At Cape Comorin, it is seen to grow on the shaded and protected sides, and at the underneath portions of boulders which are exposed to surf action. The plants in such situations are comparatively shorter, and the colour of the alga is brighter. At Tuticorin and Hare Islands, the alga is seen in deep pools in the inter-tidal belts with fine sandy bottom with sprinkling of corals and hard dead shells and stones. In these situations, the alga reaches greater lengths, and the net-like thallus is feeble and flexible, with accumulation of fine silt in the interstices of the meshes in the thallus. The alga, in its young and healthier conditions shows a light red tinge, but with age, it becomes paler and dirty red. In the older plants, the mantle gets destroyed to a greater portion, when the main axis alone with the remnants of the thallus at its upper portions persists, presenting quite a contrasting appearance. The alga though occurring in the localities mentioned in S. India above, is not very common or dominant in any situation.



1. Portion of plant showing net-like structure of the thallus.
2. Spermatangial branch system. Note the enveloping net-work of the thallus.
3. Cross section of spermatangial branch system.
4. Young spermatangial branch system.
5. Spermatangial branches and mono-siphonous filaments and connecting filaments.
6. Section of net of the thallus showing main stem and two spermatangial branch systems.



DICTYURUS PURPURASCENS Bory

ASPARAGOPSIS TAXIFORMIS (Delile) Collins & Harvey

Plants erect with a much branched, entangling rhizome like creeping portion, giving off few rhizoids here and there below, and above erect shoots, appearing bushy in well developed plants. *Stem* terete, with bushy tufts above, 20 cm or more in height, branched. Lower parts of stem for some distance from the rhizome like portion, to about 5-15 cm without branches. Higher up, branches dense, closely inserted on all sides of the stem, 2 cm long, several times pinnated, attenuated at ends. Ultimate ramuli filiform, curved or coiled inwards. *Ceramidia* at apex of transformed ramuli, with large number of spores. *Substance*, in stem firmly cartilaginous, branches and ramuli, soft and flaccid. *Colour* dark brownish or purplish red. *Cystocarps* sub-sessile, urceolate, opposite to branchlet. In drying plants adhere firmly to paper.

Habitat : Okha Port ; Dwaraka.

This elegant red sea-weed forms in favourable situations extensive formations, several vigorously growing plants being met forming dense communities. This is particularly so at Okha, where in the sub-littoral belt, this alga is seen in profusion in certain localities. It prefers somewhat a sandy bottom, and the water in such places is also turbid to certain extent. In some young plants, the main stem is without branches and naked for over 10-15 cm.

ASPARAGOPSIS TAXIFORMIS (Delile) Collins & Harvey

HETEROSIPHONIA MUELLERI (Sond.) De Toni

Plants erect, forming dense bushy growth when vigorous and healthy. *Base* creeping, rhizome-like, perennial, thick, cartilaginous with short spine-like branchlets from the surface of rhizome. *Frond*, shaggy, erect with feathery stems—the primary branches. *Primary branch*, 10 cm or more in height, 1-1.5 mm thick, dark red with somewhat hairy structures, irregularly divided or dichotomous. *Branches* widely spreading, annual. *Segments* in main stem with 10 pericentral cells. Free ends of branch system, alternating in 2 rows on both sides of the main stem. *Pinnules* formed likewise, with 2 or 3 short spine-like branchlets. *Cells* in the older thallus 30-50μ broad and 100μ long, cylindrical. *Colour* when fresh dark red to rose red, older ones brownish-red. *Substance*, main stem, rigid ; branches, soft, flaccid. Plants adhere well to paper.

Habitat : Dwaraka ; Okha Port ; Hare Is. In low lying rock-pools, and lagoons, on the exposed coast. Also cast ashore.

The alga presented here is a beautiful member of the red sea-weed. It shows a vigorous and healthy growth in intertidal rock-pools, attached sometimes to sponges etc., and is an inhabitant of the regions more towards the lower limits of low tide. It prefers submerged conditions. During unfavourable seasons and in older plants, the lower portions of the stem are devoid of pinnules, when they present quite a contrasting appearance to the vigorously growing feathery and soft plants in bushy forms. At Hare Island, it is seen in large and shallow lagoons at the intertidal zone, where the seafloor is silted heavily with fine sand and mud with large sprinkling of dead shells, corals etc. In such places where the water is more or less turbid, the alga, in its submerged state is often clothed heavily with mud or fine silt.

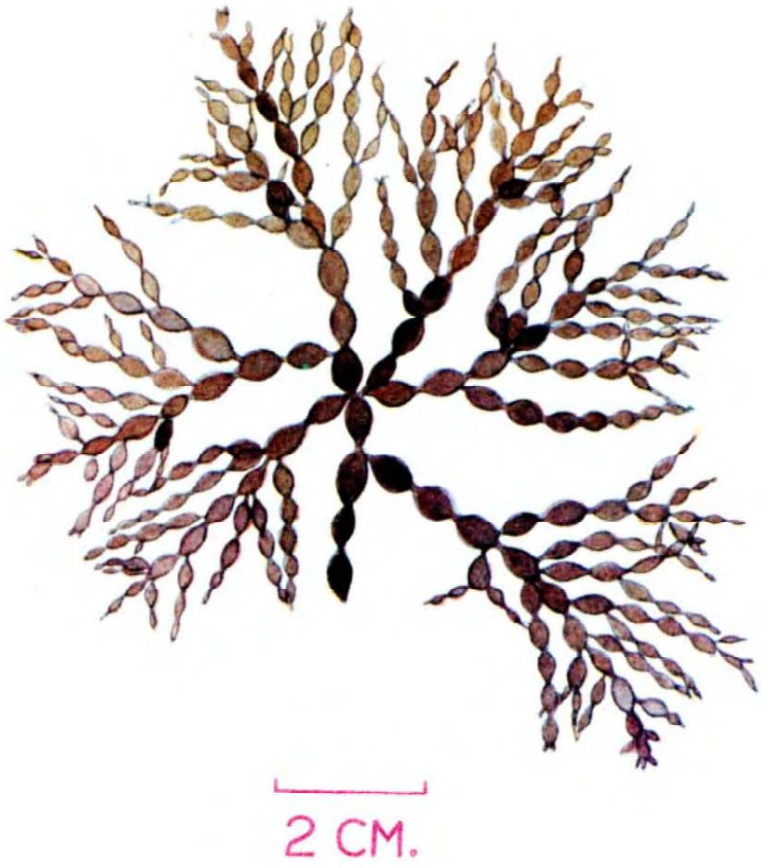
HETEROSIPHONIA MUELLERI (Sond.) De Toni

COELARTHRUM OPUNTIA (J. Ag.) Boergs.

Basal disc, minute, giving rise to a cluster of beaded and jointed fronds. *Frond* reaching up to 10 cm high, repeatedly divided trichotomous, fastigiate, constricted at intervals into bead-like internodes. *Internodes* separated by very slender, filiform nodes about 1 mm long. Internodes at basal parts larger, and at summits and free ends very small. Lower segments, cuneate, ovoid, 4 × 7 mm or larger ; terminal ones, rounded about 0.5 mm in diameter. *Conceptacles* minute, scattered irregularly on the internodes. *Substance* membranous, tenacious. *Colour* purplish red. In drying, the alga adheres perfectly to paper.

Habitat : Tuticorin ; Dhanushkodi ; Krusadai Is.; Okha Port ; Dwaraka.

The red-alga presented here is a beautiful species of the South Indian coasts, and is sometimes cast ashore, in large or small tufts. The cast ashore plants are often seen bleached white. Apparently the alga is a deep water species.



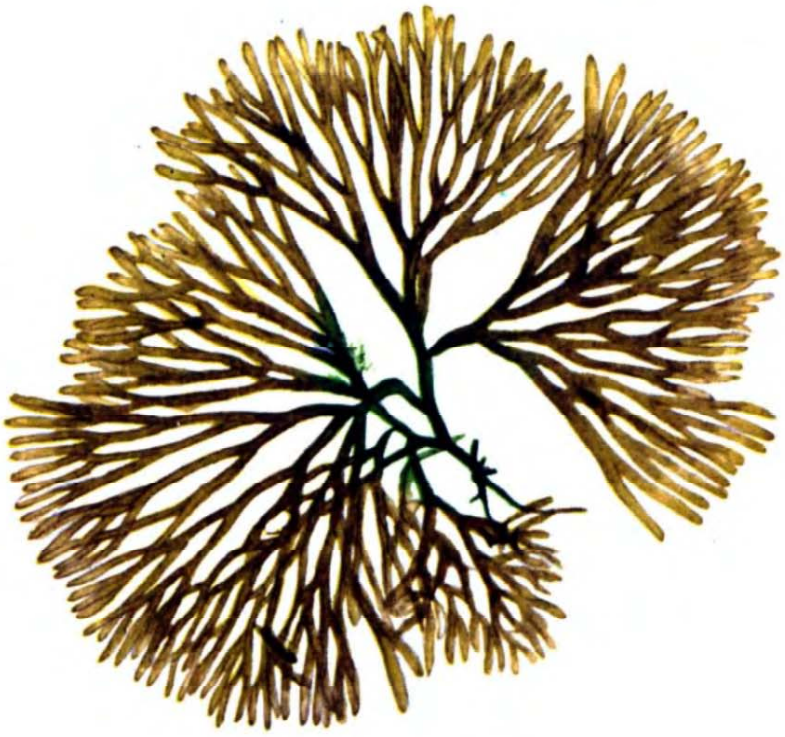
COELARTHRUM OPUNTIA (J. Ag.) Boergs.

SCINAIA FURCELLATA (Turn.) Bivonia

Frond sub-solitary or several together in clumps, reaching up to 8 cm or more in height, brownish-red to pinkish-red, firmly membranaceous or tender, gelatinous, repeatedly and regularly profusely dichotomously branched. *Branches* cylindrical or slightly compressed, acutely spreading, somewhat attenuate at base, greater in diameter in upper parts, 1-2 mm thick, very closely fastigiate. *Apex* of branch usually obtuse, occasionally attenuate. *Axial strand* obscure. *Carpospores* in masses, scattered, immersed. *Pericarp* 150-250μ.

Habitat : Okha Port ; cast ashore.

This plant is perhaps a denizen of the lower littoral regions and deeper waters. It is not so much in abundance as the other species in the locality, only few specimens being cast ashore. The species can be distinguished from the other species of the area by its more slender, cylindrical, closely fastigiate nature of the frond.



2 CM.

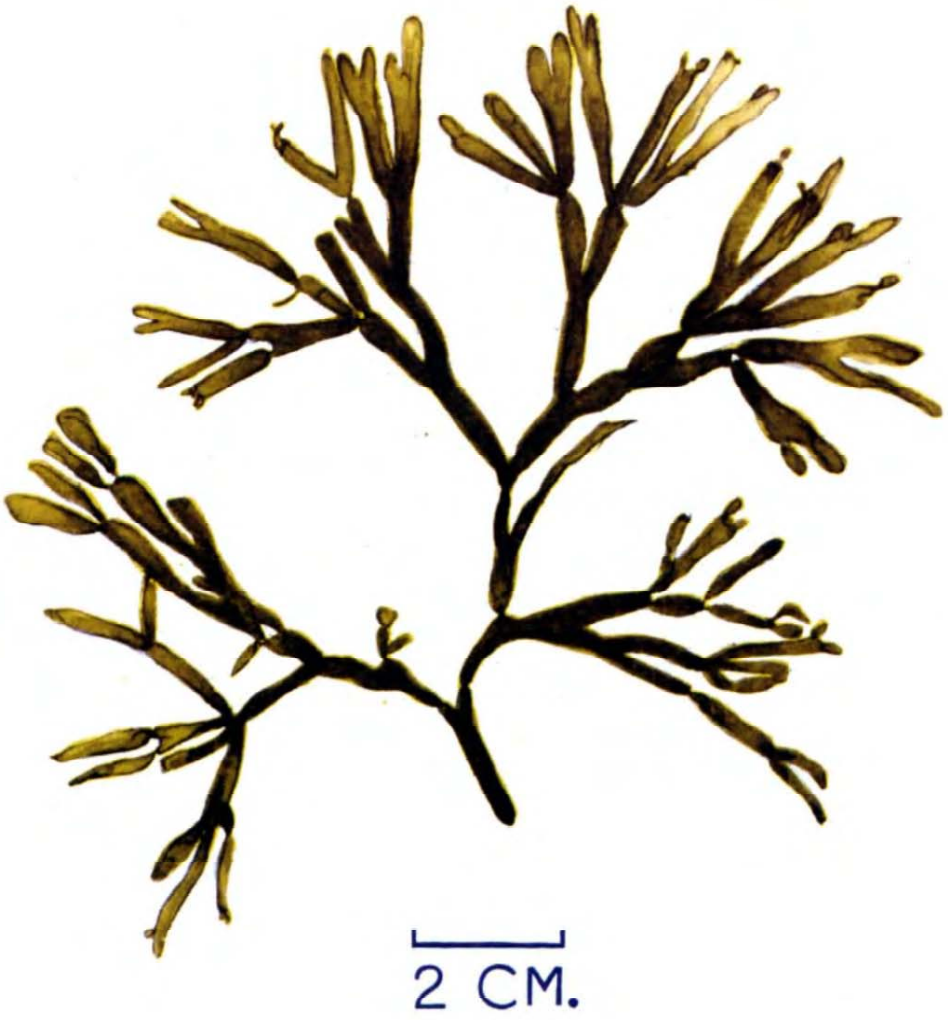
SCINAIA FURCELLATA (Turn.) Bivonia

SCINAIA HATEI Boergs.

Plant repeatedly forked, 9 cm or more in height, deep rose in colour, fading to dull and somewhat darker shades in lower parts, paler above. *Thallus* cylindrical, 2-5 mm thick, constricted at joints generally, though not always. *Segments* elongated, cylindrical, variable in size, up to 2-3 cm long in parts, tapering at base, broadly rounded or emarginate at upper ends. *Axial strand* visible in dried specimens, 230μ thick. *Epidermal cells* colourless, 23μ broad, 31μ long from surface view ; narrow coloured cells scattered among the colourless cells, some bearing the antheridia. *Assimilatory cells* pyriform, 13μ broad, 23μ long, single layered, loosely packed. *Cystocarps* roundish ; pyriform, 285μ long, 265μ broad.

Habitat : Dwaraka ; Okha Port ; in rock pools near low water mark ; cast ashore.

The species illustrated here is easily recognisable from the nature of its segments which are of variable sizes, and by the elongated and cylindrical form, and constrictions at joints being not as a rule. In the specimens examined by me I could detect the axial filaments in the dry state also. The alga though not rare, is met with in certain localised places and is also not often cast ashore in large numbers to be picked in quite sufficient quantities.



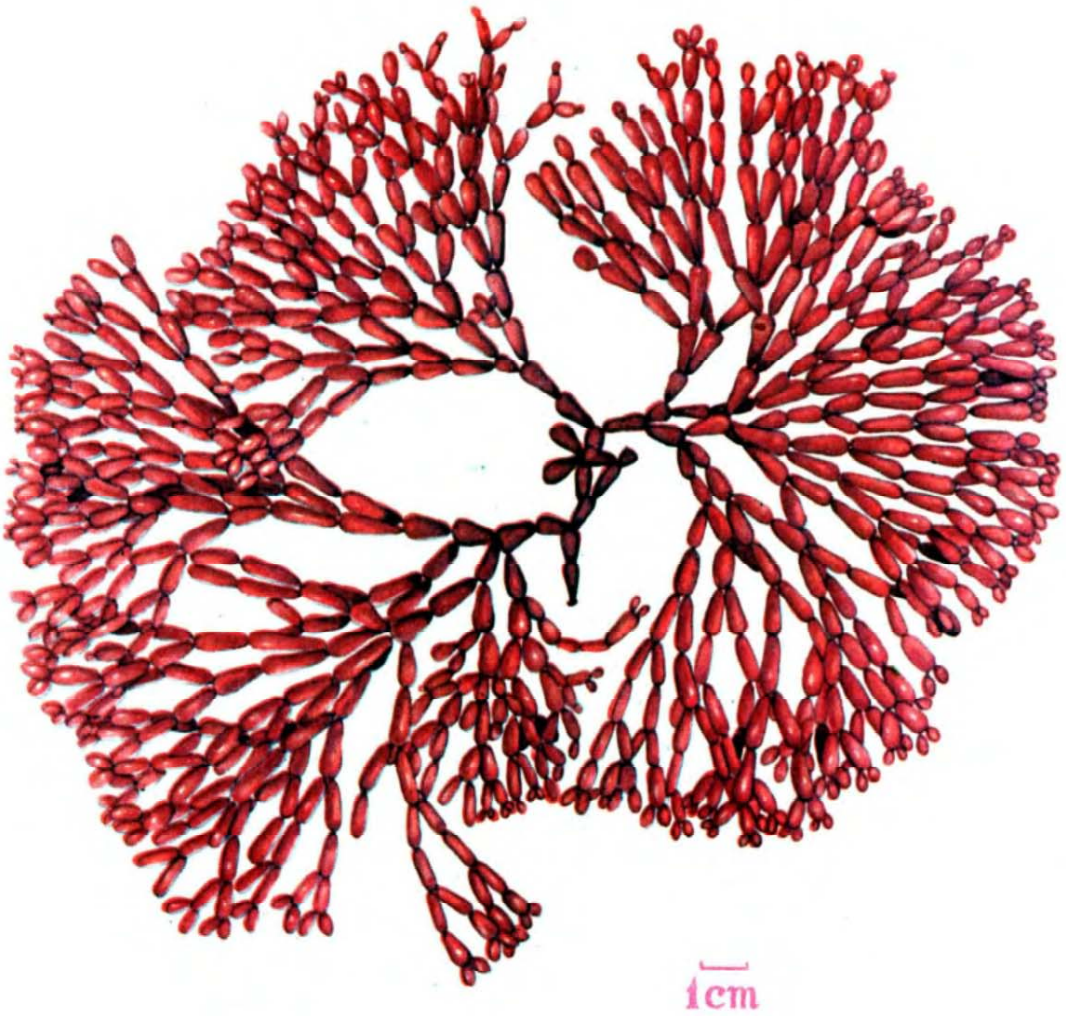
SCINAIA HATEI Boergs.

SCINAIA INDICA Boergs.

Plants fairly large sized, turgid and firmly built, reaching about 17 cm or more in height. *Thallus* repeatedly and regularly forked with deep constrictions more or less at regular intervals ; dichotomously branched more than 7 or 8 times with the result the forkings nearer the free ends giving the entire plant a clustered, articulated and beaded appearance ; greater part red in colour, tending to be darker red towards the lower portions and paler towards the tip portions. *Joints* variable in size and form ; in fresh plants either sub-cylindrical with broader rounded apex and attenuated base, 15 mm long and 4-5 mm broad or oblong oval, as long as broad, 5-6 mm long and 4-5 mm broad ; *cavity* in joints filled with mucilage. *Peripheral cells*, polygonal in surface view, colourless, 40-45μ long and 17-19μ or rarely up to 21μ broad. Between peripheral cells, a few narrow coloured cells present. *Assimilatory cells* globular or shortly pyriform, 16μ broad, forming a dense layer. *Axial strand* obscure. *Cystocarps* scattered over the surface of the joints, globose to pyriform, 250μ broad.

Habitat : Dwaraka ; Okha. Dredged at 10 metres ; frequently cast ashore in numbers.

This red-alga, is one of the most elegant and attractive form in its living and fresh condition. In its bright colour and repeatedly branched and jointed structure of the thallus, it resembles a large bunch of beads closely worked together. The alga is frequently carried by the waves from the deeper waters and cast ashore. Such drifted plants lose their bright colour, turning completely white and bleached. The alga grows below low water mark in comparatively deeper waters attached to rocks and coral pieces.



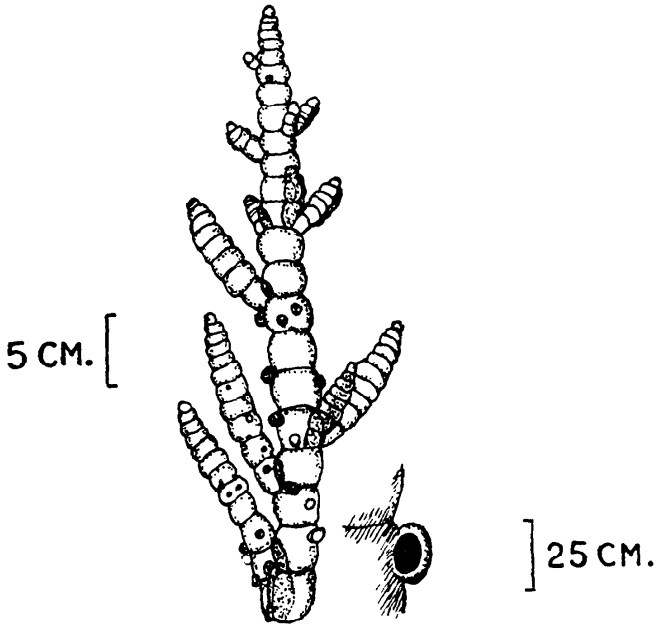
SCINAIA INDICA Boergs.

CHAMPIA INDICA Boergs.

Plants occurring in dense pyramidal tufts, 15 cm or more in height, rosy-red to darker shades somewhat. *Thallus* conspicuously articulated ; segments barrel shaped, 3 mm broad and as along as broad in the main branches ; in secondary and other branches, much shorter. *Thallus wall* one layer thick, made up of roundish polygonal cells, 50-75μ long, 50-60μ broad. *Cortical cells* present among wall cells. Cortical cells, smaller, about 12μ across. *Diaphragm* at joints, one layer thick, of polygonal cells. *Vertical filaments* traverse the interior of branches through the joints, ramified, ramifications reaching the wall-cells. *Gland cells* occur here and there, spherical. *Tetraspores* scattered over the surface of the thallus. *Cystocarps* small, depressed, subspherical, 500$\mu \times$ 600μ. Alga adheres to paper when dry.

Habitat : Dwaraka ; Okha, dredged from depths of 8 metres at Dwaraka ; cast ashore.

Among the several deep water red-algae that are ejected by the sea during swell tides, the present sea-weed is frequently to be seen carried in the body of rolling surf, and also in the stranded mass of algae on the shore. Sometimes the alga is seen growing luxuriantly in deep intertidal rock-pools at the bottom region and quite submerged under water. By its rosy-red colour and the articulated nature of the thallus, occurring in tufts, this sea-weed can be recognised in the field.



Portion of a branch showing articulations, and barrel shaped cells. Note the cystocarps scatteredonthethallus, occurring as small dots on the wall of the cells. Portion of thallus, showing the cystocarp, much magnified.

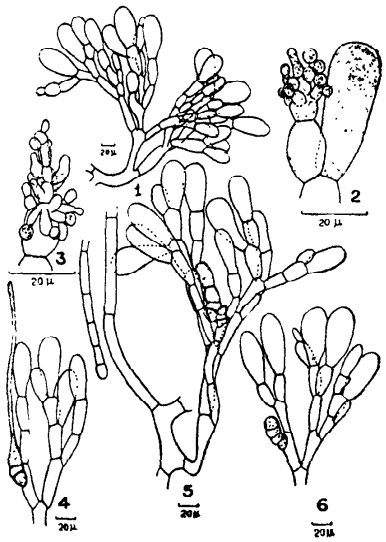
CHAMPIA INDICA Boergs.

HELMINTHOCLADIA CLAVADOSII (Lamour.) Setch. f. INDICA Desikachary

Plants attached to substratum by small, somewhat fleshy discs. *Frond* tufted, cylindrical or in some larger plants compressed, up to 30 cm or more long, nearly as much wide with extended branches, end to end, vinose-red or purple, to brick-red, gelatinous, cartilaginous, tough, elastic, very soft, lubricous. *Main stem* either thick and robust or comparatively thinner, proliferous with several branches closely set throughout the length of the main stem, 3 mm or more thick, tapering at base for a short distance from the basal disc. *Branches* worm-like, slightly thinner than the main stem, about 2 mm thick, 13-15 cm long towards the middle and upper portions ; base of branches not attenuate ; tip gradually tapering to an sub-acute apex ; mostly simple but occasionally irregularly divided once or twice, longer and shorter branches intermingled on the main stem. *Branchlets* several, lateral on the branches, simple, generally or occasionally divided, very short, slender, variable in size, 0.5-1 mm thick, about 0.1-2 cm long, densely set on the branches, most often curled. *Terminal cells* of branches large, pyriform, 15.3-25.5μ broad, 44.2-54.4μ long. *Antheridia* at tips of assimilatory branches. *Spermatia* 2.8-3.5μ in diameter. *Carpogonial branch* lateral on assimilatory branches, 8.5-11.2μ broad. Plants on drying adhere very fast to paper.

Habitat : Okha Port ; on rocky faces, facing the sea and exposed to direct wave action ; cast ashore.

The red alga recorded here is easily recognisable in the field by its highly slippery nature of the thallus and the worm like appearance of its branches. It is seen growing in large numbers attached to hard rocky sides facing the open sea, and surf beaten, more towards the low water mark. Quite a large number of plants are seen in some places as a pure formation. The alga withstands direct action of the waves as they dash on the rocks bearing them, and from where they are seen freely hanging and agitated by the movements of the swift currents and overthrow of water as breakers are incessantly dashing. In the Okha materials, the branches are seen longest in the upper part, and more towards the mid-portion of the thallus, and the branches decrease in size, both below and above this region. The alga harbours several epiphytes, of which *Polysiphonia* sp. and *Ceramium* sp. are common.



1. Assimilatory branches.

2, 3. Antheridia.

4. Carpogonial branch.

5, 6. Development of the carpogonial branch.

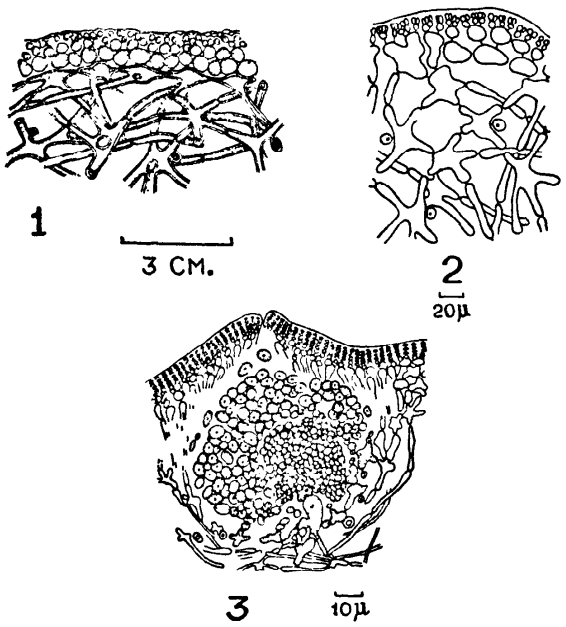
HELMINTHOCLADIA CLAVADOSII (Lamour.) Setch. f. INDICA Desikachary

SEBDENIA POLYDACTYLA (Boergs.) Balakrishnan

Plants robust, large, very tough, dark purple red to fine rose red, reaching more than 27 cm height. Basal disc small, 4 mm across, leading above to a short cuneate compressed stipe, 2 cm long before the first forking of the thallus. *Thallus* repeatedly forked dichotomously, dichotomies of the same order at same levels, fastigiate, tending to be flabellate especially at the free upper portions. *Segments* terete to greater part, a little compressed below, 5-10 mm thick. Thallus breadth below forkings up to 15 mm. Distance between forks at basal parts 2 cm, higher up about 5 cm. Free ends of segments blunt. *Thallus wall* in surface view of polygonal to rounded cells, 5-9μ across. In section, outer layer of small cells, thick walled ; below, cells larger, passing on to stellate cells in the interior. Cells at periphery, short rayed. Rays of inner cells large and longer, forming a loose tissue in the mucilaginous matter in the thallus. Breadth of filaments 4-20μ, length 130μ. *Gland cells* from stellate cells present here and there. *Tetraspores* immersed in epidermal cortical layer, scattered, variable in size and shape, subglobose to oblong, 20-27μ × 19-24μ ; cruciately divided. *Spermatangia* aggregated in irregular superficial sori, elongate, ovoid, 2.5-3.0μ in diameter. *Carpogonial branch* simple, 3-4 celled. *Cystocarps*, spherical, 150-200μ in diameter. *Carposporangia* spherical, 15-20μ wide.

Habitat : Okha port; Dwaraka.

The red alga illustrated here is common along the Dwaraka and Okha coasts. It occurs in deeper waters and detached portions of the plants, sometimes large specimens are carried by the waves during high tides. The alga is somewhat slippery and weighty to feel. The terete or compressed portions of the thallus contain clear mucilage.



1. Section of thallus showing structure. 2. Same, note stellate cells, and rhizoidal initials seen near three stellate cells. 3. Cystocarp in section.

PLATE XIV

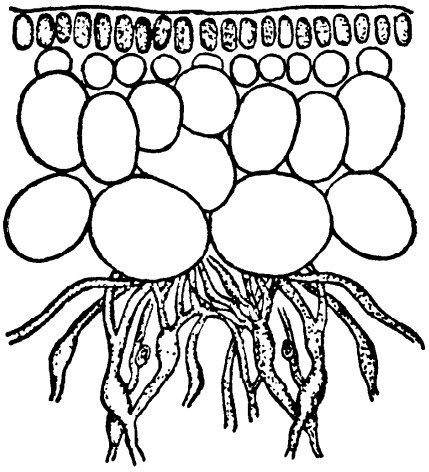
SEBDENIA POLYDACTYLA (Boergs.) Balakrishnan

SOLIERIA ROBUSTA (Grev.) Kylin

Thallus tufted, irregularly branched on all sides, 10-37 cm in height. *Main axis* 2-3 mm thick, slender and thinner specimens 1-2 mm thick ; cylindrical ; branches abruptly attenuated at base to form a short stipe ; elsewhere of almost same thickness, cylindrical, tapering slowly to an acute apex. *Apex* with tuft of short rudimentary branches. *Section of thallus* with long branching and anastomosing filaments, 6-8μ width, in the medullary portion. *Cortex* of large, oblong, rounded, polygonal cells, 110-130μ diameter. *Epidermal cells* 15-20μ in a layer, rounded, loosly arranged seen in surface view. *Tetrasporangia* in cortical layer from terminal cells of branchlets. *Tetraspores* zonately divided. *Cystocarps* producing carpospores. Colour deep red. Alga adheres to paper well.

Habitat : Tuticorin, Peral beds ; Dwaraka; Okha Port ; cast ashore ; dredged at 5 fathoms.

The present red alga is common at Okha and Dwaraka. Quite a number of specimens are washed ashore by the waves during high tides and stormy weather. The alga can be easily recognised in the field by its characteristic branches which are attenuated at bases, and the gradually tapering acute apices.



Section of thallus showing structure.

SOLIERIA ROBUSTA (Grev.) Kylin

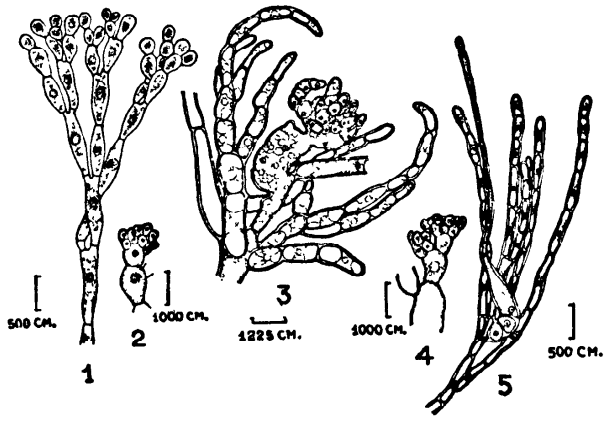
LIAGORA ERECTA Zeh.

Plants strongly calcified, profusely branched ; branching, pinnate ; lower branches of considerable length up to 14 cm or more ; branches gradually becoming shorter upwards, uppermost branches 0.5-1 cm length ; lateral branches in turn ramified like main axis ; younger portions without secondary branches. *Thallus* with a central medullary portion of several longitudinal filaments compactly arranged. *Medullary filaments* giving out assimilatory filaments forming the *cortex*. *Assimilatory filaments* repeatedly dichotomously divided, 4-6 times ; upper cells of assimilatory filaments, oblong, 5-8μ broad ; lower cells, fusiform or barrel shaped, 5-6μ broad. Plants dioecious, *male plants* larger, more than 40 cm long in the main axis ; *female plants* smaller, 12 cm long. *Antheridia* in male plants in clusters at extremities of assimilatory filaments ; antheridial mother-cell, 1-6 from terminal cells of assimilatory filaments. Antheridia 1-4 from each antheridial mother-cell. *Carpogonial branch* short lateral branches, low down in assimilatory filaments in the younger portions of the thallus, much curved at basal part, 3-4 celled, 5-6μ broad. *Carpogonium* 13-15μ long with long thin trichogyne. *Cystocarp* large, sub-globular, of densely aggregated gonimoblast filaments, surrounded by involucrum. *Colour* dirty reddish-brown, and very light red in younger parts. Alga adheres to paper very well on drying.

Habitat : Madras beach ; Covelong near Madras ; Mahabalipuram ; in very exposed localities.

The red alga presented here is very remarkable for its periodic occurrence at certain months of the year. It is seen at its luxuriance at Mahabalipuram. Here the alga appears regularly during December as very small plants here and there on some of the large boulders near the shore which are exposed to very strong and direct surf action. By January, it comes up in large numbers over wider areas, and by February, it attains very robust form. The older parts of the thallus harbour rich epiphytic growth, the more common being *Ectocarpus mitchellae*, *Hamelella geminifructus*, *Lyngbya* sp., *Acrochaetium* sp. etc. Very soon, the alga shows degeneration, and by April, it is very rare, existing only in few places in extremely poor condition ; the branches of the alga are lost, and it remains as a mere short stumpy quill. By May, the alga disappears completely from the area.

The alga is also seen at times growing at the upper limits of the high tide level, and the plants themselves being seen buried for greater length, in fine to coarse sand of the beach, the young tips alone projecting above the ground level.



1. An assimilatory branch. 2 & 4. Extremities of peripheral filaments with antheridia. 3. Formation of Cystocarp. 5. Carpogonial branch.

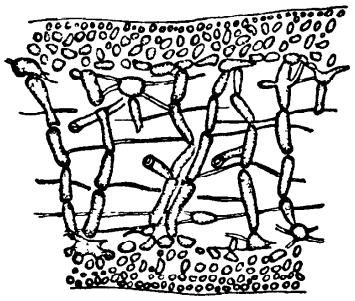
LIAGORA ERECTA Zeh.

HALYMENIA PORPHYROIDES Boergs.

Plants, leaf-like expansions, reaching large dimensions up to 48 cm long and 41 cm broad or even more, fine rosy-red, membranaceous, thin, lubricious, tough, somewhat elastic. *Holdfast* a very minute disc like structure in young plants attached to rocks, stones and broken shells. Basal stalk-like portion quite distinct in young plants forming the stipe. *Stipe* 0.5-1 cm long. *Thallus* in young plants more or less orbicular in outline with wavy undulating margin; older plants much folded and lobed, 230-300μ thick. In transverse section, thallus made up of short cell-rows on both sides at periphery; outer rows of cells smaller than the inner rows of cells; *innermost medullary cells* largest, 10-12μ thick. *Connecting filaments* traverse the thallus in the cortical layer. Connecting filaments crossed by thinner filaments at various points, 3-5μ in width. *Thinner filaments* arising from stellately divided cells occurring in large numbers below cortical layer. *Cortex* 3-5 layered, innermost cells being larger, irregular to sub-stellate, 15μ in diameter. *Stellate cells*, 20-25μ in diameter; arms of stellate cells, 150μ long. *Tetrasporangia* scattered in cortical layer appearing as deep red minute spots, oblong or ovoid, 12-15μ long, 10-16μ broad. *Tetraspores* cruciately divided, 16μ $\times$ 24μ, uni-nucleate, densely protoplasmic with several long ribbon shaped chromatophores. *Cystocarps* in individual clusters formed from an auxiliary cell, scattered, subspherical, 200μ in width, ostiolate, totally immersed in the thallus. *Carpospores* irregularly rounded, 15μ in diameter, uni-nucleate with few ribbon shaped chromatophores. Alga adheres perfectly to paper on drying.

Habitat : Okha Port; Dwaraka; Muldwaraka. Below low water mark on rocks, stones and dead shells; drifting and cast ashore.

The redsea-weed featured here is a very elegant one, especially the younger fronds with the glossy, fine rosy-red flat and expanded thallus. It is often seen in good numbers during high tides, rolling with the waves as the strong surf throw out huge masses of algae of different kinds. This sea-weed grows below low water mark, in comparatively deeper waters in exposed coasts. Two or three plants are at times seen arising out of a common disc, although generally the alga appears to grow as individual plants. Even when the thallus is about 10 cm across, and appearing almost orbicular in outline, tetrasporangia and carpospores could be seen during favourable seasons, and they are seen scattered without any definite pattern, all over the thallus, as distinct deep red spots which are easily detectable by the naked eye, or with the aid of a hand lens. I found in many specimens small perforations in the expanded thallus, sometimes these perforations are quite conspicuous. Older thalli which are drifted and exposed to sun loose their colour and turn dirty red with light yellowish green patches. In older thalli lobes are profusely seen, and are pronounced. *Coelarthrum* and various other algae occur associated with this alga.



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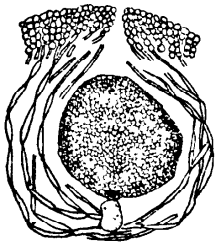


2

1. Transverse section of thallus showing peripheral layer of short cell-rows and inner large transversely set filaments. Note thinner filaments connecting them, originating from stellate cells.

2. Section through thallus showing cystocarp.

HALYMENIA PORPHYROIDES Boergs.

HALYMENIA VENUSTA Boergs.

Plants attached to substratum by a small disc. *Stipe* very short, 0.5 cm long, cuneate, expanding abruptly into a much broadened and flat thallus. *Thallus* variable in size and shape, flat, light to deep red, or darker with age, sometimes hardly divided, forming large flat fronds up to 30 cm or more long, or divided into several lobes, tough, 500μ thick. *Margin* of frond densely proliferous throughout. *Proliferations* on the whole surface of the frond also, varying in size, generally very small up to a few cm long, repeatedly divided. *Cortical layer* of thallus at periphery formed by short forked cell-rows. *Peripheral cells* oblong, densely packed, 5-7μ broad, 10μ long. *Cortical layer* 50-60μ thick ; innermost cells large, giving out stellate and irregularly twisted filaments, crossing each other in the mucilaginous interior. *Cystocarps* scattered throughout the thallus in the interior of the tissue. *Carpospores* dense roundish bodies, surrounded by curved filaments, surmounted by an ostiole. *Ostiole* 50-80μ in diameter. *Tetrasporangia* in cortical layer, scattered throughout the thallus, small, 12μ broad, 20μ long, cruciately divided. Plants adhere to paper very well.

Habitat : Dwaraka; Okha Port; Beat Dwaraka; Muldwaraka; in exposed coasts, in low lying rock pools near low water mark; on submerged portions of rocky faces and huge boulders little out into the sea.

The red-alga dealt with here is curious looking for the numerous proliferations seen all over the surface and margins of the thallus. At times the alga attains very great sizes. I have seen specimens as large as 100 cm or more. Such large specimens are especially found on a few isolated huge rocks which are far away from the shore, and well out in the gulf between Okha and Beat Island. Here the alga was seen to grow on the rocky faces, below water level. It is also seen extending to rocky surfaces above water level, but frequently submerged with the swell during high tides. Specimens growing in such situations are exposed to the scorching rays of the sun during low tides and several such specimens get dried up on the surface of these rocks as thin filmy colourless expansions.

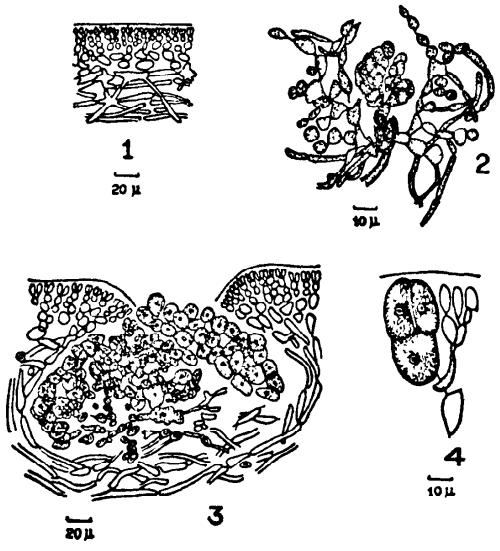
HALYMENIA VENUSTA Boergs.

GRATELOUPIA INDICA Boergs.

Plants attached to substratum by a very small basal disc. *Stipe* short, compressed, cuneate, expanding into broad thallus. *Thallus* flat, oblong to linear, extensively divided, tough, slippery, large, reaching considerable dimensions to more than 1 metre, 7-30 cm or more broad at the broadest part, 300-350μ thick. *Colour* dark purple red with a violet tinge in older parts; paler above and at free ends. *Lobes* of thallus many, of various sizes and shapes; *margin* irregularly sinuate, wavy; *tips* gradually tapering; older parts of thallus perforated, perforations 1-2 mm across. *Proliferations* from margins of older thalli. *Section*, peripheral layer of densely packed short cells; medullary innermost cells, large, loose in texture, giving irregularly divided filaments, lying in mucilaginous matrix in the interior. *Medullary filaments* 5-8μ in diameter, interspersed with stellate cells and slender rhizoids. *Stellate cells* 15-20μ in diameter; arms of stellate cells, 75μ long. *Rhizoids* 3-4μ thick. Stellate cells either connected by rhizoids or by themselves. *Outer medulla* more compact than inner. *Cortex* many layered, divided into outer and inner cortex. *Inner cortex* cells more loosely arranged than outer cortex cells; cells of inner layer 10-15μ long, 10-12μ broad, outside cells small, rounded. *Outer cortex* of densely packed, dichotomous cortical filaments, cells rounded, 5-8μ×3-5μ. *Terminal cells* of cortical filaments cylindrical, 6-9μ×3-4μ with rounded tips, densely pigmented. *Tetraspores* cruciately divided, scattered in the thallus in the cortical layer, 35-40μ×15-20μ. *Carpogonial branch* in special ampullae. *Cystocarps* dispersed throughout the thallus, subspherical to spherical, occasionally flattened, 250μ in diameter, 150-225μ high. *Carpospores* polyhedral, with rounded corners, 18-20μ×10-15μ, uni-nucleate, with ribbon shaped chromatophores. Alga adheres well to paper on drying.

Habitat : Okha Port.

The species of red alga given here is perhpas a deep water form. It is often brought by the waves with other algae and cast ashore. It can easily be recognised by its flat, leaf-like mucilaginous thallus, purple red colour, with wavy margins and lobed condition of the plant body.



1. Longitudinal section of thallus showing structure. 2. Auxiliary ampulla, later stage with gonimoblasts and nutritive branches. 3. Cystocarp in section. 4. Mature Tetrasporangium.

PLATE XIX

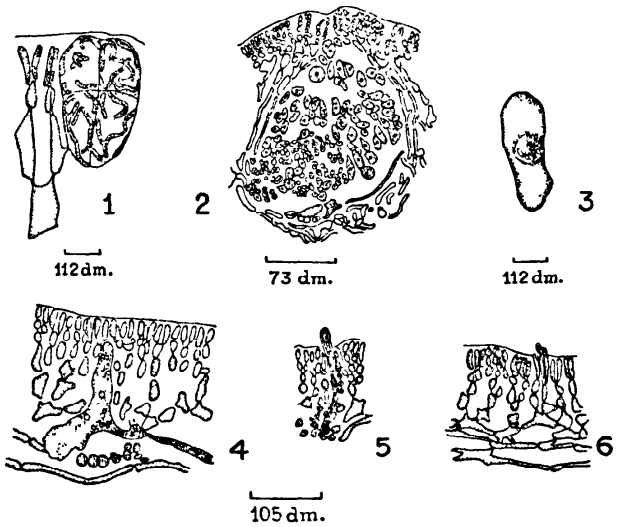
GRATELOUPIA INDICA Boergs.

GRATELOUPIA LITHOPHILA Boergs.

Plants in dense tufts on hard substratum on rocks and boulders. *Thallus* flat, simple or irregularly divided, 10-15 cm long, 0.5-2 cm broad, linear lanceolate tapering from the middle towards both ends, sinuate and undulating; upper ends of fronds, truncate becoming more or less broadly rounded. Proliferations arising from upper ends and from sides of fronds, many. *Colour* darkly olive-brown with occasional tinge of violet. *Section of thallus* with a central medullary and peripheral cortical portion. *Cortical portion* of short dichotomously branched filaments. *Cells of medullary region* adjoining cortex, about the same size as cells of cortex, regular in shape. *Inner medullary portion* of very loosely lying stellate cells, either directly connected with one another or attached by long monosiphonous rhizoids. *Tetrasporangia* one celled, scattered over the surface of the thallus, occurring as lateral branches arising secondarily from the cortical filaments. *Tetraspores* cruciately divided. *Carpogonia* and auxiliary cells on special clusters of branches, the *ampullae*. *Cystocarp* sunk in thallus with an ostiole at top, scattered all over the thallus, appearing as dark specks, spherical, 120-150μ in diameter. *Substance* membranaceous, slippery, gelatinous. Plants adhere to paper well on drying.

Habitat : Mahabalipuram.

This red alga is a very common one growing luxuriantly with *Gracilaria corticata* J. Ag. at Mahabalipuram, on large number of rocks, boulders and stones which are exposed to direct surf action. It also grows luxuriantly on artificial rocky substrata facing the sea. The alga attains its luxuriance during the months of October to December; and in January it reaches its maximum growth. The plants show numerous proliferations then. By February the plants get dried up in many places, though still good growth is to be seen on rocks which are well out in the sea. By April the alga disappeares from all localities. *Ceramium transversale* Collins & Harvey is a very common epiphyte, freely creeping over the somewhat slippery, flat thallus of this alga. By its tough consistency, and slippery nature of the thallus, and by its growing in dense tufts, the alga is able to withstand direct wave action, even when it is very violent.



1. Tetraspore formation. 2. Mature cystocarp with carpospores. 3. Tetrasporangium. 4. Carpogonium after fertilisation. Note the large irregular cell and the ooblastema filament growing out of it. 5. Carpogonial ampullae with Carpogonium. 6. Longitudinal section of thallus showing cortical layer with dichotomously divided filaments and stellate cells in the medullary portion.

PLATE XX

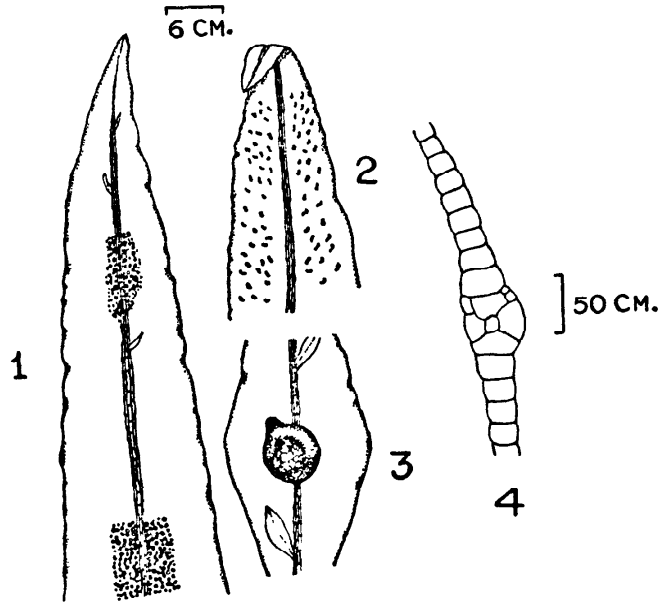
GRATELOUPIA LITHOPHILA Boergs.

HYPOGLOSSUM SPATHULATUM Kütz.

Plants densely branched, bushy, 10-12 cm or more high. *Frond* numerous, at first a single undivided leaf-like structure, linear to lanceolate, 4 mm wide, apex acute; *midrib* cylindrical, filiform, distinct at base of leaf-like structure, faint above and indistinct at apices; secondary leaves from the midrib similar to primary leaf, smaller, lower ones longest, upper ones gradually shorter; youngest always lanceolate. *Leaves* undivided, flat, margins entire, sometimes crisped, with numerous proliferations from the midrib. *Section of thallus* single layer of cells, except midrib which is three cells thick with cortical cells also. *Tetraspores* in sori, along narrow belts on both sides of the midrib. *Sori* 3 mm long, 0.2 mm broad, appearing as rectangular groups when ripe. Sterile thallus between sori 1 cm or more. *Antheridial bodies* on both sides of midrib, scattered. *Cystocarps* definite, urceolate, at midrib, appearing as dark rosy dots. *Colour* beautiful transparent pale pink, midrib darker, or fine rosy-red. *Substance* membraneous very delicate and thin, under microscope, beautifully reticulated. Adheres to paper fast when dried.

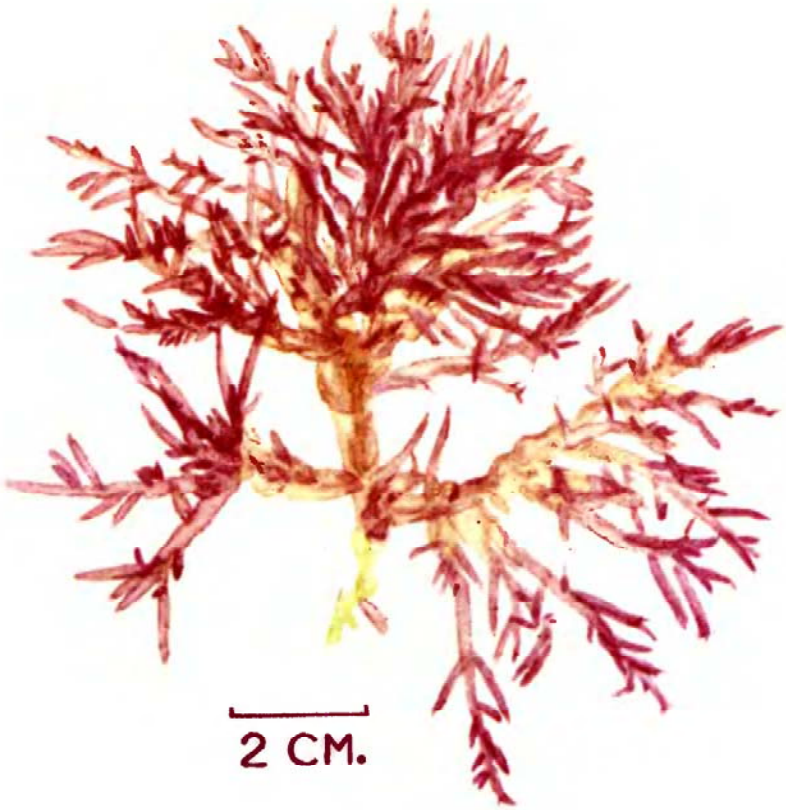
Habitat : Okha Port; on coral pieces or as clumps cast ashore.

This elegant and beautiful red sea-weed is very delicate and very soon disintegrates if not preserved properly as soon as collected. It is seen brought by the strong waves during high tide with other forms.



1. Part of thallus with Tetrasporangia. 2. Part of thallus with Antheridia. 3. Part of thallus with Cystocarp. 4. Transverse section of thallus showing structure.

PLATE XXI



HYPOGLOSSUM SPATHULATUM Kütz.

RHODYMENIA AUSTRALIS Sonder

Plants attached firmly to rocks by discoid holdfast. Stem, cartilaginous, firm, horny, 0.5 mm thick, giving out branches with dichotomous fronds. *Frond* flat, membranous, many times dichotomously forked, fastigiate. *Segments* linear, up to 3 cm long, 2 mm broad. Margin entire, without proliferations. *Substance* rigid, thick. *Colour* deep red. Plants adhere to paper partially on drying.

Habitat : Okha Port; Dwaraka; Bombay.

The red-alga illustrated here is to be looked for at most inconspicuous situations, which are cut off from direct and strong sunlight, such as the under surfaces of hollowed out rocks, and in the larger and deeper rock-pools, on the rocky faces hidden from general view and cut off from light. The alga always grows in submerged condition at Dwaraka and Okha in similar situations described above. Several plants grow together to form pure formations in favourable spots. In collecting the alga, care is to be taken to ward off harmful or injurious animal populations in the surroundings where the alga grows.

RHODYMENIA AUSTRALIS Sonder

RHODYMENIA PALMATA Grev.

Plants attached to substratum by small discs. *Frond* either solitary or tufted, 20 cm or more in height. *Stipe* thin, short, cylindrical, gradually expanding to flat, wedge shaped leaf. *Lamina* without midrib, broadly wedge shaped, fastigiate, divided into several segments which divide again a few times to a palmate or subdichotomous branching. *Segments* elliptical, sometimes linear, sometimes cuneiform, very variable in size and shape, up to 1.5-2 cm broad at the broadest part, and 20 cm long. *Margin* undulated, entire or proliferous with several smaller or larger elliptical leaves. *Lateral leaves* simple or divided and supported on delicate short petioles. Apex of segments acute to rounded. *Fructifications* scattered all over the thallus, dense, in irregular spots, deep red to blackish-red. *Colour* red, tinged with purple or pinkish. *Substance* leathery in old, and thin and membranaceous in young plants.

Habitat : Cape Comorin.

The red alga illustrated here is seen sometimes to grow in very exposed areas along the shore, at the upper limits of the high water mark, where the coast is sandy with coarse sand-grains and with plenty of shells. The plant is attached to hard substratum below, and the upper portion alone is seen above the surface of the sandy shore, from where the plants are bathed by the inrushing and returning waves.

PLATE XXIII

RHODYMENIA PALMATA Grev.

ECTOCARPUS BREVIARTICULATUS J. Ag.

Plants in low dense tufts, vigorous plants reaching up to 4-5 cm in height, firmly attached to rocky substrata. *Fronds* filamentous, filaments intertwining and held together by shortly curved ramuli and hook like structures found on the main filaments, deep brown, spongy to feel. Filaments of the thallus 27-30μ broad; cells 1-2 times their diameter in length. *Plurilocular sporangia* on short, one celled stalk, roundish, barrel shaped, at nearly right angles to the filaments bearing them, 55-60μ long, 45-60μ broad.

Habitat : Madras Harbour; Mahabalipuram on exposed rocks beaten by waves or sprayed.

This is a very interesting brown alga met with in Madras Harbour and at Mahabalipuram. It grows on very exposed situations on hard rocks, which are beaten by violent breakers and heavily sprayed. At Mahabalipuram, the alga comes up regularly and by October, it is very common to the locality. It continues to flourish till December as a dominant form. By January-February, the alga reaches its maximum luxuriance, appearing as large twisted brown strands which are spongy to feel, and rope-like. By April-May, it becomes rare, and its growth diminishes, and by June, it is rarer still with very poor growth. *Sphacelaria furcigera*, Kütz., *S. tribuloides* Menegh. and several blue greens are associated forms with this brown sea-weed.

PLATE XXIV

ECTOCARPUS BREVIARTICULATUS J. Ag.

MYRIOGLOEA SCIURUS (Harv.) Kuck.

Plants attached to rocks by small disc-like holdfast. *Thallus* 30-50 cm or more in length, 1-2 mm thick; at first simple, later with alternate or irregularly scattered branches. *Branches* similar to the primary frond, also simple; branches issuing near the base of the main frond up to 50 cm in length; in older parts branches with a few ramuli. Thallus, completely covered with thick hair like filaments. *Structure* of thallus, in the middle with string of long filaments. *Filaments* with barrel-shaped cells, 12-27μ broad, about 1½ times as long. Filaments in the middle core of thallus, thick, nearly straight, branched with few chromatophores. At periphery, filaments bent outwards, branched to the exterior. Free ends of main filaments pass on to long hairs with chromatophores. *Hairs* 15μ broad. *Plurilocular sporangia* in large numbers, terminal on short side branches of filaments, bending out at periphery, oval to sub-cylindrical, with broadly rounded apex, transversely and longitudinally divided by walls, 85μ long, 19μ broad, rarely 23μ broad. *Colour* dark olive or dark brown, or blackish-brown. *Substance* elastic, slippery, firmly gelatinous or cartilaginous. On drying, the alga adheres very firmly to paper.

Habitat : Dwaraka, Okha Port; Cape Comorin; on rocks and stones exposed to waves.

The brown alga treated here forms in favourable places a dominant and characteristic member of the community. The alga grows several together on hard rocky faces, boulders and stones, which are exposed to strong and direct wave action. The long, slippery, dark brownish filamentous and branched thalli of several plants almost cover the rocky faces on which they grow, and remain exposed to sun during low tides, to be completely agitated by strong waves again during high tides. In some specimens, the branches are more close together, and thus appearing as dense. The plants which are seen on the sea-facing sides of rocks, and thus exposed to the direct brunt of the wave actions, are seen more robust and more bushy with dark brown hairs, covering the entire thallus.

PLATE XXV

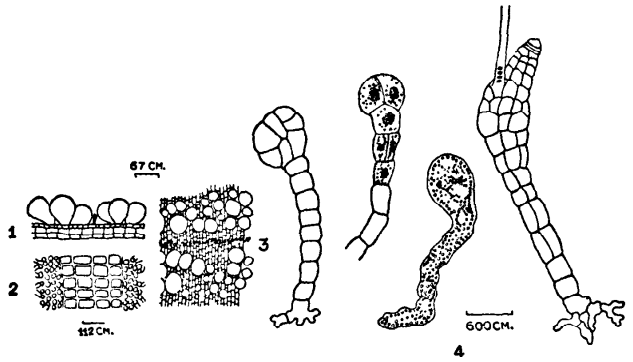
MYRIOGLOEA SCIURUS (Harv.) Kuck.

PADINA TETRASTROMATICA Hauck

Plant, erect, in several clumps, several blades arising from the same stupose basal attachment, 12-15 cm or more in height. *Rhizome*, prostrate, branched, attached to substratum by tufts of rhizoids. *Frond* stalked, varying in size, numerous, fan-shaped to reniform, thin, flat, much lobed, somewhat plicate, the larger blades loosely rolled on their longitudinal axis like a cornet, conspicuously concentrically zonate. *Blades* frequently split into numerous narrow segments, lower portions of segments attenuate; segments 1-2 cm broad. *Zonation* caused by rows of hairs and fructiferous organs in concentric zones, 0.5 mm broad in the region of fructiferous structures, and 2.5 mm broad in the intervening sterile portions of blades. *Hairs* present in younger thallus; in older ones, either rudimentary or absent, hairs shedding when fructiferous organs develop. *Fructification structures* on both sides of the hairs, and through the length of the zone in the concentric ring, in definite arrangement in relation to hairs. *Indusium* absent. *Cross section* of thallus 2 layers of cells in younger parts, 3 or 4 layers of cells in older and basal parts.. *Cells* in surface view, rectangular, 40-50μ long, 20-25μ broad. *Colour* straw coloured to brown or dark, olive-green and reddish hues in older parts; appearing whitish also due to thin encrustation of carbonate of lime. The alga adheres well to paper on drying.

Habitat : Bombay; Karwar; Mahabalipuram; Madras; Krusadai; Pamban; Tuticorin; Cape Comorin etc.; in well sheltered as well as in much exposed localities near low water mark and below; in intertidal lagoons, rock-pools, tranquil bays etc.; at mid-tide levels and lower, extending to upper limits of high tide mark, in favourable situations.

The brown sea-weed illustrated here goes by the popular name "The Peacock's tail" alga, because of the peculiar structure of the blades with the series of concentric zones, on the thin, flat, fan-shaped blades. The alga grows in situations where the boulders and other hard substrata are smothered by thick sediments of very fine sand, which sometimes make the substrata slippery. The alga tolerates repeated submergence and constant agitation during high tides, followed by complete exposure and quiescence, and even certain amount of desiccation, during low tides. In January, the alga bears plenty of tetrasporangia along the concentric zones. The older parts of the plants are heavily loaded with epiphytes, and smothered by heavy deposit of silt. The common epiphytes are diatoms and *Ceramium*. Germination of tetrasporangia *in situ* is noticed in several cases, the young germlings still attached to the parent plant thallus. In the early stages, a *central nodule* is developed, and one of the cells of this nodule grows out as a small protuberance, and by further growth and divisions of cells, a long multicellular, cylindrical structure is formed, which ultimately develops into a tiny fan shaped thallus of *Padina*.



1. Transverse section of thallus showing tetrasporangia on either side of the hair. 2. Transverse section of thallus at basal part showing structure. 3. Optical section of thallus showing rows of tetrasporangia and hairs. 4. Stages in the germination of tetrasporangia.

PLATE XXVI

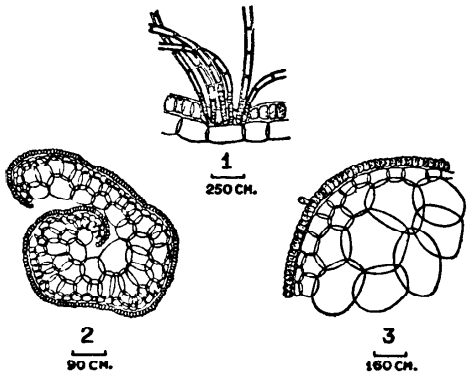
PADINA TETRASTROMATICA Hauck

HYDROCLATHRUS CLATHRATUS (Bory) Howe

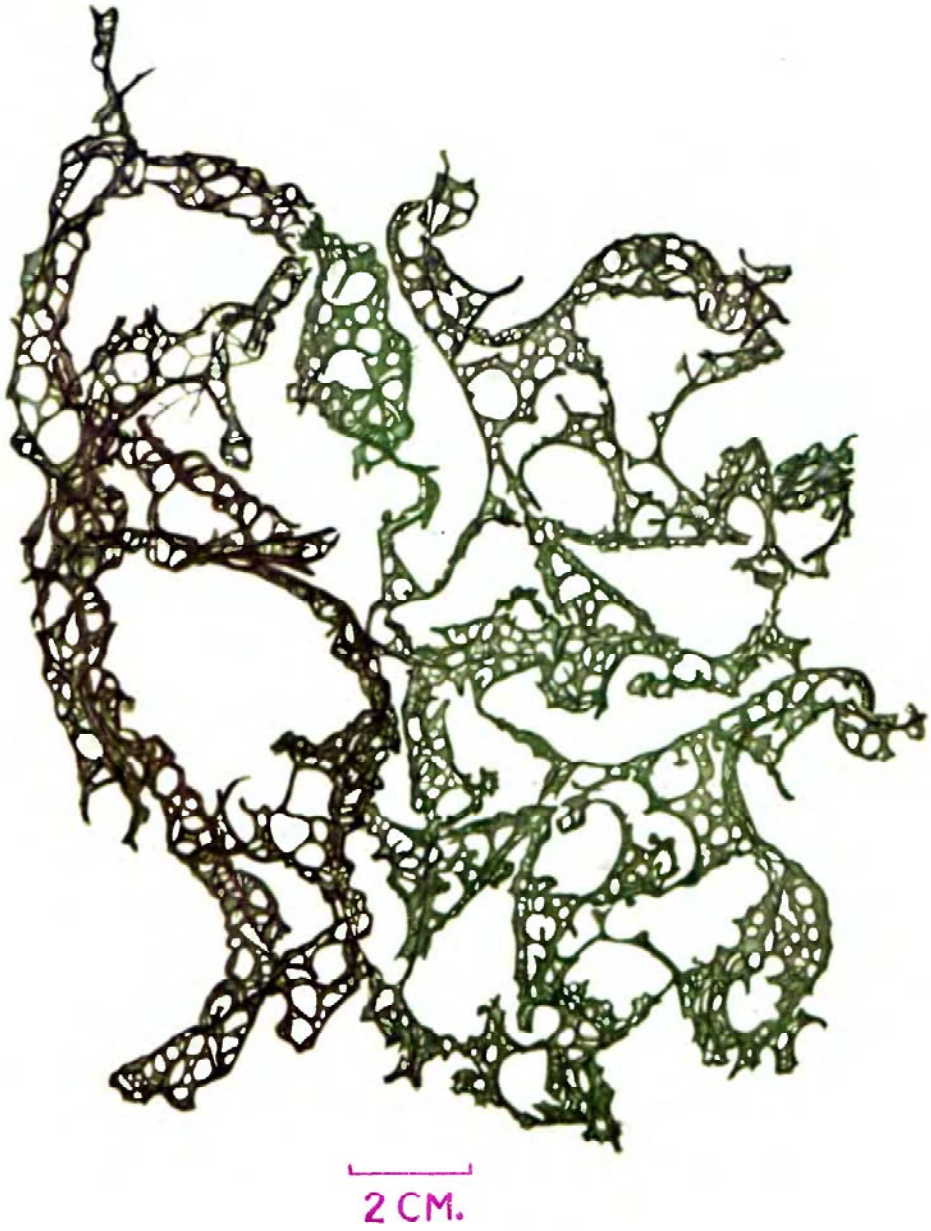
Plants, spherical when young, but soon becoming irregular in form as they grow, sinuous, irregularly lobed, hollow and net-like, bag shaped, attaining large sizes, spreading and loosely attached by the undersurface to rocks or coralline pieces and to one another by their sides, or clustered and covering large areas. *Thallus* membranaceous, perforated, giving the characteristic net-like clathrate appearance in young plants, yellow olive in colour, later darker and with age, rusty-brown, thick or in some plants thin, crisp, very fragile when fresh, older thallus tenacious and rigid. *Apertures* in thallus, very variable in size and shape, 1-3 cm in diameter, in the beginning very small and laterally compressed, but with the expansion of the thallus tissue, apertures widen and in fully grown plants, become very large even up to or more than 3 cm in diameter, irregular in outline. *Interspaces* of thallus about apertures, 1-3 mm broad, margins involute. New apertures developing in the interspaces, resulting ultimately in the complicated net-work of the plant body. Interspace tissue sometimes very delicate, lace-like, sometimes coarse. *Central parenchyma* cells 50-150μ in diameter. *Cortical layer cells*, polygonal in surface view, 5.5-9.0μ across. *Reproductive structures* in young plants, in a continuous layer, in older thalli stray or even absent. *Gametangia* 9-17μ in diameter, 13-23μ high. In drying, alga adheres well to paper.

Habitat : Krusadai; Pamban; Rameswaram Islands; Shingly Island; Tuticorin & Hare Island; Dwaraka. Commonly to be seen in shallow waters, in intertidal lagoons on exposed situations, on reefs, etc. Sometimes dredged also, from greater depths.

The brown alga represented here is a curious looking plant with a hollow sphere, made up of a net-work like plant body by which this can be easily recognised in the field. It occurs in rather exposed places on reefs, corals and rocks, and in lagoons. The plants sometimes grow to very large size, and they are very crisp and fragile. In favourable places, they form good formations, very loosely attached to the substratum and to the neighbouring plants as well. The perforations in the thallus are very variable in size and form, thus some plants look delicate and thin, while others robust with thick thallus. The thinner forms are more seen in comparatively quieter areas. The species is very widely distributed in the Tropical seas in both the hemispheres, in the Atlantic, Mediterranean, Carribean Sea and Red Sea.



1-3 Section through thallus showing structure.



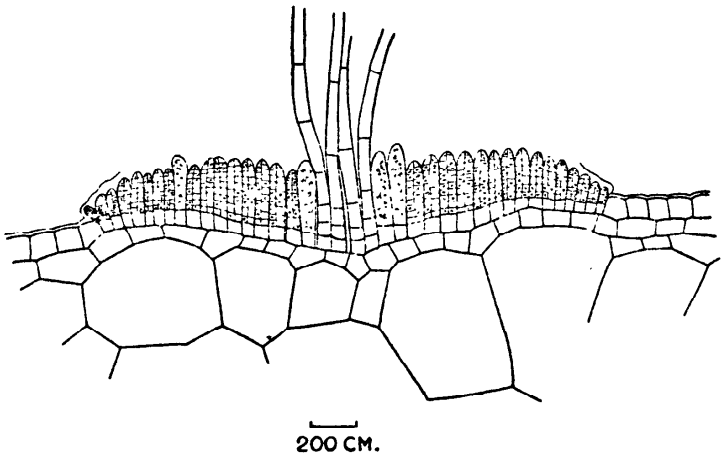
HYDROCLATHRUS CLATHRATUS (Bory) Howe

COLPOMENIA SINUOSA (Roth) Derbès & Solier

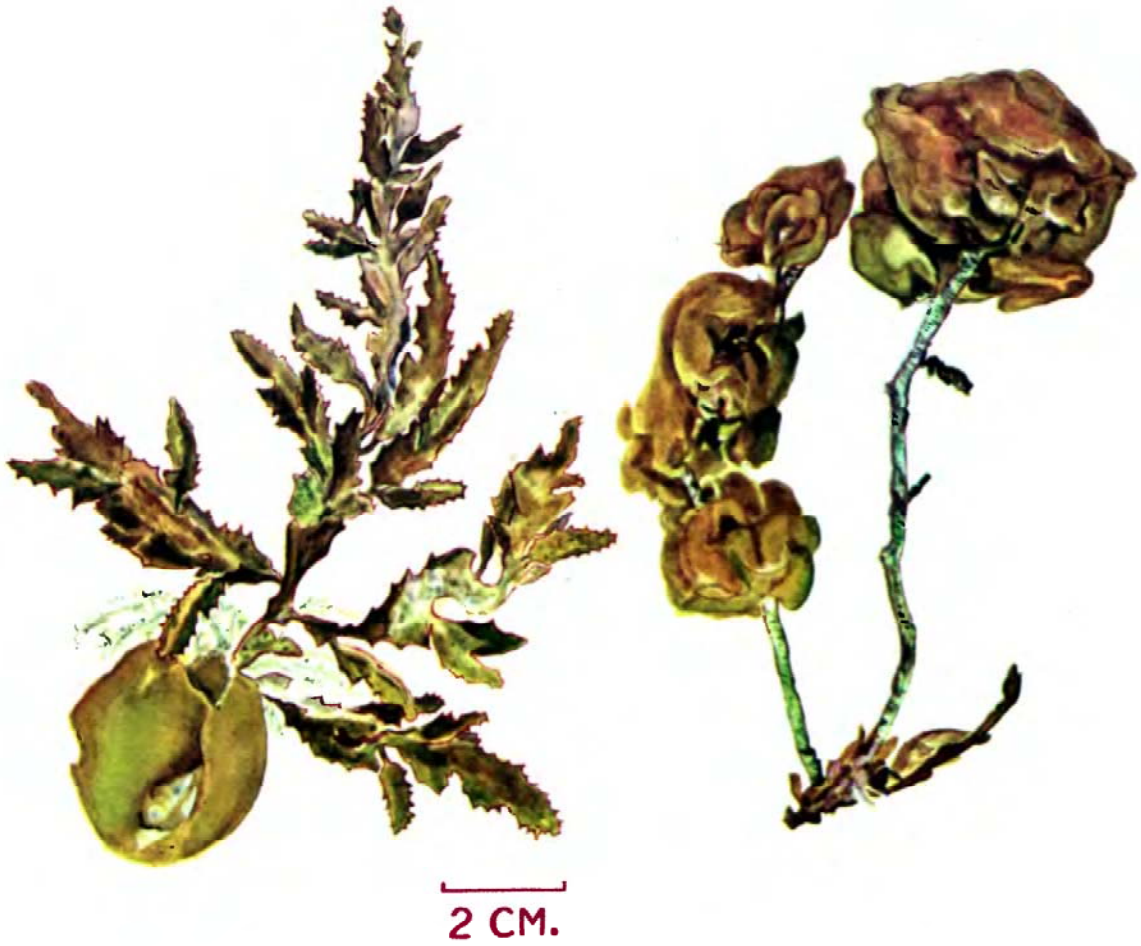
Plants sessile, when young spherical with even surface; later as they grow becoming irregularly lobed, sinuous hollow vesicles, solitary or several plants growing together closely adpressed in small groups or globose masses. *Vesicles* about 3-12 cm in diameter, light yellow brown. *Thallus* in larger plants often torn open irregularly, flattened and irregularly lobed, expanded. *Thallus wall* 0.3-0.4 mm thick; in section composed of thin walled large colourless cells towards the interior. *Innermost layer cells* 180μ across. *Intermediary cells* smaller. *Outermost 2 or 3 layers* small cells, 3.7-7.5μ across, with several chromatophores. *Hairs* superficial growths, ultimately becoming sunk in a depression of the thallus due to repeated division and limited growth of the surrounding cells. *Plurilocular sporangia* in dense sori, columnar, cylindrical, scattered over the whole surface of the thallus, formed around the depressed groups of hairs, 3.7-7.5μ in diameter, 18.8-30.0μ long. *Paraphyses* unicellular, intermingled with plurilocular sporangia, sometimes numerous, sometimes scarce or even wanting, obovate, 11μ in diameter, 47μ long.

Habitat : Krusadai; Pamban and Rameswaram Islands; Tuticorin and Hare Island; Bombay; Dwaraka; Okha; Visakapatanam coast; Cape Comorin etc. On exposed shores or in sheltered and not much exposed situations, in tide pools, on rocks, reefs, stones and branches of *Sargassum*, *Hormophysa* and other larger brown sea-weeds in intertidal lagoons near high water mark; often associated with *Hydroclathrus*, *Ulva* etc. as epiphytic growths with this alga. Drifted and dredged from shallow waters.

The brown sea-weed illustrated here is seen widely distributed in Tropical and warmer seas in many parts of the world. The alga is popularly known as the "Oyster thief", because of the fact that by its rapid multiplication it is known to have caused damage and loss to the French Oyster Fisheries. As a result of photosynthetic activity the globose thalli of the sea-weed get filled with gas and the larger thalli thus filled with gas lift young oysters and carry them out to the sea causing thereby heavy loss. It is commonly to be found in many situations along our coasts.



Transverse section of the thallus with plurilocular sporangia, paraphyses and hairs.



COLPOMENIA SINUOSA (Roth) Derbès & Solier

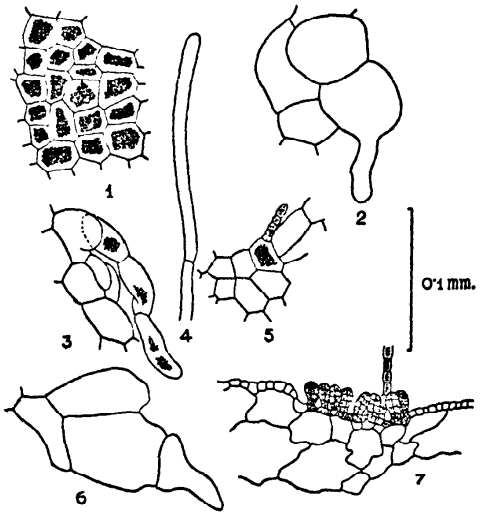
ROSENVINGEA INTRICATA (J. Ag.) Boergs.

Plants profusely branched, branching wide angled, irregularly dichotomous or pseudo-dichotomous, light brown in colour, tubular, hollow inside; *older parts of the thallus* highly compressed with uneven surface, 10 mm or more across at its widest part; *branches* decreasing in size, ultimately ending in very minute ramifications, hair like, terete, 0.5 mm across. *Transverse section* of thallus with 3-4 layers of cells, *innermost layer of cells* lining the hollow cavity considerably larger than the peripheral cells, 30-60μ or more across; *outermost layer* in surface view with irregularly polygonal cells, 9-13μ broad; each cell with a single chromatophore; *chromatophore* 9.9-13.2μ across. *Plurilocular sporangia* in plenty, several together in circular to oval sori, spread over the whole surface of the thallus. Mature sporangium clavate, 19.8μ long, 6-7μ broad. *Hairs* several in groups in sori and sterile part of the thallus.

Habitat : Chilka Lake, at outer-channel, as free floating loosely tangled aggregates of suspended masses in 60-90 cm of calm and comparatively clear water; Dwaraka; Okha; Tuticorin; Hare Island; Adyar (Madras) salt marsh.

The brown alga illustrated here is more commonly a denizen of the estuarine areas very close to the sea, and having the effect of the tidal waters also. It is also seen in purely marine conditions, and usually in the intertidal zones in comparatively quieter waters in shallow bays and lagoons, with a substratum of loose gravel or coarse sand or broken shells. The plants occur as free floating loosely aggregated tangled spongy masses, and often also drifted and cast ashore. They are also known in other parts of the warmer seas occurring at depths of 2-4 metres, and descending to over 19 fathoms, and are dredged with other forms. The species is known from the Tropical waters of the Atlantic, the Pacific, and the Indian Ocean and has its largest distribution in the Atlantic.

A Chaetophoraceous alga, *Phaeophila dendroides* (Crouan) Batters grows endophytically in the thallus of *Rosenvingea intricata* (J. Ag.) Boergs.



1. Epidermal cells in surface view.
2, 3 & 6. Rhizoid like processes from the innermost cells of the thallus.
4. Terminal portion of a fully developed hair.
5. A young hair developed out of an epidermal cell.
7. Transverse section of the thallus showing 3 to 4 layers of cells and a group of sporangia and hair on the surface.

ROSENVINGEA INTRICATA (J. Ag.) Boergs.

DICTYOTA ATOMARIA Hauck

Plants attached to substratum by small holdfast. *Thallus* large, strap shaped, thin, fragile, repeatedly dichotomously divided a few times, 30-70 cm or more long; *segments* 2.5-5 cm broad, breadth of thallus just below forkings in lower parts from 3-6 cm; *margin* of frond beset with small somewhat upwardly pointed acute ciliated teeth throughout the length at more or less equal intervals of 0.5 cm. *Marginal teeth* 1-5 mm long, or occasionally longer up to 1 cm. Longer and shorter teeth intermingled but at intervals along the margin; younger parts of frond without teeth at the margins; *tips* of frond obtuse. *Fructifications* scattered on both the sides of the thallus, numerous giving the whole thallus a spotted appearance. *Tetraspores* solitary or few together in small groups, globular, 160μ in diameter. *Antheridial* bodies in irregular groups. *Oogonia* in small groups, scattered over the surface of the thallus. *Colour* from light brown to dark brown with age. Plant adheres well to paper.

Habitat : Okha Port; Dwaraka; Bombay; in rock-pools near or below low water mark.

The brown alga illustrated here is an interesting specimen of a large *Dictyota* of our coast. While some of the specimens showed the teeth at the margins very prominently, in some specimens, the teeth are not only inconspicuous but also few and far apart set. From the older parts of the thallus proliferations are frequent. These proliferations later develop into the adult thallus in the next favourable season.

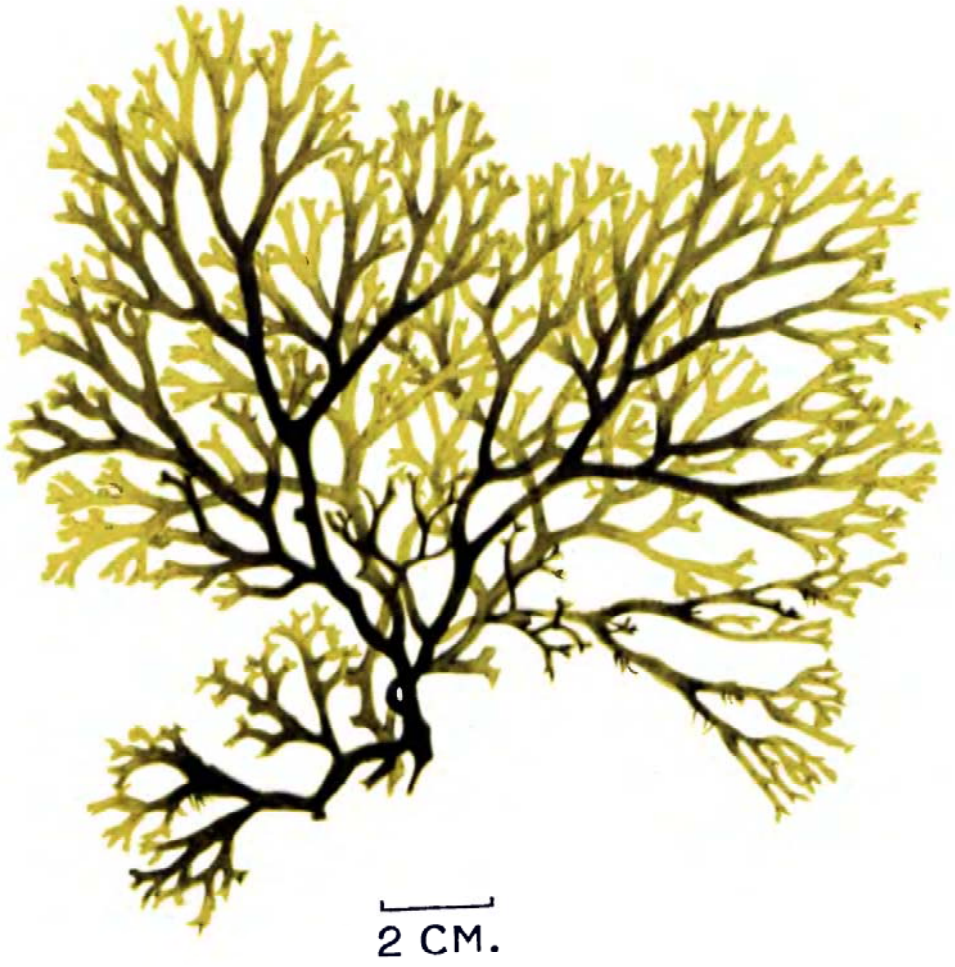
DICTYOTA ATOMARIA Hauck

DICTYOTA BARTAYRESIANA Lamour.

Plants variable, bushy in densely intermingled masses, not stipitate, attached to substratum by irregularly shaped holdfast with rhizoids, or lying loose; base naked. *Thallus* branched, branches when young complanate, later becoming bent and twisted slightly, dichotomous, equal angled, 45°-90°, usually 80°; membranous, crisp, relatively fragile. *Segments* without midrib, 2-7 mm broad or usually 4-7 mm broad. *Internodes* 1-4 times as long as broad; *margin* entire; *apex* acute, somewhat broadly rounded. *Section of thallus* cortical layer on both faces of one layer of small cells, medullary layer with large cuboidal cells with few chromatophores. *Tetrasporangia* on both sides, either solitary or a few together, scattered over the whole surface. *Gametangia* in scattered sori. *Colour* light brown or yellowish brown in upper portions and blackish-brown near basal portions. Alga adheres well to paper on drying.

Habitat: Krusadai Is.; Pamban Is.; Tuticorin; Cape Comorin; Madras; Mahabalipuram; Bombay ; Dwaraka ; Okha; in shallow pools or lagoons on sandy bottom; in partially sheltered localities; often lying loose and covering sandy bottoms of lagoons behind coral reefs at intertidal belts; also in somewhat deeper waters.

Dictyota bartayresiana is a common brown sea-weed regularly coming up at Mahabalipuram and other areas in South India. At Mahabalipuram it is seen to grow in profusion in somewhat sheltered and protected artificial pool formed by the ingushing of sea-water as a result of breakers during high tides. Here it grows on boulders smothered by fine silt and sand along with *Padina tetrastromatica. Padina, Dictyota* and a red alga *Goniotrichum* flourish during January to February, reaching maximum growth and luxuriance in February. During the latter month, the plants are loaded with heavy epiphytes and appear unhealthy. By April, this alga disappeares completely. At Krusadai, Pamban, Tuticorin and other areas, it is seen in intertidal lagoons or shoals with shallow water, and where the sea-floor is sandy. Here they occur as loose lying forms in large masses, or attached to coralline pieces etc.



DICTYOTA BARTAYRESIANA Lamour.

STOECHOSPERMUM MARGINATUM (Ag.) Kütz.

Plants in large tufts, 15-25 cm or more high. Base with irregularly ramified, bent, decumbent branches interwoven. *Rhizoids* numerous from the base, attaching the plant to the substratum. *Thallus* erect, spathulate, dichotomously branched repeatedly a few times, flat, without midrib ; segments of thallus 1-2 cm broad ; margin entire ; apex bifid or flatly truncate. *Section of thallus*, greater part with large parenchymatous cells in the middle and on either side covered by two layers of small cells. *Hairs* in groups, scattered on both sides of thallus. *Tetrasporangia* in longitudinal rows in irregular outline near the margin and extending to some distance along the margin of the thallus, 0.2-0.3 cm thick. *Colour* brown in younger parts, tending to be dark brown in the older and basal parts of the thallus. *Substance* membraneous, somewhat coriaceous. Plants on drying adhere well to paper.

Habitat : Bombay ; Dwaraka ; Okha ; Tuticorin ; Krusadai Is.; Karwar ; etc. in rock-pools in lower part of the littoral zone; in open sea ; also cast ashore.

The brown alga illustrated here is seen to grow very well and luxuriantly in somewhat quiet rock-pools in the open situations, at the lower limits of the intertidal belts. The alga harbours a number of epiphytes which grow heavily on it and among them are *Ectocarpus*, *Sphacelaria*, and young plants of *Cladophora*, *Ulva* etc. The old and decaying thallus is seen to be heavily infested with *Melobesia* which red-alga grows almost completely covering the surface of the thallus. The tips of the lobes of the brown alga get decayed and the lobes appear with broken apical parts. In the next favourable season, however, from these older broken off terminal portions of the brown alga, fresh shoots grow out, and they continue the growth of the thallus, dividing dichotomously, and these fresh shoots stand out markedly from the heavily encrusted portions of the older thalli.

PLATE XXXII

STOECHOSPERMUM MARGINATUM (Ag.) Kütz.

SPATHOGLOSSUM ASPERUM J. Ag.

Plants with an indistinct small holdfast. *Frond* 20-35 cm or more in height. *Thallus* flat, palmate, sub-dichotomously divided into larger and smaller lobes. *Lobes* elongate, linear, lanceolate, attenuated towards base and summit in larger lobes. *Apex* acute or rounded. *Margin* sinuate, irregularly dentate with larger or smaller proliferations. *Teeth* small, along the margin of the thallus especially in the lower parts of the thallus. *Surface* smooth, surface cells seen from above arranged in more or less distinct rows, quadrate, 30-40μ broad. *Colour* dark brown, turning to dirty green when decaying. *Fructifications* scattered on the surface of the thallus.

Habitat : Krusadai Is. ; Pamban Is. ; Tuticorin; Hare Is.; Church Is. ; Cape Comorin ; Bombay ; Karwar ; Okha Port; Dwaraka etc.

This brown sea-weed can easily be recognised in the field by its very large sized somewhat dichotomously divided brown thallus. It is often seen detached from its original place of growth and carried by waves and currents and stranded on the shore or left behind in tranquil bays and rock-pools etc. The bits of older thalli are often heavily infested with various epiphytes among which *Melobesia* is common. The plants do not keep fresh long after picking from the sea ; they turn dark dirty-green or bluish-green.

SPATHOGLOSSUM ASPERUM J. Ag.

DICTYOPTERIS AUSTRALIS Sonder

Plants erect with a somewhat distinct tuberous basal holdfast. *Frond* 30 cm or more in height, repeatedly but irregularly dichotomously divided ; the main rachis in old specimens becoming more or less denuded of lamina. *Proliferations* very common. *Stipe* covered with short woolly hairs. *Segments* flabelliform, 4-6 times forked ; breadth of lamina vary ; in narrow leaved forms, 0.5-0.75 cm broad ; in broad leaved forms about 1.5 cm broad. *Margin* irregularly dentate and more or less sinuate. *Midrib* vigorous, with irregularly bent veins at both sides of lamina ; much protruding. *Hairs* in groups on both sides of thallus, in rows, declining from the midrib towards the periphery of the thallus. *Section* with 2 layers of cells in the thallus, 3 layers at veins. *Tetrasporangia* in sori, around and between groups of hairs forming deflexed lines proceeding from midrib to margin, densely crowded, making the lines of hairs more marked and giving the characteristic appearance to the lamina. *Colour* bright, yellowish-olive and in older parts dark brown. *Substance* soft. Plant adheres well to paper on drying.

Habitat : Dwaraka ; Okha Port.

This is a stately brown sea-weed which presents a beautiful appearance because of the peculiarly constructed lamina which with its characteristic orientation of the sori and hairs presents the likeness to a fern-frond. The older parts of thallus, sometimes get feebly infested with *Melobesia* and other crustaceous red-algae.

DICTYOPTERIS AUSTRALIS Sonder

DICTYOPTERIS WOODWARDII (Br.) J. Ag.

Plants erect with well defined holdfast. *Frond* 10-15 cm or more in height, flat, 5-7 mm broad, linear, branched repeatedly dichotomously. *Midrib* distinct, occurring throughout the length of the frond ; lower parts of midrib, blackish, stiff, 0.5-1 mm thick ; higher above becoming paler ; at extremities fading to the colour of the frond. *Surface* of frond perforated on both sides by minute pores which are scattered. *Apex* of frond bifid with obtuse segments. *Margin* of frond, dentate, undulating. At base of the frond, the membranous portion worn out by wave action, the midrib alone remaining naked. *Hairs* in groups, and in young parts in a row on both sides of the midrib. *Colour* pale brown, olive green tinged with yellow. *Substance* very thin, flaccid, tender. *Fructifications* in a narrow belt close to midrib on both sides of it.

Habitat : Krusadai Is. ; Okha Port ; Muldwaraka ; Malvan.

The interesting brown sea-weed illustrated here is seen to grow in deep rock-pools well submerged. Elsewhere, it is seen also on open intertidal zone, in shallow lagoons and the like situations. It is cast ashore during high tides attended with heavy breakers. The plant is not, however, very common in our coasts, though in restricted localities some assemblage of the same is to be seen.

DICTYOPTERIS WOODWARDII (Br.) J. Ag.

CYSTOPHYLLUM MURICATUM (Turn.) J. Ag.

Plants reaching 50 cm or more in height, 1-2 mm thick. *Stem* rough with densely covered minute filiform processes on all sides, cylindrical. *Branches* lateral, 25-40 cm long ; secondary branches, filiform, pinnated at lower half with simple, slender ramuliform leaves bearing 2-3 ovoid vesicles. *Basal leaves* present only in younger or vigorously growing plants ; simple, linear, flat, with a midrib 4-5 cm long, and 3 mm broad. *Margin of leaves* entire ; *apex* rounded or acute. *Vesicles* all of the same size, oval, with cryptosomes scattered over the surface ; solitary or 2 or 3 or more together, always separated by short stem-like intervening portion. Uppermost vesicle, ciliate. *Receptacles* sub-cylindrical, ramified, at ends of branches from terminal ramuli or leaflets, racemose. *Colour* full olive, turning black on drying. *Substance* coriaceous ; brittle when dry. On drying, plants do not adhere well to paper, but younger portions, and vesicular parts adhere well.

Habitat : Tuticorin, Hare Is. ; Pamban Is. ; Krusadai Is. ; Dwaraka ; Okha. In shallow waters.

The brown sea-weed illustrated here is a common species of the shallow lagoons at intertidal belts at Krusadai, Pamban, Hare Islands etc. in heavily silted and sandy covered sea-floors with broken coralline pieces of larger or smaller sizes. The chain-like ovoid vesicles in large numbers in the branches, and the muricate stem are characteristic of the alga with which the plant can be easily recognised in the field. *Ectocarpus*, *Sphacelaria* etc. occur as heavy epiphytes on the stem, when it is denuded of vesicular and foliar structures.

CYSTOPHYLLUM MURICATUM (Turn.) J. Ag.

HORMOPHYSA TRIQUETRA (C. Ag.) Kütz.

Plants erect, with a conical well formed holdfast. *Frond* generally three sided, up to 30 cm or more in height, 3-10 mm broad, much branched irregularly. *Axis* at base somewhat terete to 5-6 cm from basal holdfast, with similar secondary branches. *Branches* higher up and elsewhere winged with a short basal stalk-like portion, a cylindrical rachis from which membranous wings are formed triquetrously. *Membranous wings* toothed at margin. *Cryptostomata* ovate, scattered on both surfaces of foliar wings. *Vesicles* in ultimate or sub-ultimate branches, elliptical, immersed in the frond, solitary, at times irregular and randomly placed series. *Conceptacles* scattered in the wings of the thallus in ultimate and sub-ultimate branches, bisexual with oogonia and antheridia. *Colour* brown, turning to paler red on exposure, blackish in dry state. *Substance* coriaceous to cartilaginous, thin. The alga does not adhere well to paper on drying.

Habitat : Krusadai Is.; Pamban Is.; in shallow lagoons.

The alga has a very peculiar construction of its thallus which is triquetrous. In shallow bays and lagoons in the intertidal belts at Krusadai and the neighbouring islands, this alga is seen, but rare. The three sided fronds and the winged nature of the fronds make it easy of distinction in the field.

PLATE XXXVII

HORMOPHYSA TRIQUETRA (C. Ag.) Kütz.

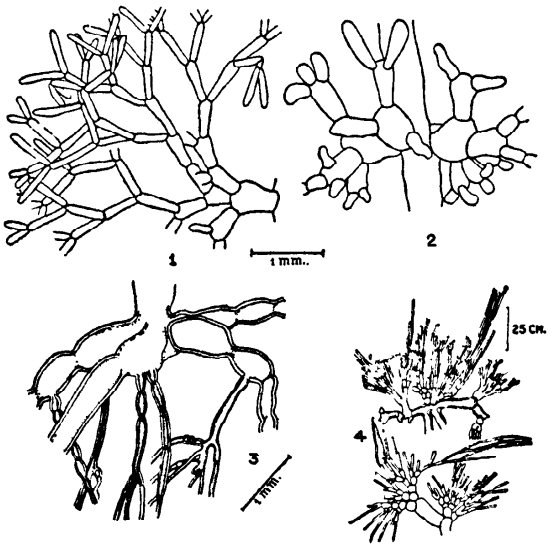
TYDEMANIA EXPEDITIONIS Weber-van Bosse

Coenocyte, feebly calcified showing a prostrate and erect system. *Prostrate system* of thick branched rhizome creeping on substratum, monosiphonous, constricted at shorter or longer intervals ; 280-532μ or more across. *Rhizoids* developed on the lower side of filaments, constricted at their base and torulose. *Flabella* rare, on prostrate filaments, minute, delicate, 4-4.5 mm high, monostromatic, composed of laterally connate, dichotomously branched filaments. Stalk of flabella 200-410μ thick. *Erect system* with erect shoots from the upper side of the prostrate rhizomous filaments. Upright shoots with a series of contiguously placed spheroid to sub-spheroid branched structures, the glomerules, giving the characteristic appearance to the alga. *Glomerules* up to 16 or more on each axial filament bearing them, at intervals of 4-6 or 10 mm ; 1 cm high, 1 cm broad. *Reproductive structures* not seen.

Habitat : Nancowry Island, Bay of Bengal ; growing attached to coralline rocks in a sheltered bay forming clumps below low tide water mark.

The interesting sea-weed described here is a very rare green alga of our Indian Coasts, being so far known only from the Nancowry Islands, in the Car-Nicobar group of Islands in the Bay of Bengal. It was found to grow in a restricted locality on a rock which was constantly dashed by waves, and was almost always completely submerged or wetted by the swell of tides. Even here, it was seen only as a small patch, and the collection of this alga was attended with certain amount of risk. At first the alga may be mistaken for its appearance to some marine animal, with thick cater-pillar like form. The genus is represented by two species, viz. *Tydemania gardineri* and *T. expeditionis*, and they have their principal centres of distribution in Malayan Archipelago, Philippines, Marshall Islands, Liu-kiu Islands, Caroline Islands, Chagos Archipelago Amirante Islands, and from Nancowry Island in the Indian region.

The alga does not adhere to paper well on drying. It takes more or less an ash colour, because of the feeble calcification of the glomerules.



1. Portion of a verticil of the glomerule of the erect shoot showing a primary branch and branches of higher orders. 2. Portions of young erect shoots, showing the axial filament and the primary branches and the branches of the second and higher orders formed by them. 3. Base of a glomeruliferous shoot showing the cruciate appearance of the prostrate filaments. 4. Flabella showing details of structure.

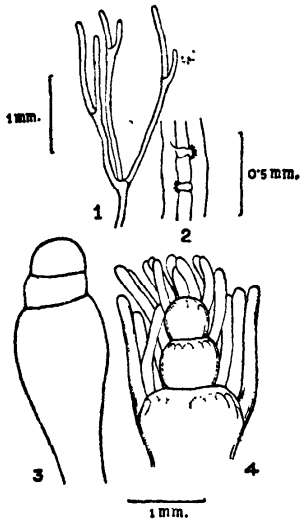
TYDEMANIA EXPEDITIONIS Weber-van Bosse

CHAMAEDORIS AURICULATA Boergs.

Plants growing gregariously in dense tufts upto 30 or more in a cluster attached to substratum by rhizoids. *Rhizoids* ramified. Fully developed plants with an erect cylindrical stem-like portion, the *stipe* which is annularly constricted throughout from base to the beginning of a head-like portion, the *capitulum. Stipe* usually unbranched, but occasionally branched also ; young stipes with no constrictions but as they grow annular constrictions appear. Upper free end of stipe in young plants slightly swollen from where whorls of filaments emerge to form the capitulum. Length of stipe before capitulum is formed upto 5 cm. In mature plants stipe up to 6 cm generally, and even up to 7-9 cm length. Filaments of capitulum grow eccentrically to one side forming an auriculate capitulum ; filaments up to 125μ across. *Capitulum* up to 2 cm in diameter across the short axis, and 3 cm along the long axis, dark green in colour on the upper side and light grey on the lower side.

Habitat : Dwaraka, in exposed localities in littoral zone with other algae in dense tufts on rocky substratum ; also in comparatively protected places at sides of intertidal rock pools, growing submerged and below water level. Muldwaraka, in rock pools at bottom and sides in large patches, together with *Hypnea, Champia,* etc. and bearing young *Ulva, Leviellea jungermannioides, Melobesia* etc. as epiphytes.

The green alga described here is an interesting member of the intertidal community especially in rock-pools, which occur in more or less exposed situations, and constantly agitated by the tidal movements, wave action, swell and currents. Several tufts grow together to form patches which in the natural surroundings is somewhat conspicuous. Though this alga is not reported from many places along the Indian Coast, in its place of occurrence it is fairly representative, though restricted to a few spots only.



1. Upper ends of filaments composing the Capitulum.
2. Portion of filaments showing tenacula by which the filaments are attached.
3. Upper free end of a filament before formation of capitulum, with two cells at top.
4. Longitudinal section of a young capitulum showing structure and formation of capitulum.

CHAMAEDORIS AURICULATA Boergs.

CHAETOMORPHA MEDIA (Ag.) Kütz.

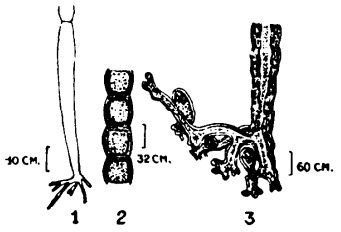
Plants attached to hard rocky and similar substrata, dense, tufted, brush-like, filamentous, unbranched, erect stiff and rigid below, flexuous above ; usually 4-10 cm high, occasionally to 20 cm or more. *Rhizoids* well developed vigorous branch system, horizontally spread out on substrata, irregularly ramified, branches ending in small coralliform irregularly shaped discs by which the plants are fastened to rocks and other substrata ; rhizoids swell up here and there, filled with starch, ultimately giving new shoots from them. Young plants, clavate without cross wall, up to 1.5 cm long or more, before first cross-wall is formed. *Basal cell* of filaments stout, clavate, 5-8 mm long, 300-550μ across at top, 150-205μ at base, with annular constrictions at basal part, thick walled, stratified, 25μ or more thick. *Vegetative filaments* above basal cell, cylindrical, barrel-shaped, 400-550μ broad ; length of cells varies, 1-4 or 5 times the breadth, usually 1-3 times the breadth. Cell wall lamellate, 60μ thick. *Colour* fresh green or dark green.. Plants on drying adheres well to paper.

Habitat : Mahabalipuram; Madras ; in very exposed localities on rocks dashed by strong waves or sprayed. Okha Port, in creeks in shallow waters, exposed to tidal action.

The green alga pictured here is common in the Tropical waters. At Mahabalipuram, the alga is found growing luxuriantly on quite exposed rocks and artificial rocky constructions, on the vertical faces, which are constantly dashed by violent breakers, and wetted by overthrow of huge quantity of water and in spray zones. In these much exposed localities, the plants are stunted, with the filaments broken or cut off at their upper ends, but very robust and healthy. The free extremities of these filaments appear colourless, obviously because of the escape of zoospores or gametes, the cells producing them being ultimately depleted of the contents. The alga is seen heavily infested with *Acrochaetium* sp. and *Erythrocladia subintegra* Rosenv. which impart a red hue to the filaments of the alga. Besides rocky faces, the alga is also seen to grow well on large Barnacles, *Balanus tintinnabulum* Linn. var. *communis* Darwin, on similarly exposed situations and dashed by violent breakers. Associated with this alga is another interesting brown sea-weed *Ectocarpus breviarticulatus* J.Ag.

Seasonal activity of the alga is well seen at Mahabalipuram. During October, the alga is seen in various stages of development, from young tufts to well developed ones. In November-December, the alga extends over a large area. In January, the plants become much stunted and are found only scattered here and there. By February, the alga disappears from many areas where they were luxuriantly growing, and whatever left appears only as very tiny, unhealthy tufts of a few mm height. In April, the growth becomes very poor and very much restricted, and in the following month of May, the plants became poorer still and disappears almost completely. In July, with the onset of monsoons, fresh shoots start growing in several places.

The plants that grow in comparatively sheltered places, reach good lengths, and they are not generally so robust and rigid as the ones found in the exposed localities, but more flexuous.

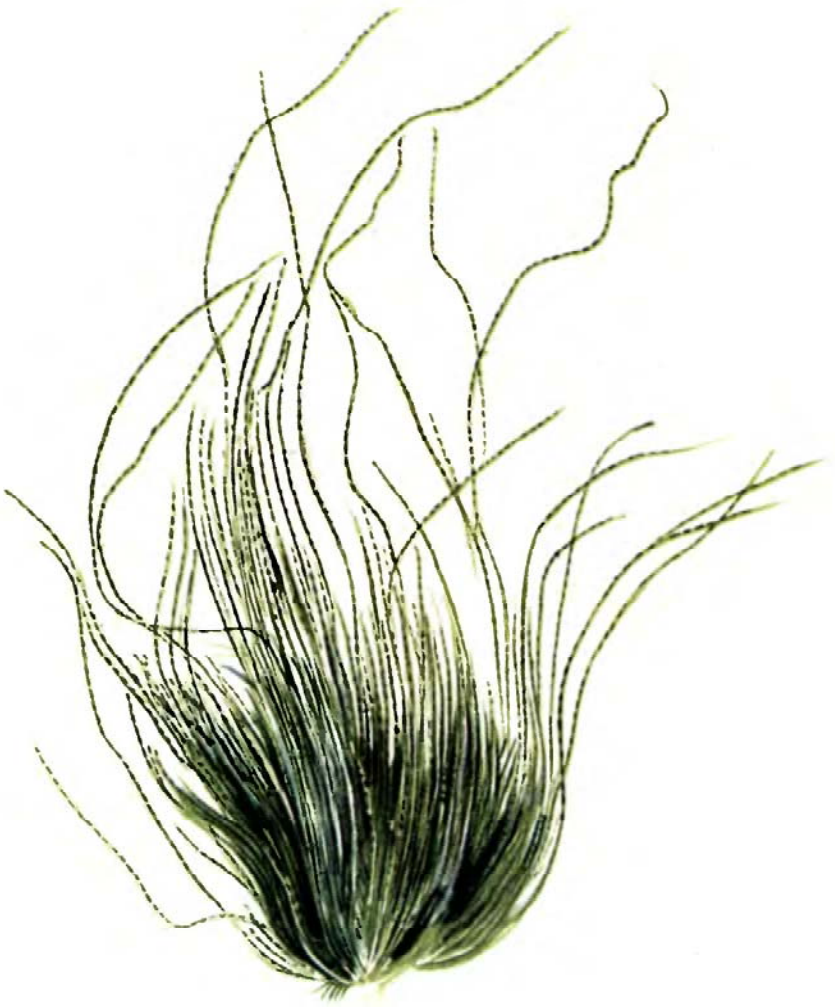


1. Basal cell, much elongated and with rhizoidal formations.

2. Barrel shaped cells in the upper portions of the filament.

3. Basal part of filament with rhizoidal portions, and irregularly shaped holdfasts and clavate structures with rich contents.

PLATE XL



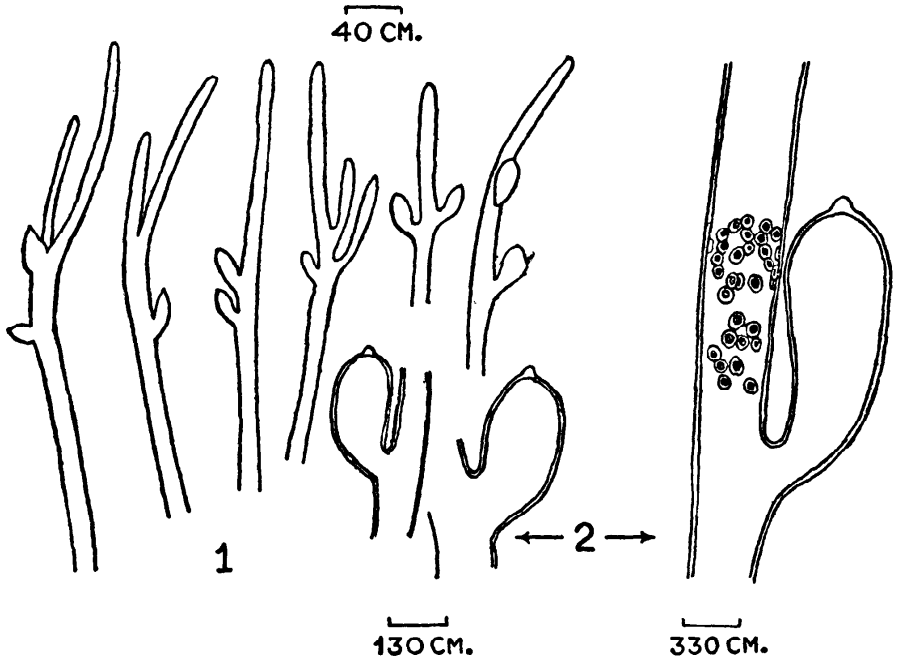
CHAETOMORPHA MEDIA (Ag.) Kütz.

PSEUDOBRYOPSIS MUCRONATA Boergs.

Plants erect, attached to substratum by numerous rhizoids, reaching more than 12 cm height. *Stem* terete, about 250μ thick in lower part, upper part of main stem branched ; main stem densely clothed on all sides by soft ramuli. *Ramuli* nearly cylindrical 2-3 mm long and 40-80μ thick at base, tapering slowly upwards ; higher up ramuli, 20-35μ thick at their ends, mostly unramified, but occasionally with single or a few pinnules near the upper ends. Base of ramuli narrowed. *Chromatophores* large rounded discs, 5-12μ broad with large pyrenoid. *Gametangia* broadly oblong-ovate or obovate with mucronate upper ends, 80μ broad, 150μ long, one gametangia to each ramulus, occasionally 2 to a ramulus.

Habitat : Bombay in shallow water ; Dwaraka ; Okha ; Muldwaraka ; in intertidal rock-pools and shallow waters in intertidal regions.

The green alga presented here is an interesting member of the rock-pool communities at intertidal belts at Dwaraka, Okha and Muldwaraka. Here the plants flourish well, growing from the sides of the rock-pools and the plants are generally seen more towards the upper limits of the rock-pools, but well submerged. The alga is easily distinguishable by its general appearance and habit. It adheres well to paper on drying.



1. Portions of ramuli with gametangia. 2. Gametangia much enlarged.

PLATE XLI

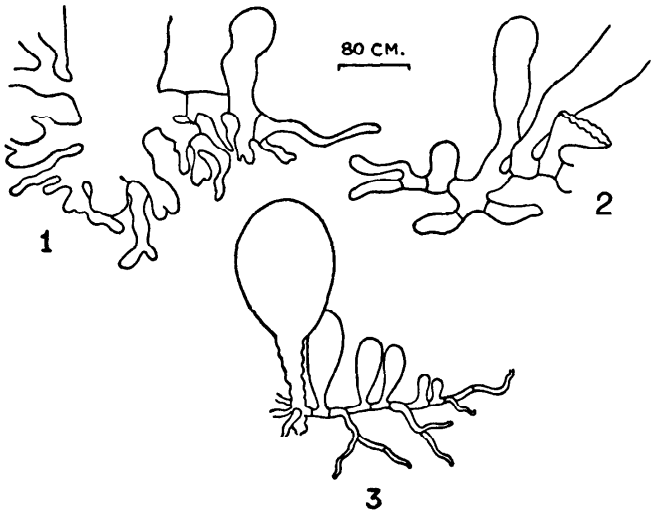
PSEUDOBRYOPSIS MUCRONATA Boergs.

BOERGESENIA FORBESII (Harv.) Feldm.

Plants erect, miniature balloon-like, occurring in smaller or larger clusters attached to dead coralline or similar substratum, attached by means of rhizoids formed at base. *Rhizoids* septate, horizontal, and in continuation with the erect portion. *Erect thallus* broadly clavate, or linear oblong, vesicular, swollen with narrow base and broader upper portions, balloon-like, filled with clear sea-water, turgid. Number of vesicles proliferating from the basal rhizoidal branches resulting in a dense cluster of vesicles of different ages and sizes and shapes, 25-50 mm long, 10-20 mm broad. *Vesicles* forming plenty of cysts inside. *Cysts* growing into new plants under favourable conditions. *Reproduction* by cysts and by numerous 4 ciliated motile spores formed inside each vesicle, escaping through a large number of rounded apertures on the wall of the vesicle. *Sexual* reproduction not known. *Colour* light to yellowish-green, translucent. Plants on drying adhereing perfectly well to paper.

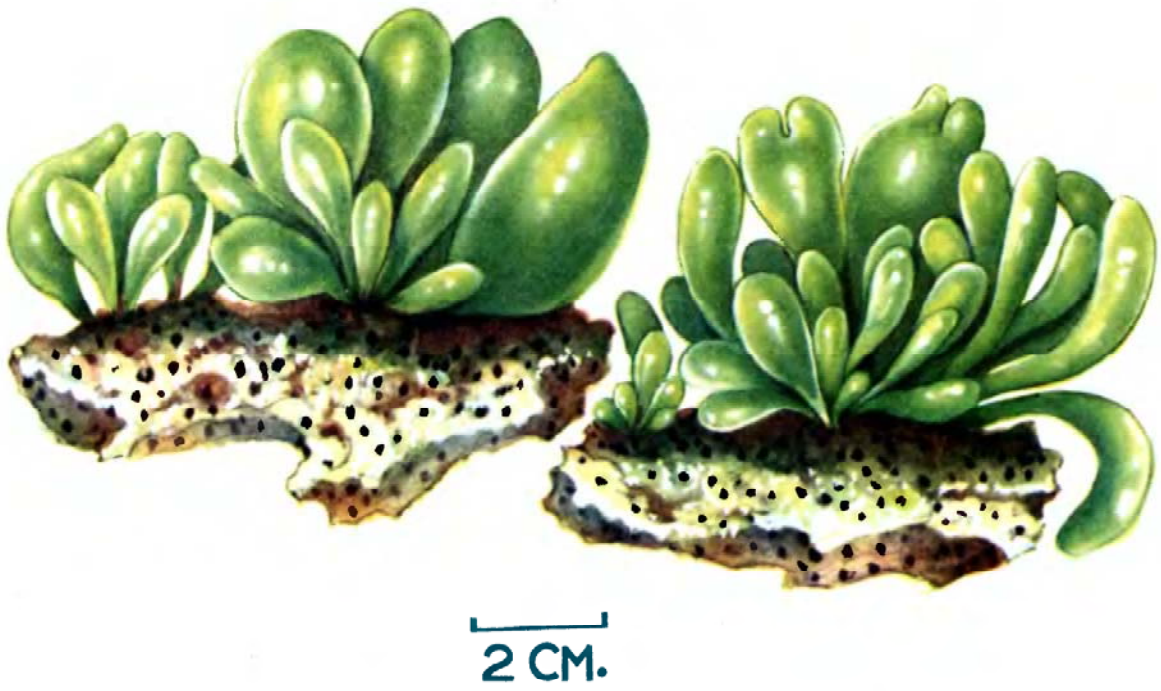
Habitat : Krusadai Is.; Rameswaram Is.; Pamban Is.; Tuticorin; Hare Is.; Andaman Is. ; Car Nicobar Is. ; in reefs and coralline substrata, heavily silted with fine and smooth sand or mud, and which get frequently exposed during low tides. Inside, shallow lagoons and tranquil bays, nearer upper limits of tide marks.

The green-alga illustrated here is a very fine and beautiful alga of the coralline coasts particularly, occurring right from the uppermost limits of the high tide mark in the littoral belts. In nature, it resembles bunches of grapes, for which reason, they are popularly known also as "Sea-grapes". The alga occurs in dense clusters, and the individual alga may be either balloon-like, with broad upper portion, almost straight or somewhat elongately-balloon-like and even strongly curved upon itself as a scythe. Normally the vesicles are undivided ; occasionally the upper portions may be divided also. The plant is filled with water, and feels quite turgid, and when picked, gives much a temptation to squeeze the water out. It is often seen in places where more or less pure white silt is formed with coralline pieces or rocky substratum in the reefs. Associated with this queer alga, in restricted places, are species like *Acetabularia, Neomeris, Caulerpa, Udotea* etc.



1. Base of the plant showing rhizoids formed from the stalk. Note a young vesicle also formed. 2. Rhizoid with vesicles well formed. 3. Diagramatic sketch of a series of plants in various stages of development. Note the annular stalk in the largest plant.

PLATE XLII



BOERGESENIA FORBESII (Harv.) Feldm.

CODIUM ELONGATUM C. Ag.

Plants firmly attached to substratum by well formed disc. *Frond* 10-30 cm long, ramified. *Ramifications* irregularly dichotomous. *Shape of thallus* very variable, compressed and in some, more or less terete. *Thallus* below the furcations broadened out, cuneate and always compressed, the broadest part up to 1.5-2.5 cm ; elsewhere the width of segments about 5mm. *Hairs* abundant. Ends of branches somewhat broader upwards. *Utricles* of variable sizes, 1150μ long, 450μ broad. *Gametangia* 270μ long, 90μ broad.

Habitat : Dwaraka ; Okha Port.

The interesting species of *Codium* illustrated here, is a common alga at Okha and Dwaraka. It occurs in deep rock pools, firmly attached by the basal disc to the substratum, and the free irregularly divided thallus floating or freely hanging and subtended in the body of water. It is more common towards the lower limits of low water mark. In favourable places, the green alga forms good patches, and the fronds get exposed during low tides, and may be seen lying flat on the substratum, several plants together, and even drying up in the scorching sun.

PLATE XLIII

CODIUM ELONGATUM C. Ag.

AVRAINVILLEA ERECTA (Berkel.) Gepp.

Plants solitary, with a flexuous, stout, cylindrical stalk, buried under mud in sea-floor. *Stalk* up to 20 cm long or more, 2 cm thick, composed of dichotomously branched filaments united to form the loose cylindrical basal stalk and anchored by colourless rhizoids. *Frond* above the cylindrical stalk formed by the threads spread out and interwoven to form a leaf-like flabellate expansion of the frond, shortly stipitate or sub-sessile, brown, up to 6 cm or more wide, 8 cm or more high, reniform to subcuneate, thick, very obscurely zonate ; margin entire to fibrilose-fimbriate. *Filaments* of fronds 27-42μ to 30-60μ, wide very variable in width, cylindrical, non-torulose, brown in colour. *Sporangia* terminal on filaments.

Habitat : Krusadai Is. ; Shingle Is. ; Hare Is. ; Tuticorin; Church Is. ; Andamans.

The green alga illustrated here is a very rare plant of our coasts. It is found in surroundings which are built of coralline reefs, with intervening depressions silted and muddy, at the intertidal belts and extending to low water mark. The alga for greater part of it, is buried in the sand or mud, and only the flabellate expanded portion, and a little portion below it, project above the sea-floor. At Tuticorin, Hare Is., the alga is found in greater numbers than at Krusadai Is., and at Andamans still in larger formations. But at no place it forms a dominant species, although, wherever it occurs, it attracts attention.

PLATE XLIV

AVRAINVILLEA ERECTA (Berkel.) Gepp.

CAULERPA CRASSIFOLIA (C. Ag.) J. Ag.

Plants creeping by well developed stolon. *Stolon* cylindrical, naked, about 1 mm thick, sending out rhizoids from lower surfaces and assimilators from the upper surfaces. *Assimilators* with or without pedicels, several arising from the horizontal stolon, flat, linear, lanceolate, 10-12 cm in length, up to 1 cm broad at the broadest part, pinnate. *Ramuli* upcurved, quite flat, opposite, of more or less the same width at base and middle part of ramulus, 5 mm long, 1-1.5 mm broad. *Apex* of ramuli rounded or mucronate. *Proliferations* arising from the assimilators, continuing to grow to form fresh assimilators. *Colour* somewhat yellowish green. *Substance* membranous. Plant adheres well to paper on drying.

Habitat : Hare Is.; Tuticorin.

The *Caulerpa* illustrated here is seen in moderate to somewhat deeper waters in depressions in the intertidal lagoons, bays and at low water marks, where the bottom is sandy and where there are broken pieces of corals and dead shells. It is seen to grow attached to shells also. In older parts of the fronds, the ramuli get destroyed and bleached to some extent.

PLATE XLV

CAULERPA CRASSIFOLIA (C. Ag.) J. Ag.

CAULERPA SCALPELLIFORMIS (R. Br.) Weber-van Bosse

Plants in large associations, with prostrate rhizome-like stolons, rooting from the lower surfaces at intervals and erect branches above. *Stolon* simple or slightly branched, glabrous, glossy, 15-20 cm or more long with erect assimilators on the upper faces at intervals of 1-2 cm. *Assimilators* with distinct stipe below, 1-2 cm long, simple, rarely forked; occurring in two rows from the upper face of stolons, bilateral, flat, leaf-like, 8-24 cm or more long, 1 cm or more broad; linear lanceolate in outline, occasionally constricted at middle; upper ends broadly rounded; pinnately branched; *branches* on the main broad thickened flat rachis closely pinnate, alternately linear, subacute, plano-compressed; 1-2 cm long, 0.3 mm broad; different forms with different characteristic assimilators. *Section of thallus* with spongy net-work of anastomosing filaments, filled with semifluid matter. *Substance*, horny, membraneous, devoid of calcareous matter, flaccid, glossy. *Colour* bright yellowish-green to olive green. Plant adheres somewhat to paper on drying, tending to lift up and curl on long exposure.

Habitat: Cape Comorin; Kovalam; Tuticorin; Hare Is.; Krusadai Is.; Shingle Is.; Rameswaram Is.; Pamban Is.; Dwaraka; Okha; Veeraval; Muldwaraka; Barwar; Bombay; Visakapatanam. In littoral and moderately deep waters; on exposed and sheltered areas.

The green alga featured here is a very elegant species and is locally abundant in many parts of our coasts. It grows in littoral zones, in low-lying flat depressions, and in rock-pools, lagoons and bays, covering the sandy bottom of the sea-floor and in places, it grows covering extensive tracts as carpets on the sea-floor, in shallow as well as deeper waters. It also grows on rocks, wharfs, wooden and iron pillars of jetties etc., hanging freely and constantly agitated by the turbulent waters of the sea, due to wave action. In such situations, its glossy green and serrated ling linear leaf-like structures simulate the appearance of fern-fronds. The alga is interesting in that the frond after drying is hygroscopic, and when moistened slightly with water, on one side, the frond rolls or curls up, and because of this property, it goes by the name the ,'Marine sensitive plant".

PLATE XLVI

CAULERPA SCALPELLIFORMIS (R. Br.) Weber-van Bosse

CAULERPA SERRULATA (Forsk.) J. Ag. emend. Boergs. .

Plants creeping on substratum by stolon, giving out rhizoids below and assimilators above. *Stolon* 1 mm thick. *Frond* glabrous, erect, decomposito-dichotomous, sub-fastigiate. *Stipe* below, cylindrical, 5 mm high, 1 mm thick. *Assimilators* spirally tortuous, inequal, without midrib, 3 mm broad, 4-5 cm long, coiled or twisted; *margin* distinctly dentate, teeth 1 mm apart short. *Apex* of assimilator rounded, also provided with teeth all over. *Colour* yellowish-green. *Substance* cartilaginous. Alga adheres to paper very well on drying.

Habitat : Krusadai Is.

The green alga given here is very curious looking for its assimilators which are twisted and coiled and with dentate margins. It frequents sandy to silty bottomed shallow lagoons, with sprinkling of corals and dead shells. Compared to the other species of *Caulerpa* of the area, this species is very rare to the locality.

PLATE XLVII

1 cm.

CAULERPA SERRULATA (Forsk.) J. Ag. emend. Boergs.

CAULERPA SERTULARIOIDES (Gmelin) Howe

Plants, coenocytic with prostrate branched cylindrical rhizome-like stolons creeping on substrata, anchored by well branched rhizoids below, forming large colonies. *Stolons* naked with a number of upright, delicate and flexible cylindrical axis with lateral outgrowths—the assimilators, on the upper side. *Assimilators* flattened, feather-like, 10-15 cm long, 13-22 mm broad, with laterals in two rows, pinnate. *Pinnules* cylindrical, slightly up-curved, opposite or sub-opposite, 3-11 mm long, 180-330μ broad; base of pinnules slightly larger than the apex; distance between pinnules equal to the width of the pinnules; apex of pinnule mucronate, rounded or conical. *Colour* light green to yellow green. Plants adhere very well to paper on drying giving beautiful herbaria.

Habitat: Krusadai Is.; Pamban Is.; Rameswaram Is.; Shingle Is.; Tuticorin; Hare Is.; Church Is.; Cape Comorin; Bombay; Dwaraka; Okha; Andamans Is.; Laccadives Is.

This elegant green alga is a littoral species and is common from the surface of the sea to a few metres depth. It grows both in exposed situations as well as in relatively sheltered and shallow and moderately quieter waters, in lagoons, and in protected places at the sides and ledges of coral-reefs and creeks; in sandy-bottoms of shallow lagoons and shoals, it covers rather wider areas of the sea-floor, forming dense colonies, accumulating fine silt and sand in amidst the tufts of the rhizoids. Sometimes it is dredged also from deeper areas. It is associated with other species of *Caulerpa* in our coasts.

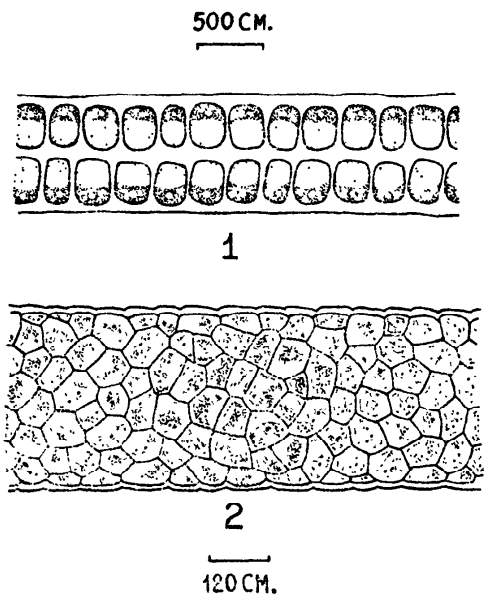
CAULERPA SERTULARIOIDES (Gmelin) Howe

ULVA LACTUCA Linn.

Plants, initially attached, later on at times becoming detached and drifting in broadly expanded and torn sheets. *Holdfast* very small, inconspicuous. *Thallus* foliaceous, membranaceous, expanded plane, reaching up to 18 cm tall, obovate in young conditions, broadly ovate or as rounded expansions in older plants, rarely incised but occasionally laciniate with small perforations of various sizes in the thallus. *Margin of thallus* ruffled and wavy and folded. *Substance* very thin, delicate, semitransparent. Surface glossy. *Colour* bright green to light green, fading to yellowish and sometimes darker when young. *Thallus lobes* varying in thickness, 40-45μ at margins, midportions 60-65μ; one cell layer thick. *Cells in cross section* subquadrate with rounded corners; in surface view closely packed, 13-15μ in diameter. Chloroplast cup shaped, filling outer third of a cell. Plants closely adhering to paper on drying.

Habitat: Dwaraka; Okhā; Bombay; Krusadai Is. Cape Comorin and many other places along the Indian coast; epiphytic on other algae or growing on small coralline pieces of rocks, on rocks and stones, on wood-works and artificial substrata in wharfs, wooden posts etc.; on exposed shore between tide marks, nearer low tide level; in quieter sheltered localities in shallow waters near shore and in rock-pools. At times dredged from deeper waters.

The green alga, popularly known as Sea Lettuce, is cosmopolitan in its occurrence and is widely distributed in many parts of the world in the Tropical and Sub-Tropical belts. In our shores, it forms luxuriant growth in quieter rock-pools as large expansions of green, membranaceous sheets, either as epiphytes on other algae or on coralline and rocky substrata and artificial wooden pillars etc. The larger thalli sometimes get torn and get detached and these fragments float as loose living communities, vegetatively reproducing also. The plant is annual and seasonal in its occurrence. In dry summer months of the year, they are conspicuously absent from many situations.



1. Cross section of thallus showing sub-quadrate cells with chloroplast filling outer third of each cell. 2. Thallus seen in surface view showing closely packed polygonal cells.

ULVA LACTUCA Linn.

ULVA RETICULATA Forsk.

Frond deeply and quite irregularly laciniated; laciniae undulated and torted; perforated by pores of different sizes, circular, oval, elongated or irregular in outline. Width of the thallus around pores about 1-2 mm; thickness 45μ. With pores, the plant resembles a broken network where the meshes are produced by local decaying of cells and confluence of pores. On the natural margin, very minute microscopical teeth-like structures present at distant intervals. Cells of thallus isodiametric, or may be longer than broad. Colour of plant bright green. Alga adheres to paper, but older thalli at times imperfectly adhering to paper.

Habitat : Okha Port; Bombay.

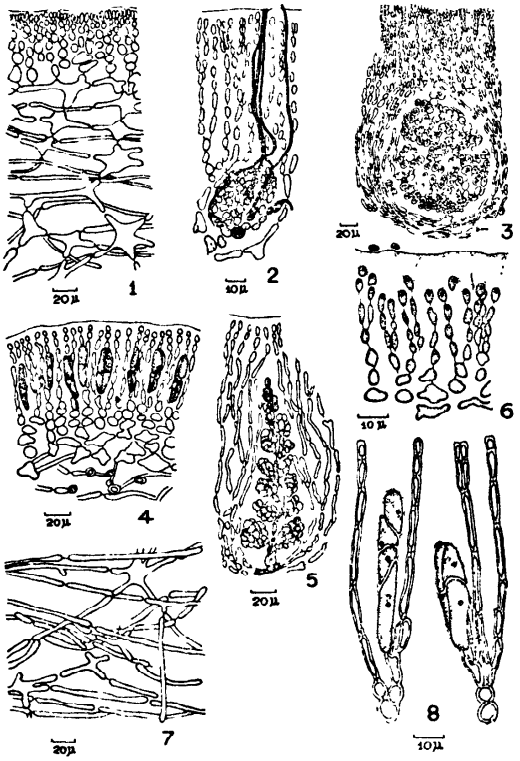
This interesting green sea-weed can easily be distinguished by the very peculiar habit of its thallus, which is like an irregular net. It is bright green in colour when fresh, but gradually fading to yellowish green or even completely bleached when it is colourless with a papery consistency when dry. Although not a very common and dominant form in our shores, this alga is sometimes cast ashore with the huge mass of other alga during stormy weather.

PLATE L

ULVA RETICULATA Forsk.

CORYNOMORPHA PRISMATICA (J. Ag.) J. Ag.

Plants in tufts, several growing together in patches over large areas, quill-like, gregarious, rigid, erect, dark purple ; younger plants developing in the midst of older ones from the basal disc. *Disc* very small, attached to the calcareous and hard substrata on rocks. *Thallus* generally simple, terete in living condition with a somewhat glistening dark purple colour in older parts and of lighter shades in younger parts, 15 cm or more in height, 3-4 mm thick, narrowed at base near the disc ; *apex* obtuse. Branching of thallus not infrequent *branches* dichotomous, once or twice or monopodial 3 to 4 forkings in succession. *Inner core* of thallus of loosely interwoven longitudinal filaments, laxly branched, thick-walled, 6-10μ diameter.



1. Longitudinal section of portion of thallus showing cortical and outer medullary regions. 2. Female nemathecium in longitudinal section. 3. Section of ripe Cystocarp. 4. Tetrasporangial nemathecium in transverse section. 5. Gonimoblast development. 6. Spermatangial nemathecium. 7. Longitudinal section of old thallus at central medullary region. 8. Tetrasporangium with zonate division (left) and cruciate division (right).

Stellate cells intermingled with the medullary inner core of filaments, 12-18μ across, arms of stellate cells varying in length up to 80μ ; slender thick-walled rhizoids running parallel or cris-cross, connecting the stellate cells and medullary filaments, 3-5μ wide. *Cortical layer* many layered, divisible into inner and outer region. *Inner region* 3-5 layered with irregular roundish cells, 8-12μ in diameter ; cells being progressively smaller and more rounded towards and near the outer region. *Outer region* compact, 3-4 layered, uniform with rounded cells, thick-walled, 6μ in diameter. Cells of outermost layer slightly elongated, 3μ wide, up to 10μ long. Cortical layer with pigmentation. *Reproductive structures*, sexual and asexual in nemathecia, in younger portions of thallus just below the tip, circumferential. *Sexual*

CORYNOMORPHA PRISMATICA (J. Ag.) J. Ag.

plants dioecious male plants slightly smaller than the female plants. *Spermatangia* catenate in nemathecial sori just below tips, covering the entire circumference of the fertile tip. *Carpogonia* in ampullary clusters. *Cystocarps* small, numerous, immersed in much swollen tips. *Tetrasporangial nemathecia* over larger area than the sexual nemathecia, developed circumferentially. *Tetraspores* cruciately divided or irregularly divided, or obliquely transverse, uninucleate.

Habitat : Cape Comorin on rocks in the sea exposed to violent wave action ; Okha Port, in comparatively sheltered places along the sides of narrow creeks in the intertidal belts.

The present alga grows luxuriantly at Cape Comorin, on rocks which are exposed to violent wave action and is always found in places below water level, where there is also swift current and swell of the waves. In favourable places, the alga forms pure formations, growing over very extensive areas, particularly seen far out into the sea at Cape Comorin, all around the huge rock known as the Vivekananda Rock. The alga occurs also at Okha Port, but its habitat is quite different. Here it is seen at the sides of long, narrow shallow creeks at intertidal belts and as such in comparatively sheltered places. In my collections, I have come across several specimens well branched and the branchings are of various types. It may be simple dichotomy, or repeatedly dichotomous once or twice, or again with one of the arms of the dichotomy alone again growing and dividing and this repeated some three or four times, all the same the alternate arms repeating the forkings. In several cases, from what appears as a truncated terminal portion, three or four new shoots originate, all from the same level. Most of the plants, especially the older ones are invariably covered by thick epiphytic growths of delicate forms, the most conspicuous and frequent one being *Leveillea jungermannioides*.