HANDBOOKS to the FLORA OF SOUTH AUSTRALIA

Published by
THE FLORA AND FAUNA OF SOUTH AUSTRALIA HANDBOOKS COMMITTEE
(formerly the Handbooks Committee of the British Science Guild, South Australian Branch)
between 1921 and 2001
on behalf of the
GOVERNMENT OF SOUTH AUSTRALIA

administered by the
Board of the Botanic Gardens and State Herbarium,
Adelaide, South Australia

State Herbarium of South Australia
PO Box 2732
Kent Town SA 5071
Australia

Handbooks of the Flora and Fauna of South Australia, issued by the British Science Guild (South Australian Branch), and published by favour of the Honourable the Premier (Hon. R. L. Butler M.P.)

The Seaweeds

OF

South Australia

BY

A. H. S. LUCAS, M.A., B.Sc.

Part I.

Introduction

AND THE

Green and Brown Seaweeds

WITH ILLUSTRATIONS.

PRICE : 2s. 6d.

Wholly set up and printed in Australia by
FRANK TRIGG, Government Printer, Adelaide.
Registered at the General Post Office, Adelaide, for transmission through the post as a book.

June, 1936.

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EDITORIAL PREFACE.

Handbooks of the Flora and Fauna of South Australia, issued by the British Science Guild (South Australian Branch).

Recognising the need for a wider diffusion of accurate knowledge of our Flora and Fauna, the Guild has undertaken the issue of a series of handbooks.

There is an admitted lack of inexpensive but accurate books dealing with the plants and animals of South Australia, and it is felt that the absence of such has been a real handicap to young Australia, and so to the progress of Australian Science. These volumes, which have been planned to meet the want, are being prepared gratuitously by South Australian biologists and geologists ; they will be printed and published by the State Government, and will be available for schools and the public generally.

OUTLINE OF THE PROGRESS OF PHYCOLOGY IN AUSTRALIA.

Australian Seaweeds were first made known in Europe by small collections brought home by the naturalists of the early French and English exploring expeditions. Thus a few species were described by Labillardière and by Robert Brown early in the Nineteenth Century. From 1840 to 1850 considerable additions were made. Ludwig Preiss resided in Western Australia from 1838 to 1842, and his marine material was worked up by Dr. Wilhelm Sonder, of Hamburg. Ronald Gunn made extensive collections in Tasmania, and his plants were described by Dr. William H. Harvey (Professor of Botany in Trinity College, Dublin) in J. D. Hooker's "Flora of Tasmania," published in 1860, in which Harvey gave excellent coloured plates of several species. Harvey had also published several forms, with illustrations, in his "Nereis Australis," 1847. In 1854-55 he himself visited Ceylon, Australia from Fremantle to Sydney, Tasmania, New Zealand, Fiji, and the Friendly Islands, for the purpose of investigating the algae of those countries. He collected enthusiastically, and was able, on his return, to distribute many sets of mounted weeds from Ceylon, Australia, and the Friendly Islands, those from each country separately. The Australian set comprised nearly 600 species. From 1858 to 1862 he brought out in five volumes his magnificent "Phycologia Australica," giving descriptions of Australian Algae and 300 coloured plates of the greatest scientific and artistic value. Local collectors gave him assistance by forwarding parcels of seaweeds to Dublin; notably George Clifton from Western Australia; from Victoria, Henry Watts (Warrnambool), S. Hannaford (Port Phillip Heads), and Mrs. Barker from Cape Schank; Rev. John and Mrs. Fereday from the Tamar, in Tasmania. In 1870 again, Sonder published his "Algen Tropischen Australiens," describing, in some cases with coloured figures, the algae sent to him by Daemel from Cape York, and by Kilner from Port Denison, Queensland. Baron von Mueller paid attention to sea plants, as well as to land plants, and issued sets of "Algae Muellerianae." He did not himself describe the species but sent the plants to Sonder, and, after Sonder's death, to J. G. Agardh, of Lund, Sweden. Agardh was the doyen of the Phycologists of Europe during the latter half of the Nineteenth Century. Mueller made his personal collections first on the Lefevre Peninsula, near Port Adelaide, and later in Victorian waters. He also enlisted volunteer collectors in other parts of Australia. During the last two decades of the century, J. Bracebridge Wilson, Head Master of the Geelong Grammar School, spent his holidays in dredging Victorian seaweeds and sponges in the neighbourhood of Port Phillip Heads and in Western Port. The Algae he sent to Agardh for determination, and among them were several which the latter described as new species. Wilson published, in the Proceedings of the Royal Society

of Victoria, a list of the Algae found by him. Miss Jessie Hussey sent seaweeds to Agardh from Port Elliot, South Australia, and Mrs. Louisa Meredith from Orford, Tasmania. One of Agardh's more important publications was a fine Monograph of the Australian Sargassa, illustrated by 31 plates. Later Reinbold of Itzehow, Denmark, described South Australian plants sent to him from Investigator Strait by Miss Nellie Davey, and from Rivoli and Guichen Bays by Dr. A. Engelhardt, of Kingston.

During the present century practically the only additions made to our knowledge of Australian Algae have been made in the papers published by myself in the Proceedings of the Linnean Society of New South Wales.

The number of described species of Australian Algae at present recorded is about 1,500. Doubtless more will be discovered, especially when the Northern Coasts have been systematically investigated; and indeed in well-worked areas new forms may be expected.

HINTS ON COLLECTING AND PRESERVING SEAWEEDS.

Collecting.—The seaweed hunter is at times helped abundantly by Nature when by aid of storms she piles up specimens in heaps on the beach. The collector of land plants is not similarly favoured.

In a recently formed heap, fresh and complete weeds are often to be had for the labour of picking out the different kinds. After exceptionally heavy gales the forms which grow in deeper water appear amongst the rest. But such gales only occur two or three times in the year and the collector is fortunate if he be on the spot at the time. A beach may be visited again and again without profit if one relies on the weeds strewn on the shore.

At low tide, flats and rocks are uncovered so that it is possible to gather growing species without wetting the feet. It is better, however, to be prepared to wade in water a foot or two deep, and rubber wading boots are serviceable. It is convenient to carry a stout knife to remove closely adhering plants or to secure the base of a weed with its attachment.

A certain amount of collecting can be done in a rowing boat, making use of a rake or drag, but the best method of gathering deeper water plants is that of dredging from a motor boat.

For shore collecting the equipment need not be elaborate. A basket or two for holding the weeds, a hooked stick or small rake for plants just out of reach of the hands, and a stout knife, are all the paraphernalia in general required in the case of plants intended for mounting and drying. If the weed has to be carried some distance, and especially if the weather be hot, it is as well to be provided with a bucket or tin so that the weeds may be conveyed home in sea water. Small and delicate weeds are best placed separately in small tubes or phials containing a 1 per cent. solution of formaldehyde.

Different weeds will be found on mudflats and on rocky bottoms. On sandy beaches weeds cannot obtain a sufficiently permanent footing to be able to grow. The mudflats are often covered with the "sea grasses" *Posidonia* and *Zostera*. These should be searched for true seaweeds which grow upon them.

Weeds growing on the rocks and exposed at low tide are often eaten down by mollusca, and are stumpy and bushy, and so abnormal. Such plants, for instance stumps of *Sargassa,* are not worth collecting. Plants should be fresh and well grown, and the complete plant gathered with its attachment.

Preservation.—Algae may be preserved as dry mounted specimens or kept in formalin in jars. Dry mounts keep their colour and structure for an apparently indefinite period, provided that they are not constantly exposed to light. Harvey's plants gathered and mounted 80 years ago are unaltered at the present time. Portions can usually be moistened and removed for examination under the microscope after having been kept dry for years. But for investigation on the development, especially of the reproductive organs, it is essential to harden fresh growing material by fixing agents and then to preserve in formalin or alcohol.

To mount weeds place in flat basins containing fresh water. All washing and cleansing from sand and foreign growths should be accomplished previously with sea water. Cartridge paper, cut to standard sizes, is then placed beneath the weed in the water; the plant is floated out over the paper to display it as naturally as possible. The paper is then gently raised for the water to run off, and then laid on a sloping board to drain.

Drying is effected in a press. Newspapers are quite good for the purpose, but a special "drying paper" can be obtained from some wholesale stationers. Blotting paper is useless. A sheet, doubled if of newspaper, is laid down, and the drained mount laid on it, and over this again a sheet of butter muslin. A second layer of newspaper, a second mount, a second muslin; more triple layers until the pile is built up. On the pile a board is laid, and on this weights of some sort are placed so as to apply an even pressure. The weight should be steady but not so as to crush the specimens. A full-sized sheet of cartridge, when folded into four, gives a convenient size for the larger mounts, about 15in. by 11in. One of these quarter sheets folded again gives an intermediate size, which is suitable for most specimens; and this folded again serves for the small plants.

Most marine algae when placed in fresh water exude a mucilage by which they adhere to the cartridge paper and less closely to the muslin. The papers should be changed after 12 hours, dry papers and muslins replacing the wet. Further changes should be made until the plants are dried. The muslins peel off readily, and the plant remains fixed to the cartridge.

Plants which do not adhere by their own mucilage can be fixed in position by strips of adhesive linen tape.

Many of the coarser Brown Weeds if pressed on the paper stain it badly; it is as well to dry them between the newspaper (with muslin) first, and then to fasten them on the mounting paper by strips of tape.

A very few weeds, such as *Sarcomenia,* break up and dissolve in fresh water, and had better be mounted in seawater.

If the colour of Red Weeds runs, when the plants are placed in fresh water, they should be hurried through and the mounts carefully swabbed and dried before putting in the press.

When dry, the mounts should be labelled, showing the locality, the month and year, and the collector's name. They can then be best kept in cardboard boxes of appropriate size, classified according to their relationships. The boxes in the Sydney Herbarium are 18in. by 12in., and 3in. deep.

THE CLASSES OF SEA PLANTS.

Sea plants belong to two different classes. The one bears anthers and ovaries, and forms a complex fruit and seed on the same plan as some of the less highly developed terrestrial flowering plants. The other class produces, sexually or non-sexually, single-celled spores. The first are Monocotyledonous Angiosperms, the second, or Seaweeds proper, are Algae.

SEA PHANEROGAMS.

Of the Phanerogams or Angiosperms there are very few forms. Probably not a dozen kinds occur on our Australian shores. In South Australia we have the genera *Halophila, Posidonia, Zostera,* and *Cymodocea.*

Halophila is assigned by botanists to the Family *Hydrocharitaceae,* to which belong the freshwater plants *Hydrocharis* (Frogbit), *Ottelia,* and *Vallisneria.* It has a slender green stem which creeps along the bottom in mud or sandy debris, and bears successive pairs of opposite, bright-green, broadly elliptical leaves, 1.3 to 5 cm. long on long petioles. These leaves closely resemble those of *Ottelia,* on a smaller scale. The flowers, very different from the large, white petaloid flowers of *Ottelia,* are enclosed in a spathe, green and inconspicuous, with 3 sepals but no petals, 3 anthers and a one-celled ovulary. The fruit is globular with numerous seeds. The plants are most abundant in fairly deep water, but apparently are only found flowering or fruiting in quite shallow water where they are exposed more directly to sunlight. There is but one species in South Australia, *H. ovalis* (R.Br.) J. Hooker.

The remaining genera are placed in the family *Fluviales,* or *Potamogetonaceae,* to which belong the pond and river weeds *Triglochin, Potamogeton,* and *Naias. Posidonia* and *Zostera* often form extensive meadows on the seafloor, the former in rather deeper, the latter in shallow water. *Zostera* flats are often uncovered at low tide.

Posidonia has a basic stock, clustered with flat sheathing leaves. The leaves grow to a length of from 30-90 cm., and have a width of 6 to 12 mm. The leaves are tough and fibrous and the base of the plant becomes covered with the fibrous remains of the leaf-sheaths. Presently, as the softer tissues decay, the base fibres are torn off by wave action and are rolled together into close balls, often of considerable size. Vast numbers of these balls sometimes strew the beach. Flat flowering stems rise, 30-60 cm. high, bearing 3-4 spikes at a distance from one another, each about 5 cm. long. The flowers, 6-12 in each spike, are enclosed in a long bract. There are 3 short peltate sepals, no petals, 3 anthers on a short common filament, and a single 1-seeded carpel. The fruit is ovoid-lanceolate, 14-16 mm. long, with a succulent pericarp. When ripe, the pericarp splits into four

rather irregular lobes, and the seed is set free. This is nearly as long as the pericarp, is almond-shaped, and is provided with a thin wing along one edge, so that it floats and is easily dispersed. In North Tasmania the fruits ripen towards the end of December.

The Australian species is *P. australis* J. Hooker.

The fibre of *Posidonia* is of commercial value, having a breaking strain only slightly less than that of jute. Possible uses suggested by the Imperial Institute, the South Australian Department of Chemistry, and the Commonwealth Institute of Science and Industry, are—(1) as a diluent of wool in the manufacture of low grade fabrics, (2) for the manufacture of guano bags, horse-blankets, etc., (3) as an insulating agent for heat, (4) as a substitute for jute in the backings of oilcloth and rugs, (5) as a substitute for horsehair or kapok in bedding and upholstery, and (6) for papermaking. On the north-eastern beaches of Spencer and St. Vincent Gulfs accumulations of drift material have formed deposits of fibre mixed with sand extending over square miles and in places 7ft. deep. Various companies—British, Australian, and Dutch—have exploited these deposits with a measure of success, but have been hampered by the preliminary difficulties of cleaning and drying the fibre. The final product is known in the market as Marine Fibre.

Zostera, the Sea-Wrack, or Eel-Grass, has a tough creeping rhizome fixed firmly by roots, from which spring at intervals shoots with long narrow leaves like blades of grass borne alternately on the shoots. The leaves may be a foot long and are about a line wide. The flowers, when they form in the summer, are enclosed in the leaf-sheath; they are numerous and sessile on a flat band-like stem. Each inflorescence consists of a spike, bearing male and female florets in alternate rows. There are no sepals or petals, the anther is solitary, as is the ovulary and therefore the fruit.

There has been much confusion among authors as to recognition of species, resulting in much synonymy. Of the three species which we may recognise as Australian, one (*Z. capricorni* Ascher.) is a northern form, and two others are common in the south. The latest worker on the genus, Professor Setchell, of the University of California, who has studied much Australian and Tasmanian material and has had access to Irmisch's original plants and notes, writes me: "In *Z. tasmanica* G. von Martens the vascular bundles are always more than 3, viz., one central one and 3 to 5 on each side of it just between the outer cortex and the inner cortex. In *Z. Muelleri* (Irmisch) Ascherson, the vascular bundles are 3, *viz.,* one central one and one on each side of it in a similar position to the more numerous lateral vascular bundles of *Z. tasmanica.*"

Zostera flats afford feeding grounds to a number of marine animals. In the north the Dugong (*Halicore dugong* Gmelin) pastures on the "Eel-Grass" and rejects seaweeds proper. Both *Zostera* and *Posidonia* absorb iodine from the sea water, and store it in small quantities as a component of an organic compound.

Cymodocea (also belonging to the family *Potamogetonaceae*) has a creeping rootstock, which sends up erect leafy stems at intervals. The stems are hard, almost ligneous, branched, 15-30 cm. high, the stem and branches naked below, marked with the scars of fallen leaves, and terminating in leafy pinnate bunches. The leaves are alternate, stiff, linear, 2.5-7.5 cm. long, truncate at the end and sheathing at the base, the junction of the lamina with the sheath being marked with a transverse line, along which the lamina falls off. The flowers are solitary, the male and the female separate, hidden in the leaf-axils without a proper perianth. Male flowers of 2 sessile, two-celled, anthers. Female flowers of 2 distinct carpels, each tapering into a slender bilobed style, each bearing one ovule. Fructification various and in some species unknown.

C. antarctica Endlicher (*C. zosterifolia* F.v.M.) is the species found on the South coast of Australia. It grows gregariously in deeper rock pools and in shallow waters. Its stems and branches are often beset with many varieties of seaweeds, especially the Corallines, *Corallina, Jania,* and *Metagoniolithon.* Its fructification is almost viviparous, the embryo germinating within the carpel and producing a young plant which finally breaks away and anchors itself by its "comb" to the bottom of the sea.

THE TRUE SEAWEEDS OR ALGAE.

Seaweeds play a part of the utmost importance in the scheme of Nature, and incidentally may be of great direct service to Man.

THE WORK OF SEAWEEDS IN NATURE.

The larger seaweeds abound in the debatable ground of the foreshores of the whole world; microscopic forms exist in untold myriads on the surface layers of the oceans. All form and contain chlorophyll, that wonderful substance, the only substance known which, under the action of light, can manufacture food out of inorganic material. Seaweeds draw all their supplies from the seawater which surrounds them—water, oxygen, carbon dioxide, and mineral salts. In the light, the chlorophyll decomposes the carbon dioxide, setting free a large part of the oxygen and retaining the carbon for the uses of the plant. The exhalation of this oxygen into the surrounding water keeps the balance of the dissolved gases, so that the sea animals can obtain plenty of oxygen for respiration. Further, *Galaxaura, Halimeda,* and the Corallines absorb the carbonic acid, and form carbonate of lime which they incorporate in their tissues, thus removing it permanently from the sea water. Thus the seaweeds keep our harbour waters pure, and available for the life of fish and invertebrates; they absorb the excess of the detrimental carbon dioxide which is always being given off in the respiration and decay of animals,

and provide fresh supplies of oxygen. Destroy all the seaweeds and the harbours will inevitably be polluted.

The grasses and other forage plants constitute the foundation of all terrestrial animal life. "All flesh is as grass," may be truthfully rendered "All flesh is assimilated grass." For the herbivorous animals this is true directly, and for the carnivorous intermediately. All animal material and energy is derived ultimately from the plants.

In the same way all marine animal life depends upon, and has its basis in, the marine plants. The algae, unicellular green plants and diatoms, floating in the plankton, manufacture their substance from inorganic matter and utilise directly the light energy of the sun. Smaller animals (crustacea, &c.) feed on them. Surface feeding fishes and the great whales themselves feed on this small fry. The surface-feeding fishes descend and some of them fall a prey to the inhabitants of the zone below. These again descend to further depths and serve as the food supply to a lower zone of life; and so, proceeding downwards, ultimately the abysmal fish and squids obtain their source of life from food derived from plants of the ocean surface.

In similar fashion life spreads outward from the fringe of fixed plants which grow around the unending shores of the oceans. The algae are mainly confined to a depth of water not exceeding 25 fathoms. Invertebrates of all classes, and some fish, feed on the seaweeds, and the dugong on the sea-wrack. These are preyed on by other forms—crabs, crayfish, cephalopods, and other fish—and the dugong by man himself; so the cycle extends to the sharks and dolphins (we have no true porpoises) and killers.

A striking instance is given by Sir Douglas Mawson in his paper on "South Australian Algal Limestones in Process of Formation" (Q.J.G.S.). Lake Robe, in the South-East of the State mentioned, is 1¼ square miles in area, and is constantly inhabited by several thousand black swans. It has puzzled the local inhabitants of Robe to determine what so attracts and maintains the swans on this sheet of water. It has been found that growing in the water are species of algae which are fed on by abundant crustaceans, both algae and crustaceans forming the attraction and food supply of the swans.

We have seen that certain of the algae secrete or excrete carbonate of lime which forms a skeletal structure. Coral reefs abound in such calcareous algae, the green *Halimeda* and the red *Galaxaura, Liagora, Amphiroa, Corallina,* &c. When they die the skeletons survive and, being brittle, break up into fragments which fill up nooks and corners between the coral blocks. They thus serve as a sort of mortar in the reef building. They are of more importance than is usually realised. W. Stanley Gardiner in writing of the coral reefs of Funafuti, Rotumah and Fiji, says, "The chief organisms, so far as I have seen, engaged in building up coral reefs

are massive and incrusting Nullipores." Madame Weber van Bosse similarly emphasises the great part filled by seaweeds in reef-building, as observed by her in the Siboga expedition to the Dutch East Indies. But it is not merely as adjuncts to the corals, for *Lithothamnion* and other stony seaweeds, Nullipores *par excellence,* build up reefs independent of the corals. Thus Madame Weber says, "Near the coast of Haingsisi, an island near the N.W. point of Timor, the whole reef which stretched from the shore into the sea was literally covered with knolls of *Lithothamnion erubescens,* up to 9 cm. in diameter. The living ones were red all round, the dead or dying totally or partially white. As far as the eye can reach, the bank is covered by the pretty beautifully pink-coloured knolls, heaped up close together." And again, "Another remarkable bank was one south of the island Saleyer, marked on the charts as a 'coralbank.' It was found to be an enormous bank of *Lithothamnion,* that gave a red colour to the bottom of the sea 8 to 10 metres deep, intersected by white bands consisting of heaped up dead joints of *Halimeda.*" There is an extensive *Lithothamnion* reef at Lord Howe Island.

Thus the algae perform geological work in the building of protecting fringing reefs and of the gigantic breakwater, the Great Barrier Reef itself. Then the reefs break down and out of their detritus islands are formed, or the land is added to, and footing is provided for plants and birds and insects. Geologists meet with stony algae in layers of enormous thickness in various parts of the world, thus demonstrating that the rock-building work of the algae has been continued through the ages.

An instance nearer home is provided by the Blue-Green Algae which are playing an important part in the formation of the "biscuits" and other limestone structures on the south-east coast of South Australia, described in Sir Douglas Mawson's previously referred to account.

USES OF SEAWEEDS TO MAN.

Food.—Primitive races having access to sea shores make seaweeds an important part of their food. In Hawaii a long list of species eaten by the natives was recorded by American biologists. In earlier days in Tahiti Professor Tilden found the natives still existing under the effects of a diet consisting largely of sea-foods, including raw seaweeds, vegetables and fruits, and the people were vigorous in body and mind, handsome and healthy, and their teeth were perfect. Dr. Olive Wood made a collection of seaweeds edible in Tonga. She writes that inland native women in a state of pregnancy will go and reside on the coast in order to gather a particular seaweed, which is beneficial to them in their condition. In Japan there is a flourishing industry, with fleets of boats in which to gather the kelps, shops and markets in which the dried weeds are sold in bundles, and an export trade to China. Bundles of seaweeds are sold for the making of soups and to furnish vegetable dishes. In Wales, Scotland, and Ireland,

dulse and lavers are looked on as special delicacies, the former eaten raw, the latter cooked as a spinach or made into laver bread. Ladies in Western Australia make jellies of *Eucheuma,* and ladies in Tasmania make jellies of *Gracilaria,* jellies much appreciated at their tables. Carrageen or Irish Moss, *Chondrus crispus* has long been used as a medicinal food.

Seaweeds contain proteid matter, starches and oils, minute quantities of iodine, and are rich in vitamins. The kelps are too tough for digestion, but many of the Green and Red seaweeds can supply nourishing material which can be prepared for the table and dressed as vegetables. In the cooking, however, the vitamins will be destroyed. Hence a method has been devised which will preserve the vitamins. The weeds are dried at a moderate temperature and then ground to a powder. This can be sprinkled on the food as we use salt or pepper. It is almost tasteless but will provide a valuable vitamin and iodine reinforcement. A diet so reinforced will act as a preventative from such diseases as goitre, rickets, scurvy, beri-beri, tooth-decay, &c. And as powder or dried weed such preventive can be brought to inland districts where such diseases are prevalent. Very much more use can be made of seaweeds as foods in our modern civilisation than has hitherto been the case.

No seaweed is poisonous.

Manure.—Seaweed spread on the land, rotted and dried by atmospheric action, and then ploughed or dug in, forms a good manure to supply food for crops. This is taken advantage of by the cultivators near the sea where the various kelps, or coarse Brown seaweeds, grow in plenty along the shores. Our kelps are rich in potash, and the Laminariaceae contain also small amounts of iodine. For impoverished folk, as in Connemara, for whom artificial manures are out of the question, the seaweed furnishes an economical means of replenishing the soil. The kelps form a broad brown fringe along a great part of the coast of the West of Ireland, and the storms of the Atlantic pile the torn off weed in long high banks on the beaches. The men hunt the weed in their curraghs, and the women collect it in wicker baskets, and carry it to the little plots of cultivated ground. In Normandy the Varech harvest is a great season when the thrifty fisher and farm folk go out in boats to cut and collect the kelp. The early settlers in Western Australia made great use of the heaps of weed thrown up by the heavy winter storms. In fact in many parts of Australia there are available considerable, if erratic, heaps of unclaimed manure which can be utilised at the expense of collecting and transferring to the land to be manured.

Agar-Agar, or Bengal Isinglass, is imported from Singapore and is obtained from various seaweeds in Malaya and Eastern Asia. The plants which yield it chiefly are *Gelidium corneum, G. corniculatum, Eucheuma spinosum,* and especially *Gracilaria lichenoides.* These being bleached and dried and treated in hot water form a jelly which sets, and can be hardened by drying into a solid gelatine-like substance. This is cut into

strips and sold as agar. It is employed as a nutrient jelly in which to cultivate germs, bacteria, and fungi, in medical and bacteriological laboratories all over the world.

Potash, Soda, Iodine.—In former days the alkaline carbonates were derived almost exclusively from plants. Potash was obtained by the lixiviation of the ash (Potashes) of the leaves, twigs, and rootlets of shrubs and trees. Soda was supplied by the treatment of Brown Seaweeds, especially the Fuci, reduced to "kelp" by imperfect combustion of the weed on the coast. So important was the industry during the time of the Napoleonic wars that fortunes were made. It is said that £400,000 per annum was paid for the kelp of the Hebrides alone. Then barilla, the impure ash of certain maritime land plants, *Salsola, Salicornia,* &c., was found to be richer in soda and was imported on a large scale from Spain, the Canaries, and other stations where the plant could be grown under supervision. But the discovery of the Le Blanc process, and later of the Solvay process, of manufacturing sodium carbonate from the cheap and omnipresent common salt, put an end to the employment of kelp and barilla alike. Sodium carbonate is no longer obtained from plant material.

Almost all seaweeds absorb both potassium and sodium chlorides, but they vary greatly in their predilections. Some, as the *Fuci,* have a rich sodium content, but are poor in potassium, while the *Laminariaceae* have higher percentages of Potassium, so much as to render them a convenient source of potash salts. But here again the discovery of potassium salts in commercial quantities in the Stassfurt beds in Germany has ousted the plants. When the German prices became high the Americans conceived the idea of obtaining potash from their own resources, that the kelps might furnish all they wanted. Accordingly, they made a most detailed and elaborate survey of the extensive kelp beds along the whole coast of California, Oregon, and Alaska. Perhaps in view of this threat, German prices came down and the kelp scheme is for the present abandoned. But the Stassfurt accumulation cannot last for ever, and we may yet see the kelps established as an important source of alkali.

Iodine is present in most seaweeds but in most of them in inappreciable quantities. That the weeds should be able to extract it at all is remarkable enough in itself, since the surrounding sea water contains normally 1 part of iodine in 260,000,000 parts of water. The *Laminariaceae* are among the richest, and factories are at work in Norway on species of *Laminaria,* while still more extensive are the factories in Japan, where other genera, such as *Ecklonia,* are also employed. In South Australia the *Laminariaceae* are represented by *Ecklonia* and *Macrocystis.* A third genus, *Lessonia,* flourishes on the southern half of the coast of Tasmania. At my request, Mr. G. Ampt, of the Organic Chemistry Department of the University of Melbourne, made a complete analysis of samples of *L. corrugata* from the estuary of the Derwent. In the moisture-free material he found .176

per cent. of iodine with 6.26 per cent. of potassium and 5.017 per cent. of sodium. At present the greater part of the world's supply of iodine comes from the Caliche, the crude sodium nitrate of Peru and Chili, included in the form of sodium iodate. Again, these South American deposits cannot last for ever, and we may be obliged once more to rely on the concentrates of iodine made for us by the incessantly active algae.

Other Uses.—The tougher kelps have been used in the manufacture of paper. In Japan, the potassium chloride of the kelps is used as the foundation in the manufacture of potassium chlorate for the making of matches. In Tasmania fishermen often moor their boats by tying them up to the stems of the "Bull kelp," *Sarcophycus,* or of *Macrocystis.* In South Australia seaweed has been used as a foundation upon which to construct metal roads on loose sand, with apparent success, and algal limestones are used as road metal in the Coorong district.

The Algae, being the simplest of self-supporting living organisms, present the problems of metabolism in the simplest known terms, and the solution of these physiological problems may well be sought in the study of the Algae.

CHLOROPHYCEAE. (Green Seaweeds.)

Algae containing in their cells pure chlorophyll, located in definite bodies (chlorophores), and in consequence typically green.

There are unicellular and multicellular forms. The unicellular may be quite simple, very small single cells, with a single nucleus, or may be multinucleate and form a highly elaborate thallus or frond. The multicellular consist of cells which grow in a single row to form a simple or branched filament, or of cells which are in addition united laterally and so form a membrane or tube.

Multiplication is effected non-sexually or sexually. Non-sexual multiplication (propagation) occurs by the division of the whole plant, if it consists of a single small cell, or of a part of the plant, if it be a complex of cells. The separated divisions do not conjugate. If active they are termed Zoogonidia or Zoospores, but if persistently inactive they are termed Aplano-spores or Cysts.

Sexual multiplication (generation) consists in the formation of an immobile cell (zygote, oospore) by the union of sexual cells (gametes) which lack a cell wall. There are four varieties of such union:—

1. Union of equal quite similar gametes which are ciliated and active: *Isogamous reproduction.*
2. Union of mobile antherozoids with an immobile oosphere: *Oogamous reproduction.*
3. Union of immobile antherozoids (Pollinidia) with an immobile oosphere: *Oogamous reproduction.*
4. Union of two large immobile gametes: *Conjugation.*

The last occurs in the freshwater Zygnemaceae, *Zygnema* and *Spirogyra,* and the Desmids.

The great majority of the Green Algae flourish in fresh waters, but representatives of most families (excluding those of the Conjugatae) are met with in the seas. Minute free-floating pelagic forms abound in the plankton near the surface of the great oceans. The attached forms live mostly in quite shallow waters and between tide marks. In his monumental work, the Sylloge Algarum, in the volume published in 1895, De Toni, the great Italian phycologist, enumerated nearly 3,000 species of marine and freshwater Chlorophyceae as then known in the world's flora. So far only 130 marine species have been recorded from Australia; of these only 29 have been found in South Australia; these belong to the two Orders *Confervoideae* and *Siphoneae.* The former are multicellular and the latter unicellular. The *Siphoneae* are well represented in the warmer waters of the coral islands and the Great Barrier Reef.

Order **CONFERVOIDEAE.**

Family ULVACEAE.

These are among the first seaweeds that meet the eye of the naturalist on reaching the shore, for their green colour renders them conspicuous as they grow on the sides of the rocks or in the rock pools. The fronds are quite simple in form and in structure, consisting of a membrane composed of uninucleate cells, each a small green mass surrounded by a colourless margin. The thallus is formed of one layer or, more usually, of two layers; the chlorophore of each cell is continuous. The frond is foliose or hollow; the leafy fronds are of a single layer (*Monostroma*) or of two layers (*Ulva*). The hollow or tubular fronds are entitled *Enteromorpha.*

ULVA Linnaeus. Sea Lettuce or Green Laver.

The Sea Lettuce shows great variation in the form and the colour of the fronds. On rocks exposed at low tide it is often ragged and shapeless and usually pale from the action of sunlight. In deeper and less disturbed water it assumes more definite shapes; the fronds are larger, ovate or rounded, and of a deeper green. The young plants consist of a small rounded frond attached by a short cuneate stipes which broadens out above into the frond. Later the stipes may become inconspicuous and the plant appears to be nearly sessile, or the whole basal part may become thickened, an intermediate layer forming filamentous processes which become irregularly interwoven and contribute to the fixing of the plant to the substratum. The frond does not grow quite in one plane and the margins are in consequence waved and furbelowed. They are often perforated by larger and smaller holes due to the molluscs which feed on them, and often bear other small algae as epiphytes.

There are no conspicuous organs of reproduction. Quite normal looking cells are found at times with the contents breaking up into a number of small rounded bodies, which are ciliated and free swimming. These are of two kinds, which may or may not be produced by the same individuals. The first are smaller, with two cilia, and are quite similar sexual gametes; the union of pairs of these form zygotes; the zygote develops directly into a new thallus. The other bodies are larger, with four cilia at the anterior end; they are non-sexual zoospores. They become attached to a substratum, lose their cilia, and grow out into a filament, out of which, by gradual subdivision of the cells, a normal frond develops.

It is not a simple matter to observe the release of the spores from the cells and the union of the gametes. Dr. C. L. Anderson described his observations to the Microscopical Society of San Francisco. He gathered

a quantity of *Ulva* for his marine aquarium, the fronds being well grown and of a beautiful deep green colour. The plants were put into the water at night, and quite early next morning the water of the aquarium had a turbid appearance. "As the sun came to shine on the side of the aquarium, I noticed a band of grey green matter bordering the side in the sunshine, and adhering, apparently, to the glass at the upper surface of the water, and the aquarium was clear. When the green band was touched there seemed to be a dispersal of the material but it readily came together

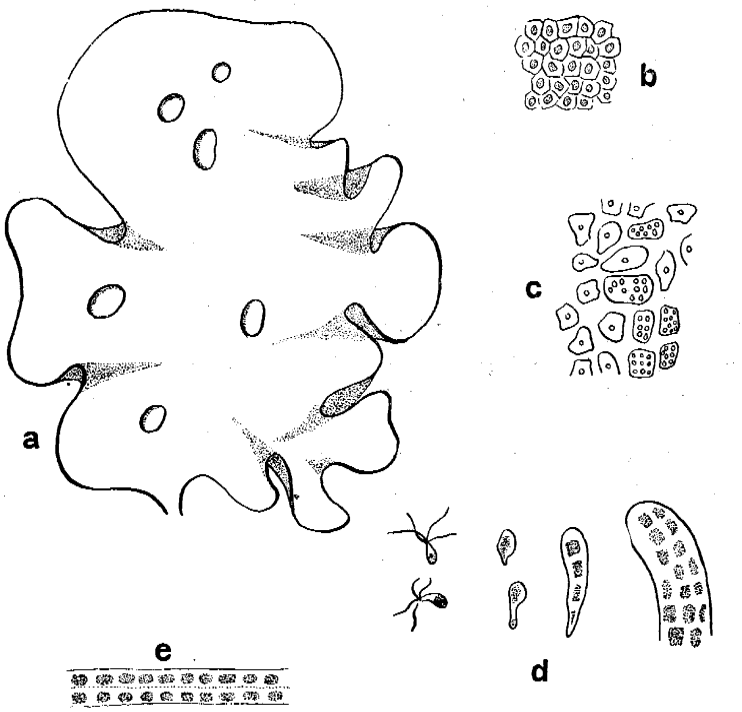

Fig. 1.—*Ulva lactuca*—(a) Frond with perforations; (b) vegetative cells: (c) cells forming zoospores, some emptied; (d) zoospores developing into thallus; (e) cross section of frond.

again." Under the microscope there were seen to be two kinds of spores. "One was quite round and moved slowly with an irregular rolling motion. I could not detect cilia although the motion would indicate their presence." The other kind was smaller, conical, and with cilia at the apex, and very active. "On further examination I found some of these zoospores clinging to the broken walls of the cells, both forms, and exhibiting active exertions to be free." He did not, apparently, observe the union of the gametes.

The so-called "species" of *Ulva* are all so unstable that they are probably best considered as races of one species. One may tabulate forms at one's pleasure.

Our common plant is distromatic, and all its varieties may find a place among the eight named forms recorded by De Toni under *Ulva lactuca* of Linnaeus. The general description given by De Toni is: Frond 4in. to 2ft. long, of variable outline, rounded, ovate, oblong, reniform, or lanceolate, undivided or irregularly laciniate, sometimes perforated, more or less waved or folded, shortly stipitate at the firmer cordate or cuneate base, or nearly sessile, with the margin usually quite entire.

Another form met with not infrequently in Australia is *Ulva laetevirens* of Areschong. The frond is divided nearly to the base into long twisted ribbons, the margins of which are abundantly and closely undulate. The membrane is very thin, pellucid, and the two layers of cells are easily separable in the upper parts, so that we have a transition to a well known form of *Enteromorpha, E. linza.* This form is of a deep green and grows in deeper water.

LETTERSTEDTIA Areschoug.

A genus allied to *Ulva,* but differing in the possession of lateral quasi-foliar appendages, which subsequently fall off from the older parts of the main shoot, leaving it bare and irregularly toothed at the margin. The type species is from Natal, but J. Agardh described a species (*L. petiolata*) said to grow on some kind of sea-grass on the shores of New Holland. The locality is not indicated but it is an interesting form which should be looked for.

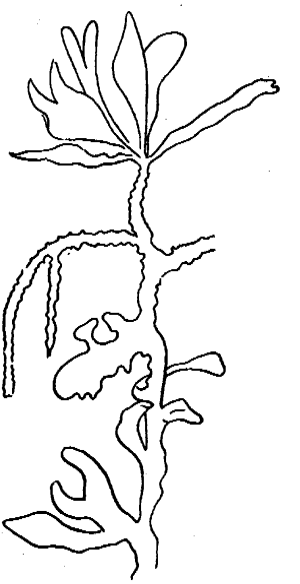

Fig. 2.—*Letterstedtia insignis.* **(After G. Murray.)**

ENTEROMORPHA Link.

This genus is closely related to *Ulva*. The membrane has two layers of cells as in *Ulva*, but the layers separate and the frond is therefore hollow. The individual cells are alike in the two genera, though a tendency to arrange themselves in longitudinal rows is more evident in *Enteromorpha*. Very occasionally the chlorophores are grouped in fours. The reproduction is as in *Ulva*.

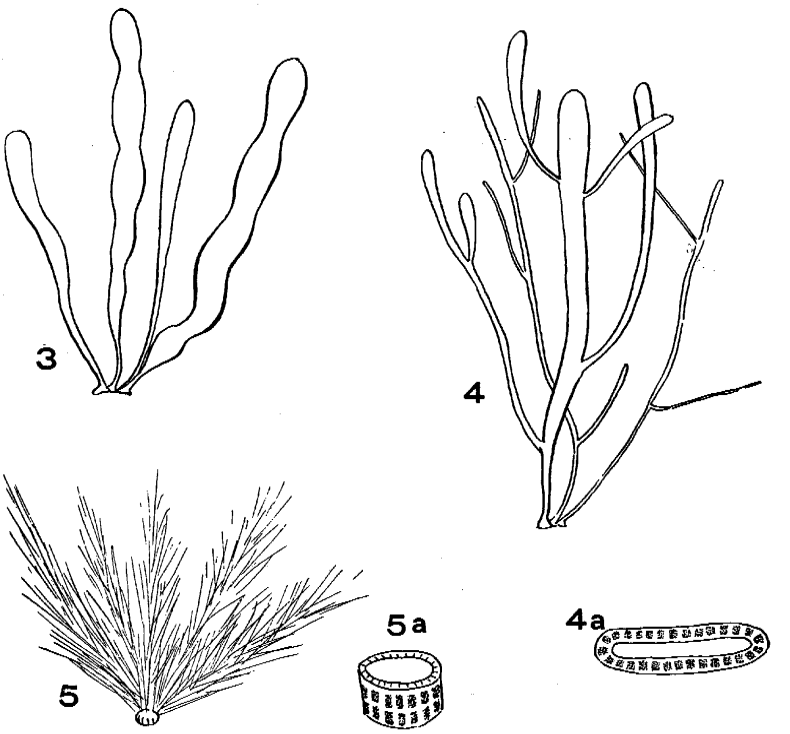

Fig. 3.—*Enteromorpha intestinalis.* **Fig. 4.**—*Enteromorpha compressa*—**(a) Cross section.** **Fig. 5.**—*Enteromorpha clathrata*—**(a) Cross section.**

The coarser species are *E. intestinalis*, unbranched and inflated, and *E. compressa*, more or less branched and flat. They vary greatly in diameter from 1 mm. to 20 mm. or more, and also in height. They grow socially in tufts and in great numbers. They are largely used as a fish bait, especially for mullet. Ships coming into dock after long voyages have usually to be cleaned from a heavy growth of *Enteromorpha*, and thus the plant may be widely distributed.

The finer, filiform species are *E. crinita* and *E. clathrata*, if indeed these are worthy of distinction. Harvey calls the plant sent to him by Mueller from the Lefevre Peninsula *E. clathrata*, "a most variable" species, of

which he himself had figured seven forms in his "Phycologia Britannica," all of them described previously by authors as distinct species. They are all very delicate tubular plants, with many elongated branches, mostly pale green in colour.

Family CLADOPHORACEAE.

The thallus is a single row of cells, simple or branched, each cell multinucleate, the nuclei minute. The chlorophore lines the wall of the cell but is often broken up. The cell wall is firm, sometimes lamellose. Reproduction takes place by means of tetraciliate zoospores and by the union of biciliate gametes, just as in Ulvaceae, with confervaceous habit.

Sub-Family CLADOPHOREAE.

Thallus simple or branched, filamentous, articulated, branches separated by a septum from the cell from which they arise.

a. Filaments of the thallus quite simple . . . . . *Chaetomorpha.*
aa. Filaments freely branched . . . . . *Cladophora.*
aaa. Filaments sparingly provided with short, mostly unjointed hook-like branchlets . . . . . *Rhizoclonium.*

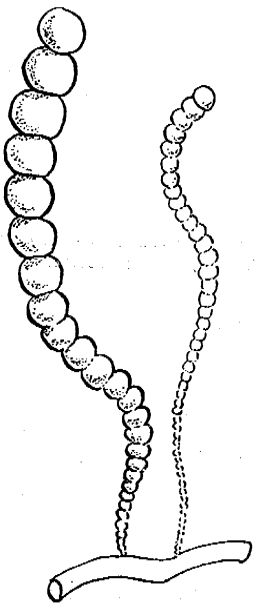

Fig. 6.—*Chaetomorpha Darwinii.*

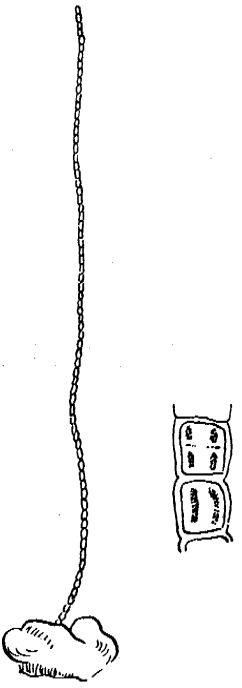

Fig. 7.—*Chaetomorpha aerea.*

CHAETOMORPHA Kuetzing.

Filaments quite simple, each with its own attachment, a small disc or rhizoids, growing gregariously in tufts. Little is known of the reproduction and the so-called species have been defined by the dimensions and shape of the component cells. Since there is much divergence in these respects in almost any clump observed, even in the apparently adult filaments, an exact nomenclature is hardly possible. We may, however, distinguish the more outstanding forms likely to be met with on the South Australian coast as follows:—

C. Darwinii: Cells of the chain large, globular, about as broad as long, separated by narrow constrictions. Diameter, 1,000 μ to 2,000 μ.

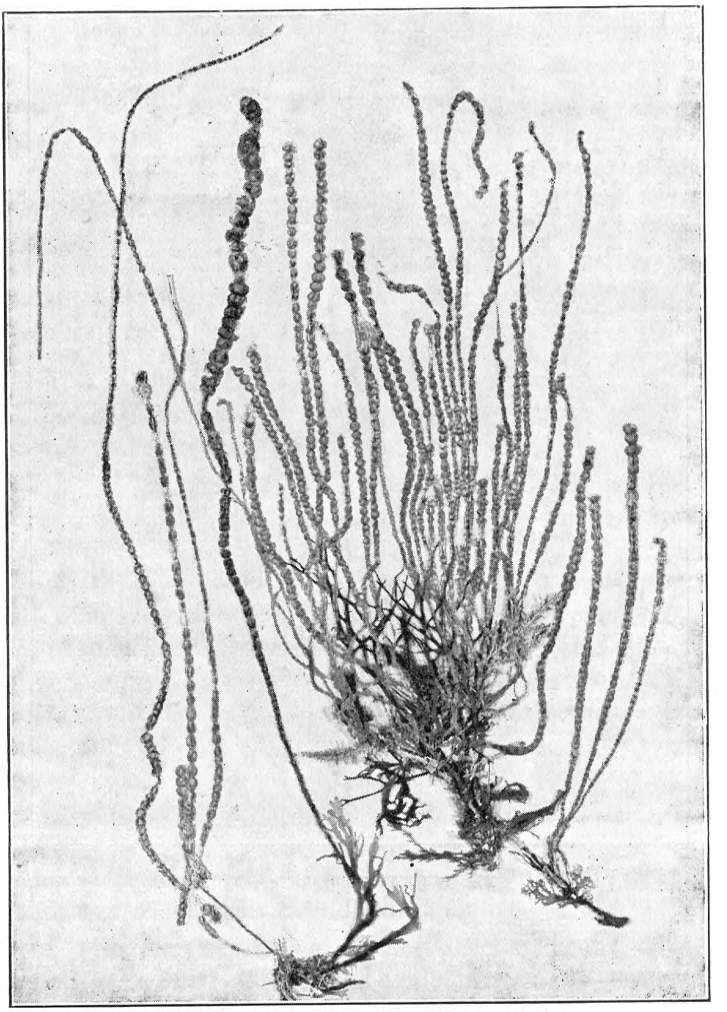

Fig. 8.—*Chaetomorpha Darwinii.*

C. coliformis: Cells inflated, but not as large as in preceding, 750 μ to 2,000 μ long, 1½-3 times as long as broad.

C. aerea: Cells small, 150 μ to 500 μ long, cylindrical, slightly constricted, from 1-2 times as long as broad.

C. Darwinii is a handsome form, growing in strings of glistening pearls, and conspicuous among the other algae of the rocks. *C. aerea* is slender and wire-like.

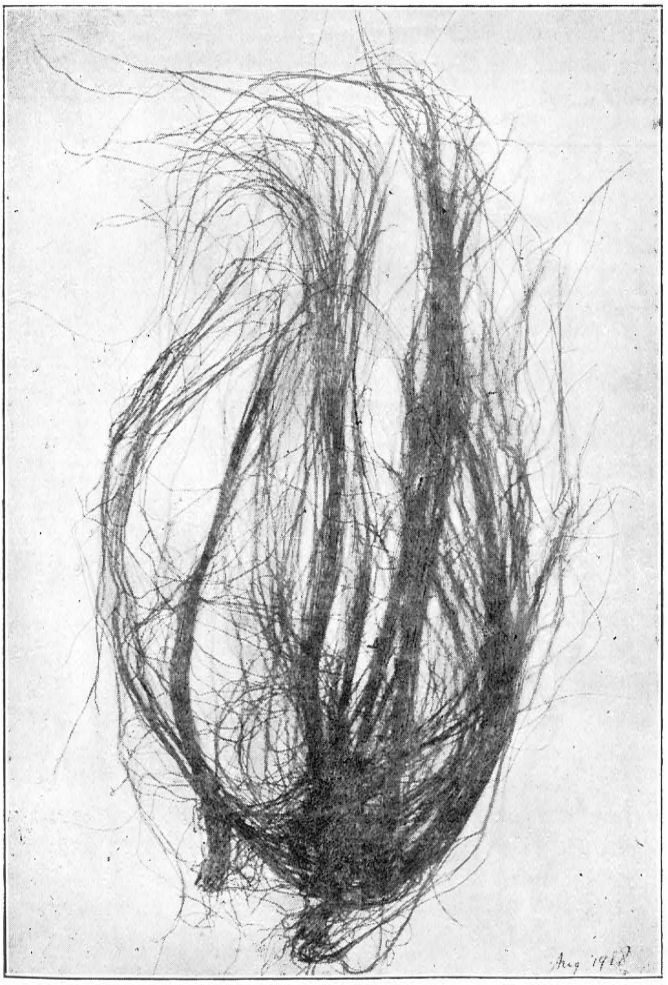

Fig. 9.—*Chaetomorpha aerea.*

CLADOPHORA Kuetzing.

A genus out of which many species have been made, both of fresh water and marine forms. All consist of usually much branched filaments articulated throughout in chains of cells. Each filament is made up of a single row of cells. These cells are cylindrical, with conspicuous chlorophores, and are multinucleate.

Both non-sexual and sexual reproduction takes place. Non-sexual zoospores arise within the vegetative cells in large numbers, and escape by a round orifice; they have four cilia. The sexual gametes arise in the same way, have two cilia, and show a red spot. The sex of the gametes is indistinguishable but they conjugate in pairs, and form a zygote, which at once begins to germinate into a vegetative thallus like the mother plant. In some species a chain of cells, endowed with thicker walls and denser granular contents, separates off and becomes a cyst which, after a period of rest, grows out into a new frond.

Most of the Cladophoras, of world-wide distribution, are bush-like plants, the branches growing out into the water free from one another, but some form globular, cushion-like or sponge-like masses, which cover the site to which they are attached, and the branches of which are closely interwoven. Doubtless many forms of both groups will be found on the South Australian coasts, as well as others in fresh water, but so far only four kinds have been recorded, all from the first group.

These are *C. valonioides* and *C. nitidula* (originally described by Sonder from Western Australia) and two other species which Reinbold ventured to create from the material forwarded to him by Miss Nellie Davey and Dr. Engelhardt.

Cladophora valonioides Sonder.

Densely tufted and bright green, more or less dichotomously branched, often with verticils of 3 or 4 branches in the upper parts; the cells are cylindrical, somewhat inflated, in the branches 6-8 and in the ramelli 4-5 times as long as broad, all constricted at the nodes; the ultimate segments are elongate-ellipsoidal and very obtuse. It grows to a height of 8 to 25 cm. in moderately deep water.

Cladophora nitidula Sonder.

Filaments setaceous, erect, bright green; the ultimate branchlets subsecund and very short; cells cylindrical, 3-6 times as long as broad.

Reinbold removed these two species to the genus *Siphonocladus*, associated with *Valonia*. This genus is diagnosed by a branched, saccate or filiform thallus, arising from a cell at first continuous and afterwards

articulated; the branches constricted at the origin, not articulated at the base. It is not clear on what grounds Reinbold made his decision, and I prefer to leave the species in *Cladophora*.

However I am convinced, from plants collected at Encounter Bay by Dr. J. B. Cleland, that *Siphonocladus* does occur. More material is necessary for specific determinations.

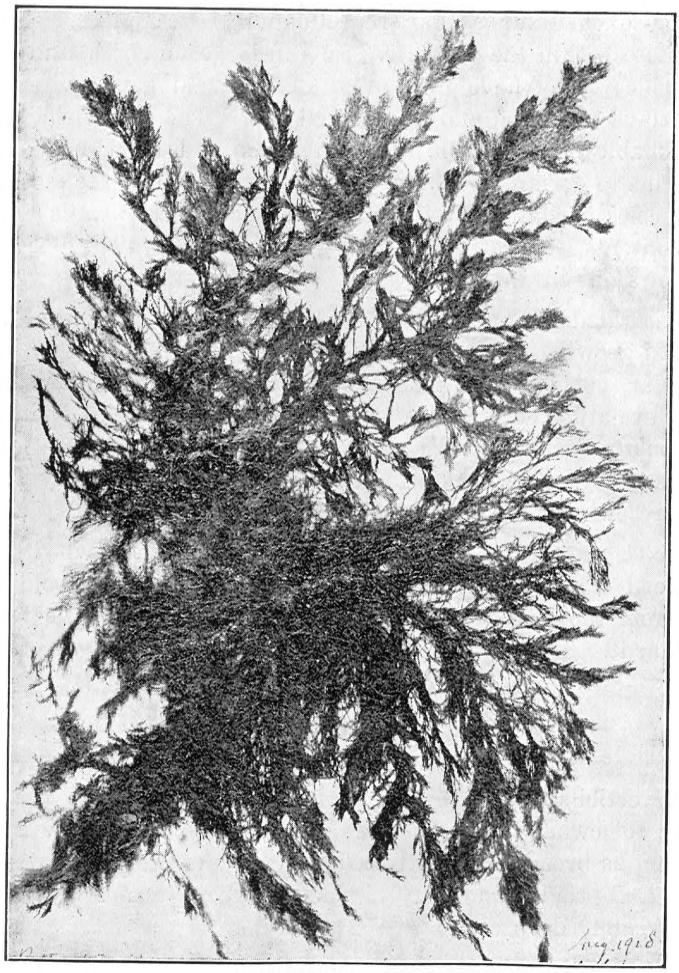

Fig. 10.—*Cladophora volonioides.*

Cladophora conformis Reinbold.

Reinbold considered this species to be distinguished from all others by the cells being of the same diameter from base to apex of the plant, while in the rest the cells of successive branches become narrower and narrower.

Cladophora Daveyana Reinbold.

A slender light-green form, at its thickest 100 μ to 120 μ in diameter, the uppermost branches spreading in a corymb; the ultimate ramelli 30 μ to 40 μ thick and often secund; cells, lower up to 12 times, and upper 4-8 times as long as broad; apices obtuse.

RHIZOCLONIUM Kuetzing.

Jointed creeping simple filaments, with scattered short branchlets, which serve as hook-like attachments to other filaments or to some other support. Cells mostly 2 or 4 nucleate, with thick firm walls. The filaments are slenderer than those of *Chaetomorpha,* usually less than 50 μ wide, and occur in tangles. Nothing is known of the method of reproduction.

R. hieroglyphicum (Ag.) Kuetz. is common in sluggish streams and on the dripping faces of cliff rocks. Probably marine forms will be detected on the coasts.

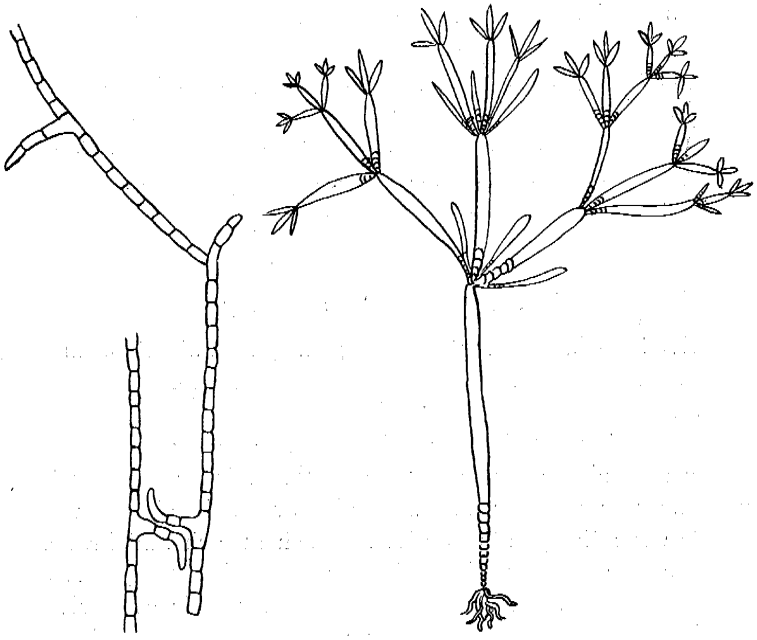

Fig. 11.—*Rhizoclonium riparium* **(European).** **Fig. 12—*Apjohnia laetevirens.***

Family ULOTRICHIACEAE.

Filamentous Forms.

Reinbold detected a microscopic green alga in plants of *Coeloclonium* and *Halodictyon* from Lacepede Bay, which he referred to *Entocladia viridis* Reinke, a member of the Ulotrichiaceae. Reinbold gives no details. De Toni gives in his Sylloge Algarum the species as *Endoderma viride* Reinke (Sub *Entocladia*). His description is:—Filaments subdendritic branching; vegetative cells 3 μ to 8 μ thick, varying in length, mostly 1-6 times the length of the diameter, subcylindrical, often contorted or ventricose.

Most Ulotrichiaceae are fresh-water forms, but *Endoderma viride* occurs as an endophyte in the Mediterranean and on the coast of the Netherlands.

APJOHNIA Harvey.

There is but one species known, the characters of which therefore are the characters of the genus. These are given by Harvey as follows:—Frond stipitate, dendroid. Stipes rooting, unicellular and monosiphonous, transversely rugulose, thinly coated with calcareous matter, at maturity crowned with a pencil of branches. Branches confervoid, umbellate, polychotomous, fastigiate, free, articulated; articulations clavate, annulated at base, and filled with bright green watery endochrome. Named in honour of Professor Apjohn of Dublin, and of Mrs. Apjohn, a zealous phycologist.

Apjohnia laetevirens Harvey.

An attractive tree-shaped plant reaching a height of about 15 cm. It grows erect from a small bunched attachment composed of unicellular fibrils, has a distinct stem and repeatedly divided branches. The branches and branchlets come off mostly in threes, in an umbellate manner. The naked stem consists of a single club-shaped cell, which is an inch or two long, tapering to the base, and for its lower half is constricted into a succession of rings. Between the points of division each branch and branchlet also consists of a single cylindrical or club-shaped cell and each is similarly constricted into rings at its base. The endochrome is of a vivid green, but thin and watery, giving a glossy, lucent appearance to the frond. Adult plants may become thinly coated with carbonate of lime and thus rendered opaque.

The species grows on the steep sides of rock pools, near low-water mark; it occurs freely on the shores of South Australia and Victoria, and rarely in Tasmania.

Unfortunately nothing is known of the means of reproduction. Superficially the plant bears resemblance to a *Cladophora,* but by its method of

attachment, its macroscopic cells and its watery content, it is more naturally placed in the Valoniaceae with *Struvea, Dictyosphaeria, Microdictyon,* and *Valonia.*

DICTYOSPHAERIA Decaisne.

Frond composed of decumbent green segments spreading outwards from a broad attachment, and consisting of a thick membrane made up of one or more layers of subglobose vesicular cells in a close network and containing green fluid endochrome.

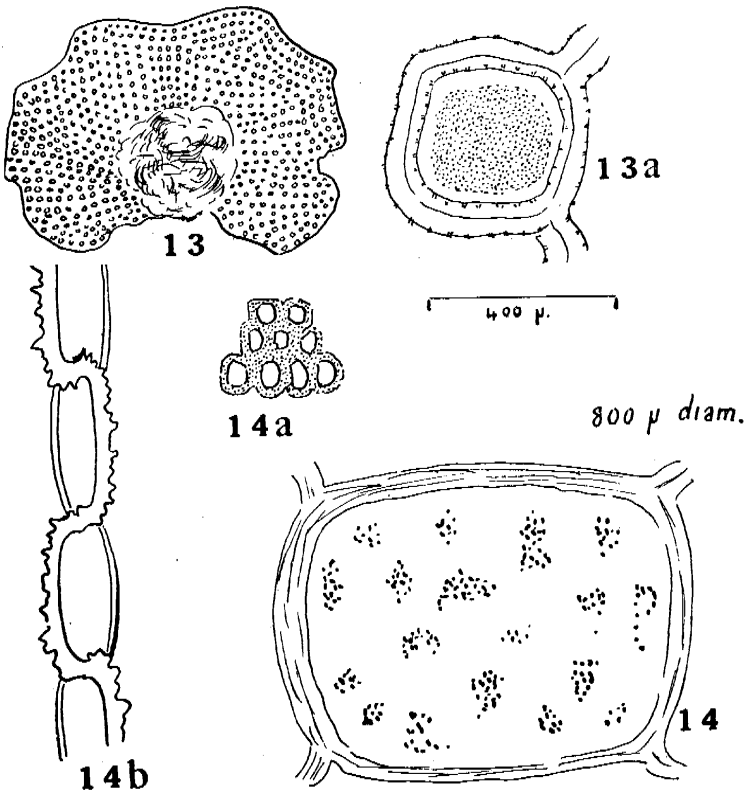

Fig. 13.—*Dictyosphaeria sericea*; 13a, cell. Fig. 14.—*Dictyosphaeria favulosa*; 14a, portion of frond; 14b, bordering cells with Haptera. (Partly after G. Murray.)

Dictyosphaeria sericea Harvey.

Attached to the roughnesses of the rocks by a broad irregularly-shaped membranous base of several layers, and difficult to remove without rupture. From the edges of the base grow out flat, firm, green semi-circular or semi-elliptical membranous fronds, an inch or two in diameter. These are free but decumbent, often incurved near the free entire borders. They may

be superposed or grow in a loose rosette. The greater part of each frond is monostromatic. The frond forms a membrane of small close-fitting subglobose 5 or 6-angled cells. The adjacent cell walls are thick and form a close network. The endochrome is fluid and gives an attractive dark-green appearance to the fronds.

D. sericea occurs in Western Australia, South Australia, Victoria, and on the north coast of Tasmania. It grows on rocks near low-water mark and is sometimes more or less bleached by exposure to sun and air.

Other species of *Dictyosphaeria* are found on the Barrier Reef and Lord Howe Island. In all of these the diameter of the cells is twice that of the cells of *D. sericea.*

Order **SIPHONEAE.**

Constructed of only one cell.

Family BRYOPSIDACEAE.

BRYOPSIS Lamouroux.

Frond filiform, tubulous, elongate, branching; the upper ramuli distichously pinnate or imbricate; zoogonidia very numerous, biciliate.

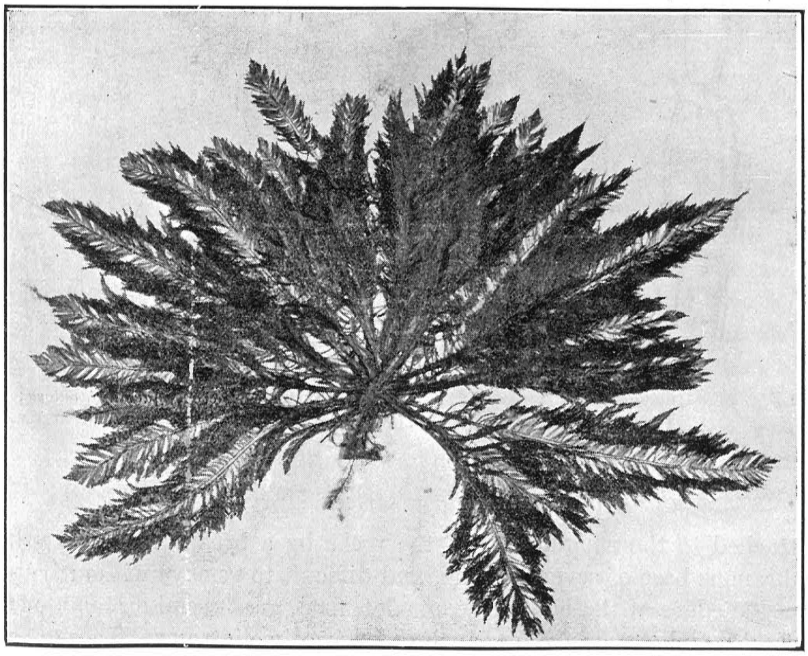

Fig. 15.—*Bryopsis plumosa.*

Bryopsis plumosa (Hudson) C. Agardh.

Fronds erect, naked below, simple or decompound pinnate above, forming elegant green plumes. There is no creeping surculus as in *Caulerpa*. The fronds are of a transparent green, glossy and shining, and there are no divisions into cells.

Growing on rocks about low-water mark, but also extending to no great depth of water.

Family CAULERPACEAE.

CAULERPA Lamouroux.

The genus *Caulerpa* (creeping stem) founded by Lamouroux in 1800, and as yet not merged or broken up into a number of smaller independent genera, is probably the most remarkable type in the vegetative kingdom.

The plants of the genus are characterised by possessing a long, cylindrical, creeping stem, the surculus, which sends downwards bunches of fine, branching, colourless fibres, the rhizoids, by means of which it attaches itself to the rocks or sand among which it creeps, and sends upwards green fronds, the assimilators, of the most varied form. The fronds of the smallest species are an inch or less high while those of the largest are over a foot in length, but, small or great, each plant is formed out of a single cell, the branchings of which constitute the rhizoids and the assimilators. There are no cross walls, and there is no aggregation of the protoplasmic matter into distinct small bodies. The firmness of stem and frond is secured by a system of narrow beams, trabeculae, which pass from wall to wall of the long cell, and are composed of a substance very like but apparently differing from cellulose.

The surculus, itself, like a strawberry runner, is of apparently indefinite length and growth, and usually gives off similar branches, which go on growing, and, if accidentally or naturally severed, still continue to give off fresh rhizoids and assimilators of now independent plants. As at present certainly known, this is the only way in which new plants are formed. The surculus is cylindrical, green where exposed to light, and may be quite smooth or beclothed with small scales, according to the species. It is slender in some species, but may have a diameter of a $\frac{1}{4}$in. in others.

It is the fronds of *Caulerpa* which are most remarkable. Nature seems to have shown what a variety of forms she can produce out of one single undivided cell, just as the one-celled Foraminifera foreshadow the designs and patterns of the Mollusca. Thus we have prototypes, as it were, of Charas, Mosses, Ferns, Horsetails, Clubmosses, Cypresses and Araucarias, Stonecrops, Cacti and Phanerogams with broad simple leaves. So marked is this diversification of type that all botanists accept J. G. Agardh's classification of the genus in sections according to the likeness to the various classes of the more elaborated groups.

SOUTH AUSTRALIAN SPECIES.

Section *Filicoideae*. Like Ferns.—

1. *C. scalpelliformis* (R. Brown) C. Agardh.
2. *C. sertulariodes* (Gmelin) Howe.

Section *Hippuroideae*. Like *Hippuris* (Marc's Tail).—

3. *C. longifolia* C. Agardh.
4. *C. Harveyi* F. V. Mueller.
5. *C. Cliftoni* Harvey.
6. *C. obscura* Sonder.

Section *Lycopodioideae*. Like Clubmosses.—

7. *C. Brownii* Endlicher.

Section *Araucarioideae*. Like Firs.—

8. *C. Hedleyi* Weber van Bosse.
9. *C. hypnoides* (R. Brown) C. Agardh.
10. *C. flexilis* Lamouroux.

Section *Sedoideae*. Like Stonecrops.—

11. *C. sedoides* (R. Brown) C. Agardh.
12. *C. vesiculifera* Harvey.
13. *C. simpliciuscula*.

Section *Opuntioideae*. Like Cacti.—

14. *C. cactoides* (Turn.) C. Agardh.

Section Filicoideae.

Fronds fern-like with pinnate or pinnulate lobes.

Caulerpa scalpelliformis (R. Brown) C. Agardh.

This is a conspicuous and elegant species, with bright green fronds. It was noted by the earliest collectors, and is one of the three which received their specific names from Robert Brown himself.

The surculus is smooth and glossy but becomes furrowed when dry. The assimilators are stalked and erect, 1 to 2.5 cm. apart, several centimetres (rarely up to 30 cm.) high, and a little more than 1 cm. wide. They often start a fresh growth by constricting and then widening out again. They are linear-lanceolate in outline, flat with a thicker median axis like a midrib, and are closely pectino-pinnate with alternate, linear, incurved, subacute, flat teeth or lobes. The lobes are about as long as the width of the rachis and come off at an acute angle.

The species grows on rocks near low water mark, usually tangled with other Caulerpas, or on stony bottoms to a depth of at least 12 fathoms, where the finest fronds develop. It occurs around the coast of Western Australia, South Australia, Victoria, and Tasmania. An allied species,

C. denticulata DeCaisne (by many phycologists united with *C. scalpelliformis*) differs in that the lobes of the fronds are markedly denticulate, while those of the Australian species are quite entire; it occurs on both sides of the Atlantic, in the Red Sea and on the west coast of India.

Fragments of *C. scalpelliformis* are not infrequently cast up on the beaches.

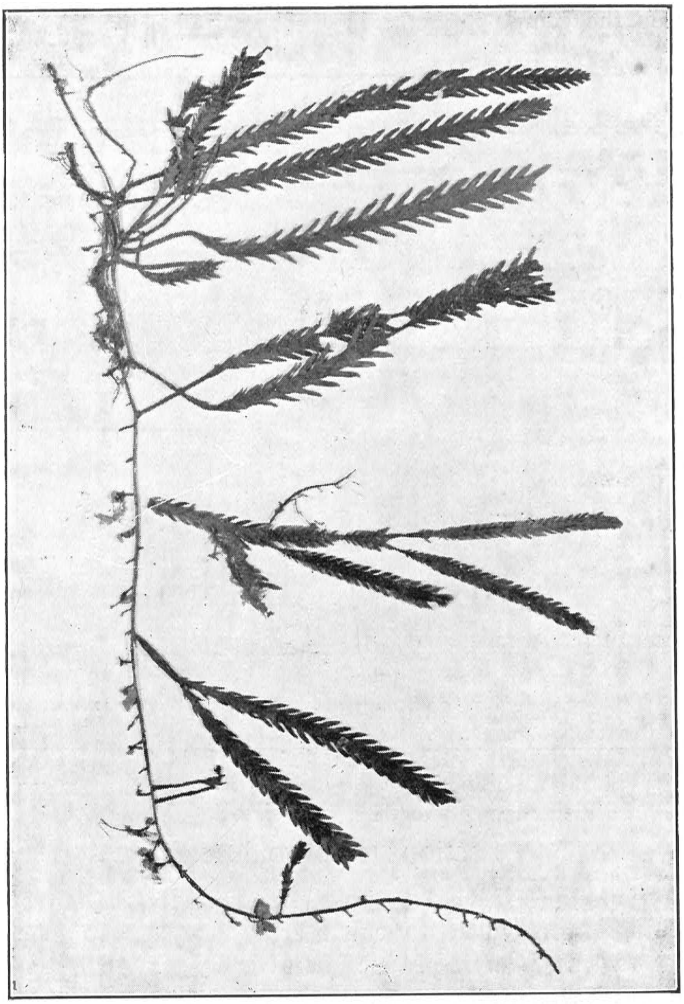

Fig. 16.—*Caulerpa scalpelliformis.*

Caulerpa sertularioides (Gmelin) Howe.

A much smaller plant than the preceding, rarely attaining 5 cm. in height and mostly not half as high.

The surculus is slender and smooth. The assimilators have a simple or branched petiole, and the fronds are pinnate from a terete rachis. The

pinnae are patent and opposite, narrow, subcylindrical, incurved at the tips. Thus the assimilator has the appearance of a delicate feather.

Found by Dr. A. Engelhardt in Guichen or in Rivoli Bay. It was formerly called *C. plumaris* Forskaal, but the present name has priority. It is widely distributed in tropical seas, as on the Barrier Reef, but it is remarkable to find it so far south. However, Dr. Engelhardt's specimen was determined as *C. plumaris* by Madame Weber van Bosse, the distinguished authority on the genus.

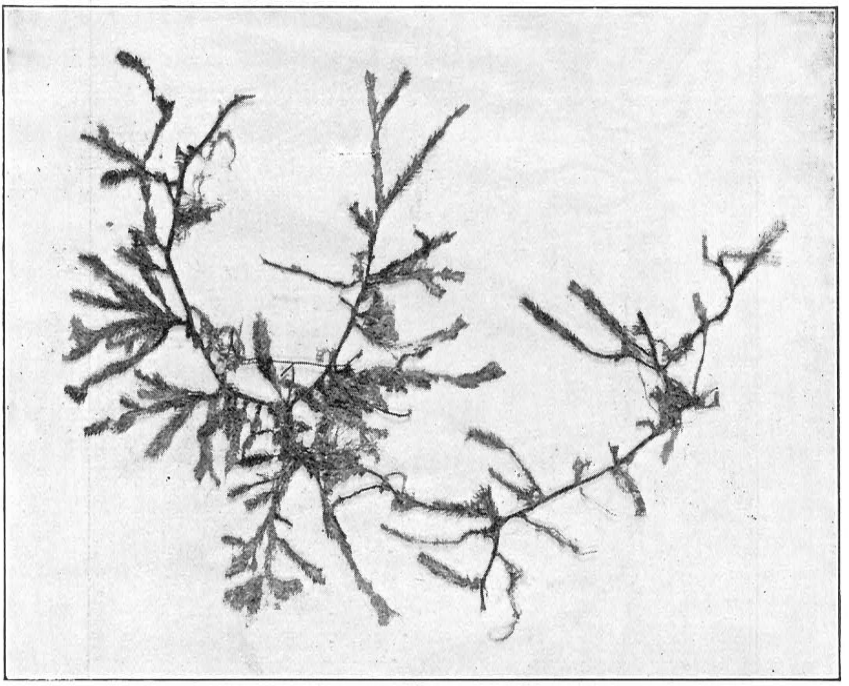

Fig. 17.—*Caulerpa sertularioides.*

Section Hippuroideae.

In the section Hippuroideae the green fronds are large and conspicuous, each consisting of an elongated rachis bearing long slender ramenta, much in the same way as the vertebrated axis of a horse's tail bears the hairs. All are confined to the south coast of the continent and Tasmania. The species may be recognised by the following key:—

a. Ramenta not arranged in distinct longitudinal rows but spreading brushwise in all directions.
  b. Ramenta simple . . . . . *C. longifolia* C. Agardh.
  bb. Ramenta pinnate . . . . . *C. obscura* Sonder.

aa. Ramenta arranged in longitudinal rows.

c. Ramenta simple in three rows (tristichous) .. .. *C. trifaria* Harvey.

cc. Ramenta in five rows (pentastichous).

d. Ramenta simple .. .. *C. Harveyi* F. von. Mueller.

dd. Ramenta forked or subpinnate .. .. *C. Cliftoni* Harvey.

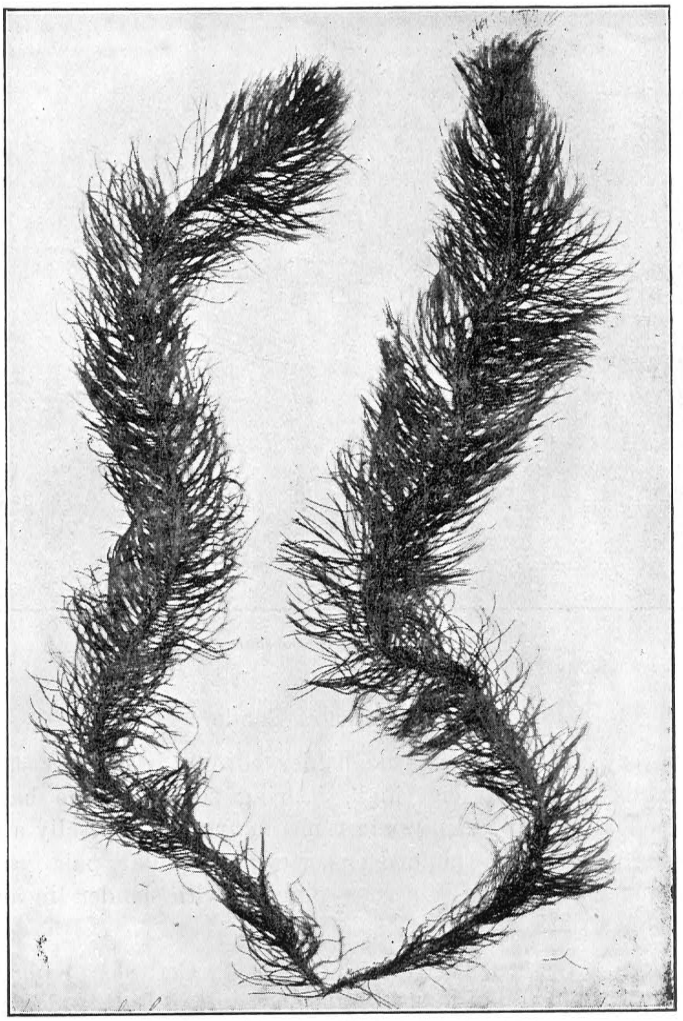

Fig. 18.—*Caulerpa longifolia.*

Caulerpa longifolia C. Agardh.

Surculus slender and smooth. Fronds from 10 to 20 cm. high, naked below, above bearing long simple ramenta in a graceful pencil. The rachis angular with ridges and furrows. The ramenta 2.5 cm. long, dark green.

Distribution.—South Australia: Encounter Bay. Victoria: Warrnambool and Port Phillip Heads. Tasmania.

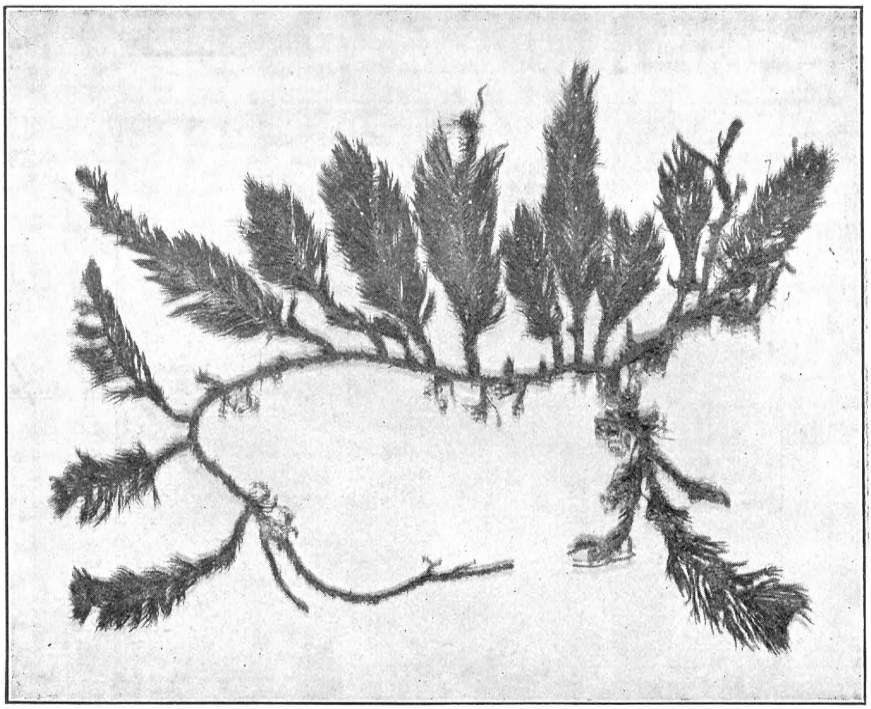

Fig. 19.—*Caulerpa obscura.*

Caulerpa obscura Sonder.

Surculus very stout, thick as a penholder, covered with short stiff forked scales. Fronds 15 to 30 cm. high, bearing scales at the base which gradually pass into crowded pinnate ramenta arranged spirally and not in vertical rows. The rachis rounded or somewhat angular, pale green. The ramenta about 2.5 cm. long, setaceous, pinnate, with slender linear pinnae, 6 to 8 mm. long, dark green.

Distribution.—Western Australia: Rottnest I., Cottesloe, King George's Sound. South Australia: Port Adelaide, Encounter Bay, and Macdonnell Bay. Victoria: Port Fairy, Port Phillip, Port Phillip Heads, Western Port. Tasmania.

This species is identical with *C. Sonderi* F.v.M., described nine years after Sonder had published *C. obscura.* Sonder's specimens were very small and dense growing, while Mueller's were most typical of the plant. Harvey identified the two as the same thing. The species must bear the name *C. obscura,* given to it by the earlier founder on account of its dark green colour.

Caulerpa trifaria Harvey.

This species has not been recorded from South Australia but it is here included for comparison.

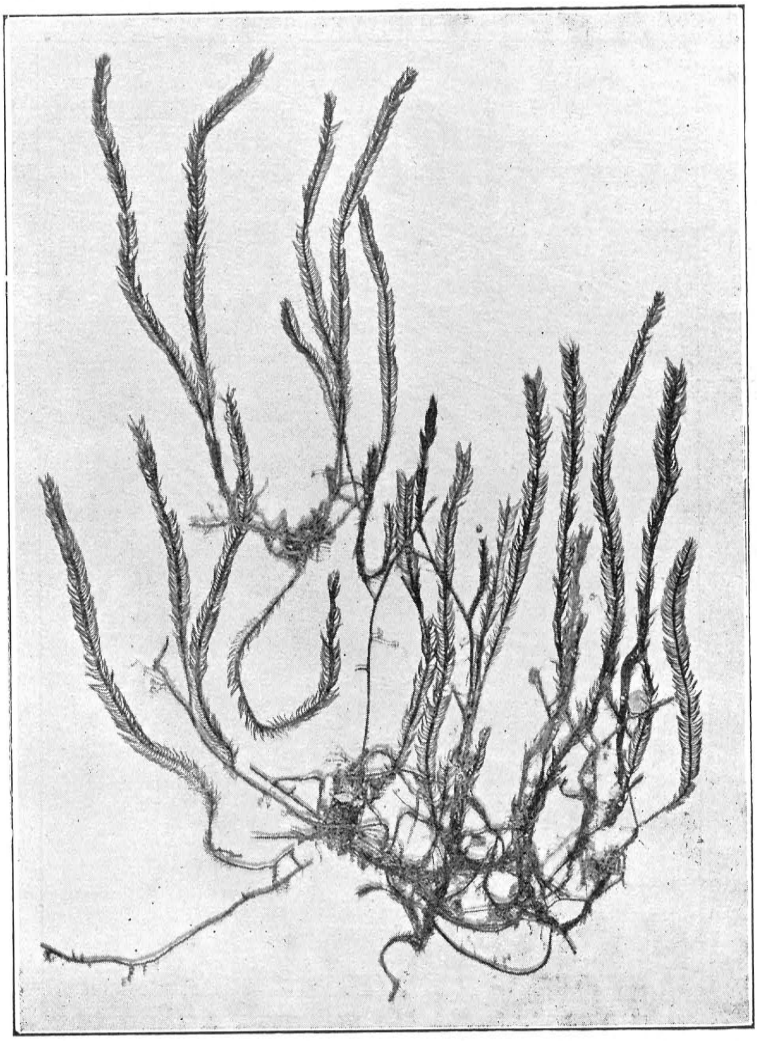

Fig. 20.—*Caulerpa trifaria.*

Surculus rough with minute teeth. Fronds to 30 cm. high, in rock pools shorter, with a petiole denticulated like the surculus, bearing simple ramenta in three vertical series. The rachis terete. The ramenta to 7 mm. long, light green.

Specimens growing in the rock pools of Point Lonsdale, Portsea and Cape Shanck, Victoria, were 10 to 13 cm. long; those dredged in deeper water at Southport and in Oyster Bay, Tasmania, reached 30 cm. in height.

Harvey suggested that *C. trifaria* might prove to be a depauperised form of *C. Harveyi* but it is more slender and has a rough surculus, and the ramenta are very constantly arranged in three, not five, vertical rows.

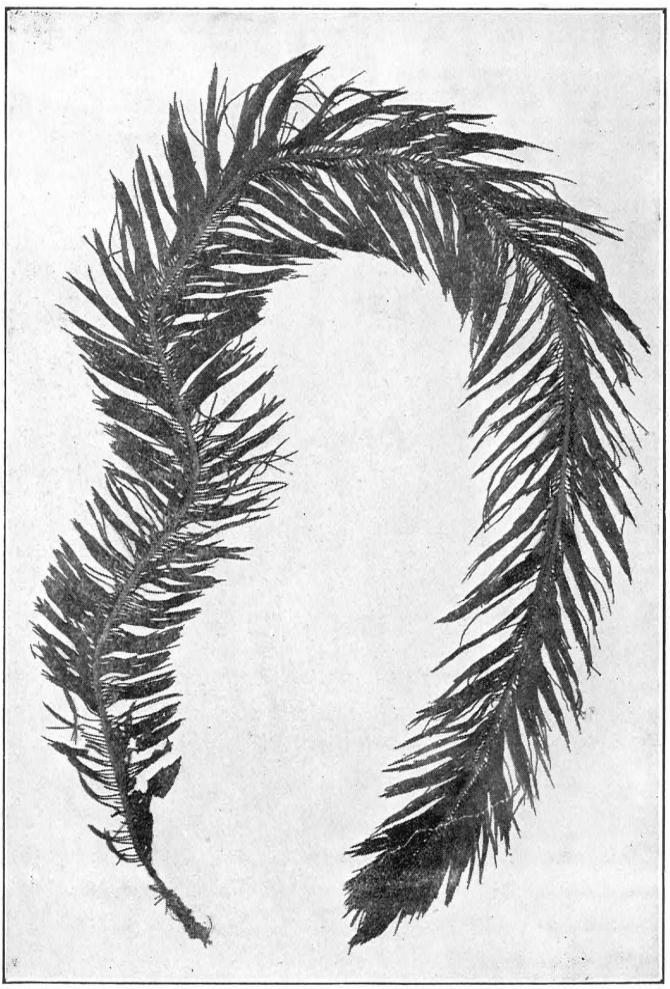

Fig. 21.—*Caulerpa Harveyi.*

Caulerpa Harveyi F. von Mueller.

Surculus robust, smooth and glossy, with stout rhizoids. Fronds to 60 cm. high, the lower 5 to 8 cm. nude and forming a petiole, the rachis bearing above crowded simple ramenta in five vertical rows. The rachis wrinkled, yellowish, herring-bone like. The ramenta 2 to 2.5 cm. long, coarsely setaceous, deep green.

Distribution.—South Australia: Rivoli and Guichen Bays. Victoria: Portland, Port Fairy, Warrnambool, Port Phillip Heads, and Western Port.

Caulerpa Cliftoni Harvey.

Surculus robust, smooth, with stout rhizoids. Fronds to 15 cm. high, without a naked petiole, bearing crowded dichotomous ramenta in four or more (often five) vertical rows. The rachis somewhat wrinkled, green. The ramenta 2.5 cm. long, setaceous, repeatedly forked, deep green.

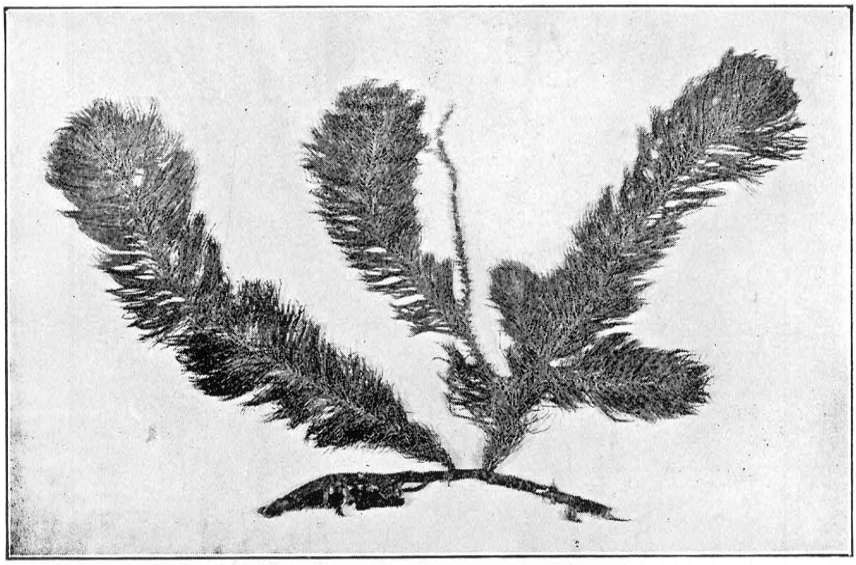

Fig. 22.—*Caulerpa Cliftoni.*

Harvey gave the name to a single specimen collected by G. Clifton in Western Australia; Madame Weber van Bosse identified it with the southern plants, which J. Agardh named *C. abies-marina* subsequent to Harvey's determination.

Distribution.—Western Australia: Fremantle. South Australia: Investigator Straits and Encounter Bay. Victoria: Point Lonsdale.

Section Lycopodioideae.

Fronds long, cylindrical, closely beset with short imbricated ramenta.

Caulerpa Brownii Endlicher.

Surculus stout, shaggy, with brown ramenta. Fronds cylindrical clavate, simple or sparingly branched, up to 30 cm. high, but usually much shorter, beset throughout their length by imbricated ramenta. The rachis rounded. The ramenta disposed all round the rachis, indiscriminately or in verticils near the apex, simple or forked, appressed, overlapping, short, 4 to 6 mm. long, deep green.

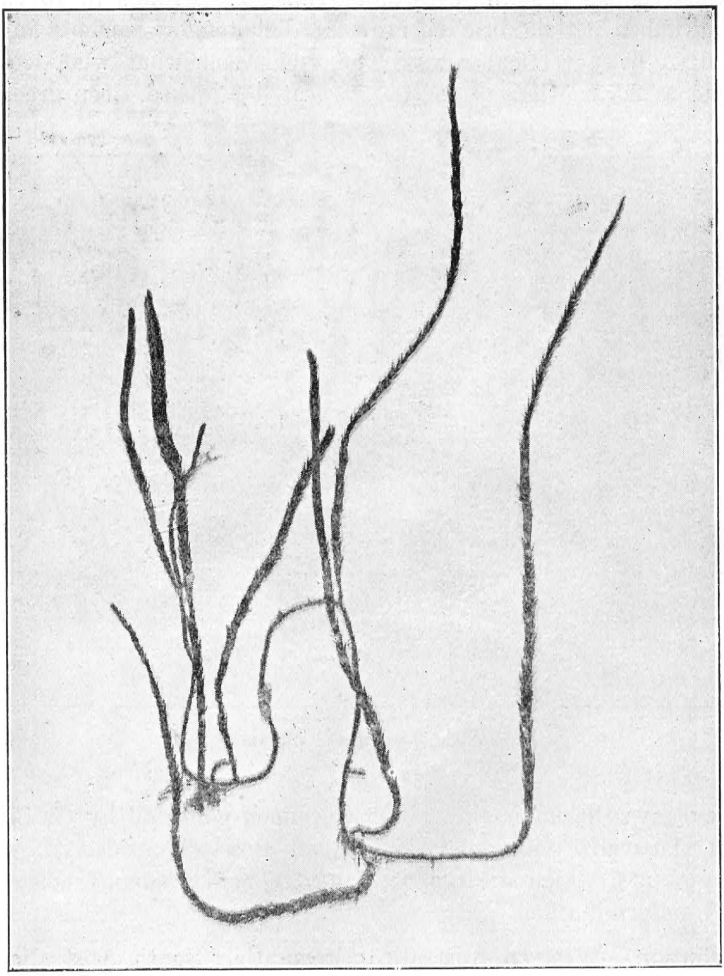

Fig. 23.—*Caulerpa Brownii.* (Slender form.)

Forms with looser and forked ramenta have been separated by some authors as *C. furcifolia* Harvey, but the species is very variable in size and in the shape of the ramenta; it grows in shallow water, the surculi often in tangled masses.

Distribution.—Western Australia: Albany. South Australia: Great Australian Bight, Investigator Straits, and Encounter Bay. Victoria: Whole Coast. Tasmania and New Zealand.

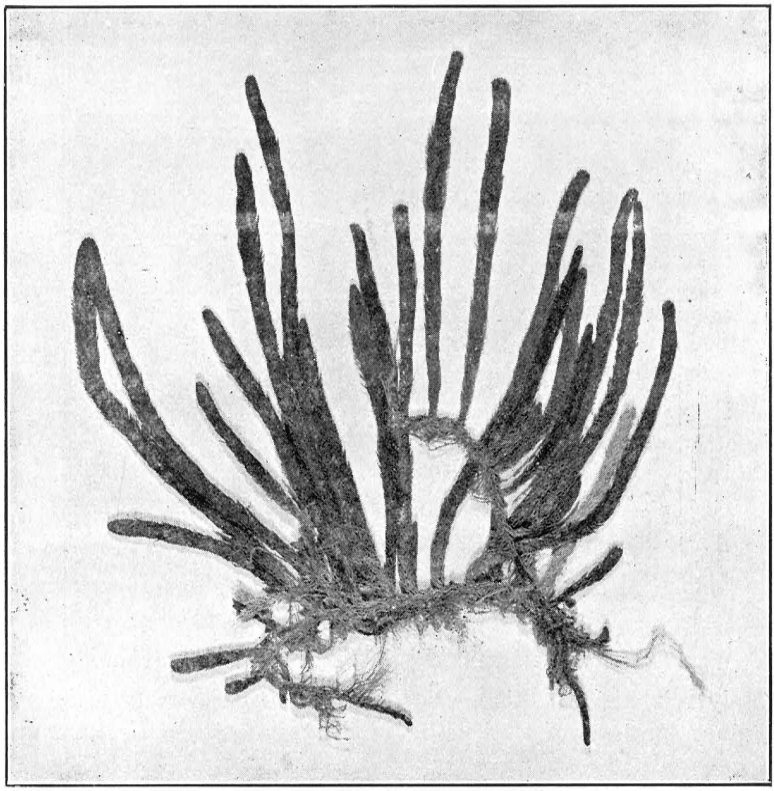

Fig. 24.—*Caulerpa Brownii.* **(Stouter form.)**

Section Araucarioideae.

Larger forms, with stout cylindrical erect axes, bearing mostly opposite distichous branches; surculus, trunk and branches densely ramentaceous.

Caulerpa Hedleyi Weber van Bosse.

Surculus squamulose, the squamuli compacted, repeatedly dichotomous, almost quadripartite, with bifurcate and mucronate apices. Trunks of fronds erect, with opposite patent branches; trunk and branches beset

with crowded ramenta, appressed, repeatedly dichotomous, about .5 mm. long, with bifurcate and mucronate apices, arranged in irregular whorls.

Dredged by the N.S.W. Trawler *Endeavour* in 1909 in some 8 fathoms of water off Kangaroo Island. Mr. Charles Hedley accompanied the trawler on this expedition and secured the algae for the Sydney Herbarium. The specimens collected on this occasion had fronds nearly 7 cm. long and about 2 cm. wide. The plant has not been since gathered in this locality or elsewhere.

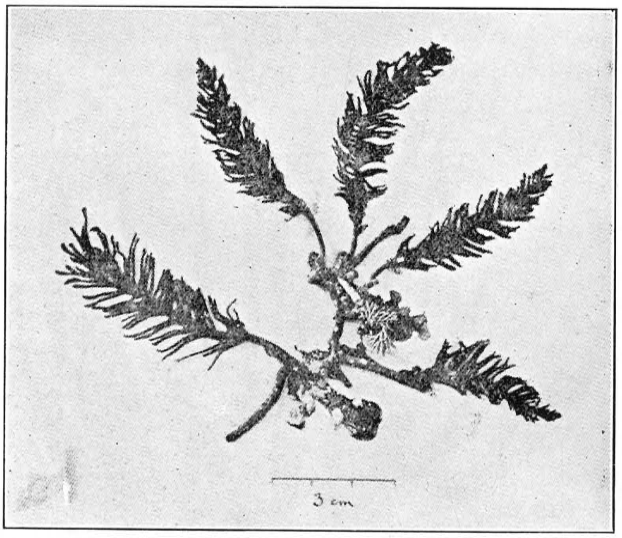

Fig. 25.—*Caulerpa Hedleyi.*

Caulerpa hypnoides (R. Brown) C. Agardh.

Closely related with this species, and probably scarcely to be separated as distinct species, are *C. Muelleri* Sonder and *C. flexilis* Lamouroux.

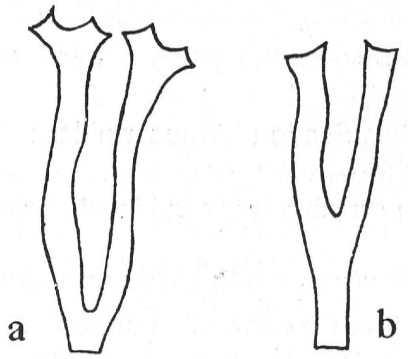

Fig. 26.—Ramenta of (a) *Caulerpa hypnoides*, (b) *C. Muelleri* (after Harvey).

They have the following characters in common:—Surculus stout, tomentose (not seen in *C. flexilis*); trunk of frond mostly simple, less often with a branch; branches patent, pinnately arranged; ramenta clothing trunk and branches on all sides, shortly subulate, one-forked, with bi-mucronulate tips. Fronds 20 to 30 cm. long, with pinnae 8 to 10 cm., feather-like in shape.

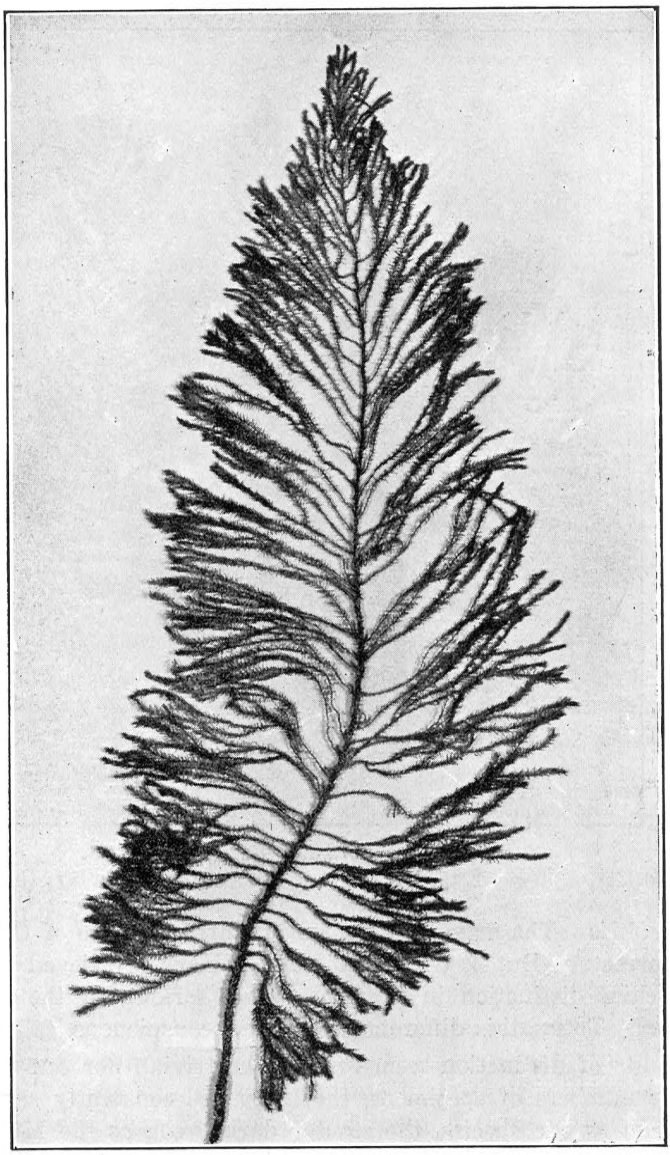

Fig. 27.—*Caulerpa hypnoides.*

Harvey says: "I have seen them both—*C. hypnoides* and *C. Muelleri*—growing abundantly on their native rocks, and can, at a glance, distinguish *C. Muelleri* by its much darker colour, more robust growth, more erect ramenta, and the less densely set and less finely divided scales of the creeping stems. A more definite character may be found in the ramenta, which, in *C. hypnoides*, are not merely connate at the base in pairs, but united for some distance above the base so as to be as distinctly forked as

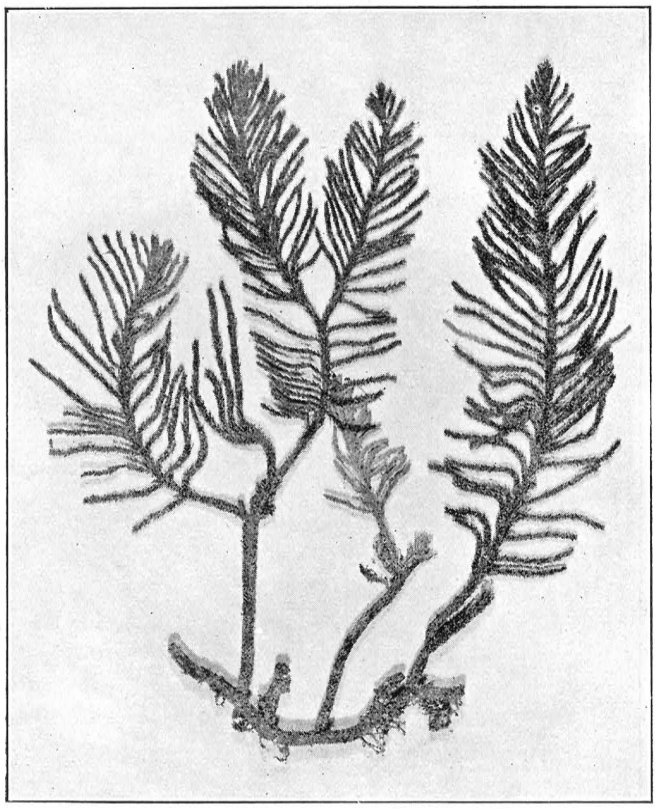

Fig. 28.—*Caulerpa Muelleri.*

in *C. furcifolia*. The magnified figures in Turner's plate of *C. hypnoides* are not correct." But J. G. Agardh says: "Harvey believed that he had found a chief distinction in the more basal forking of the ramenta in *C. Muelleri*. To me this difference seems less conspicuous."

The points of distinction seem to be to be trivial, nor can I find after examining numbers of specimens, that they are constantly associated. I regard them as one species, the stouter dark green as the Mueller form, and the slender light green as the *hypnoides typica* form. Either can be found anywhere on the Australian and Tasmanian coasts.

I should not have mentioned *C. flexilis*, described by Lamouroux from Tasmania, had not Madam Weber Van Bosse determined the plant sent to her by Reinbold from Guichen Bay as this species. J. Agardh doubted whether it was different from *C. hypnoides*. The trunk shows (according to Lamouroux) intervals of bare spaces free from ramenta nearly up to the apex; the ramenta are forked below the middle. The only specimens known are Labillardiere's from Tasmania and those sent to Reinbold by Dr. Engelhardt from Guichen Bay.

Section Sedoideae.

Fronds with globose ramenta.

Caulerpa sedoides (R. Brown) C. Agardh.

Surculus slender, smooth, branched. Fronds erect, simple or sparingly branched, 2.5-10 cm. high, bearing sessile ramenta. Ramenta loosely distichous below, leaving the rachis nude in places, denser above, rising from all sides of the rachis, spherical or obovate.

Growing like little branches of currants, along the crannies and cracks of the rocks, from just below low-water mark downwards; the shore forms the more stunted.

All round the coasts of Australia; Tasmania and New Zealand. Islands of the Pacific. Ceylon.

Caulerpa vesiculifera Harvey.

Surculus stout, glabrous, with strong rhizoids. Fronds erect, simple or sparingly branched, to 20 cm. long, densely clothed with imbricate ramenta disposed in about 8 longitudinal series. Stem and branches long, cylindrical, rather obtuse at the apex. Ramenta globose or obovate, smaller than in *C. sedoides*, collapsing when dry.

Distribution.—South Australia: Guichen Bay. Victorian Coasts. Tasmania.

Has much the same habit of *C. Brownii*, but is easily distinguished by its vesicular ramenta.

Caulerpa simpliciuscula C. Agardh.

Surculus smooth, rather stout. Fronds erect, elongate, cylindrical, in simple spikes or corymbosely branched, to 15 cm. high, with blunt tips, bearing small obovate imbricated ramenta in 12 to 16 vertical series. The ramenta not more than half the size of those of *C. vesiculifera*, collapsing when dry. Intermediate forms occur between these two species.

Western and South Australia, Victoria and Tasmania.

Caulerpa papillosa J. Agardh.

Surculus glabrous, slender. Fronds erect, narrow, cylindrical, sparingly branched or in simple spikes, with long tapering apex, bearing minute imbricated globose ramenta, disposed in 16 or more vertical series. Fronds to 13 cm. in height. The ramenta do not collapse on drying. The slenderest and most compact of the three species.

Distribution.—Victoria: Port Phillip Heads.

Will probably be found in South Australia.

Section Opuntioideae.

Fronds annularly constricted, with distichous ramenta.

Caulerpa cactoides (Turner) J. Agardh.

Surculus stout, cylindrical, continuous (not ringed), smooth, with long rhizoids in distant clumps. Fronds erect, to 30 cm. or more high, simple or sparingly branched, constricted into rings and bearing large, opposite clavo-obovate ramenta. The rachis, naked below, bears the distichous ramenta above. The ramenta vesicular, to 2 cm. long, and separated by a constriction from the rachis. Colour a vivid green. Growing from low-water mark to a depth of several fathoms.

Southern coasts of Australia. Tasmania.

CODIUM Stackhouse.

A genus of extraordinarily varied external form. The thallus may appear as a closely adhering covering on the rock, as a spongy amorphous mass, as a more or less spherical ball, as an erect, cylindrical, dichotomous frond, as a similar more or less flattened frond, or finally as a broad flattened cloth-like segment rising erect from a narrow attachment. But, whatever may be the shape of the thallus, it is composed of two layers of which the elements are branches of one single cell. The internal, or inferior, layer is made up of a densely interwoven mass of colourless filaments, which at a localised spot, or from the whole of the lower surface of the frond, send down branches by which the thallus is attached to the substratum; these filaments end outwards, or upwards, in green club-shaped terminal branches, the utricles, which are placed side by side at right angles to the surface of the thallus to form the outer, or upper, palisade-like layer. The free extremities of the utricles produce on the surface the appearance and feel of a soft velvet pile.

Gametangia are borne at certain seasons laterally, usually single, on the utricles. They are ovate-elongate and pointed and are of a darker green than that of the utricles. They are affixed at various heights on the utricle, are shorter than it, and do not project beyond the surface of the thallus.

They are cut off from the utricle by a plug of cellulose-like substance. When ripe, the content of the gametangium breaks up into biciliate gametes of two sizes. The smaller are supposed to be male, and the larger female gametes. Conjugation between them has not been observed, but the larger gametes have been seen to develop into young thalli. The genus is of world-wide distribution.

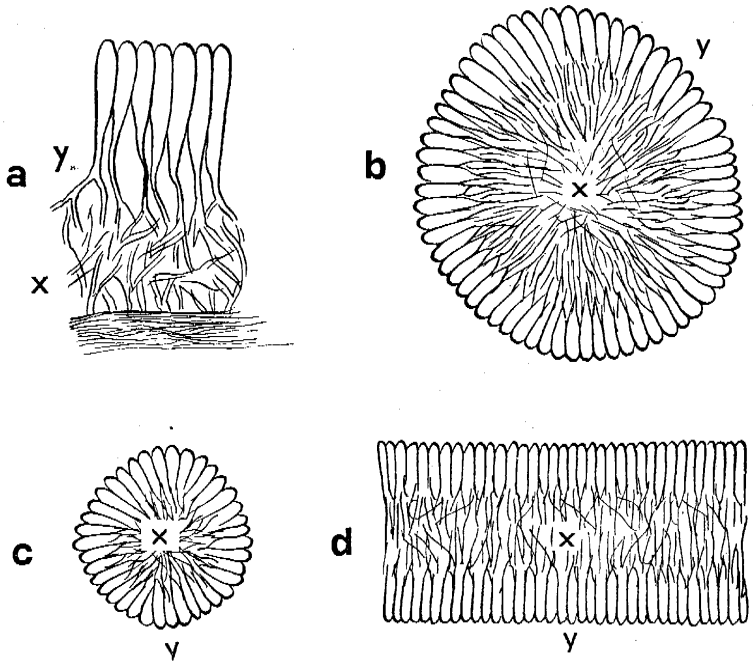

Fig. 29.—Diagrammatic sections of different forms of *Codium*: (a) cross section of Adherent form; (b) cross section of Spherical form; (c) cross section of Dichotomous form; (d) longitudinal section of Dichotomous form. x, interior or inferior layer.; y, exterior or upper palisade layer. (Suggested by O. C. Schmidt.)

KEY TO THE SPECIES.

a. Fronds unbranched.
- b. Thallus black-green, applanate .. .. *C. Lucasii.*
- bb. Thallus light-green, spongiform .. .. *C. spongiosum.*
- bbb. Thallus globular .. .. *C. pomoides* and *C. mamillosum.*

aa. Fronds dichotomous.
- c. Thallus cylindrical .. .. *C. Muelleri,* *C. galeatum,* and *C. fragile.*
- cc. Thallus flattened especially beneath the forkings .. .. *C. decorticatum.*

Section Adhaerentia.

Prostrate black-green fronds attached by the whole of the base.

C. Lucasii W. A. Setchell.

Frond prostrate, flat, cushion-shaped, orbicular at first soon giving off broader or narrower lobes which form a close flat pattern, fairly loosely adherent to the substratum, of soft spongy consistency, very slippery to the touch, dark green.

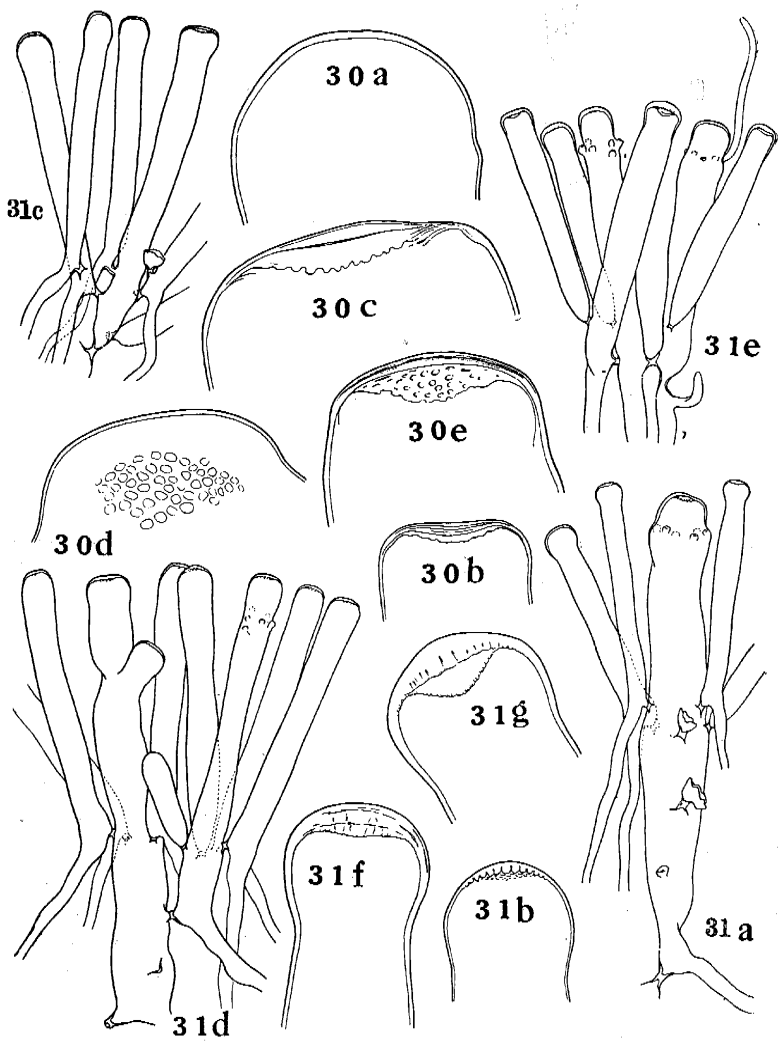

Fig. 30a-30c.—*Codium coronatum*. Fig. 31a-31h.—*Codium Lucasii* (after Setchell).

Utricles 435 μ to 600 μ long, 50 μ to 250 μ broad, cylindrical with depressed globose tips, and below the tips at times an irregular circle of hairs. Membrane thin, to 10 μ thick at the apex; tips slightly or decidedly alveolate within.

Gametangia stout, ovate, 230 μ to 277 μ long, 108 μ to 123 μ broad.

South and East Coasts of Australia; Tasmania; Lord Howe Island.

Section Spongiosae.

Spongy forms attached by the whole base.

Codium spongiosum Harvey.

The thallus consists of a soft light-green irregularly lobed and undulated sponge-like mass, of from 5 to 10 cm. in greatest diameter and 1 to 2.5 cm. or more high. It is attached to the substratum by the

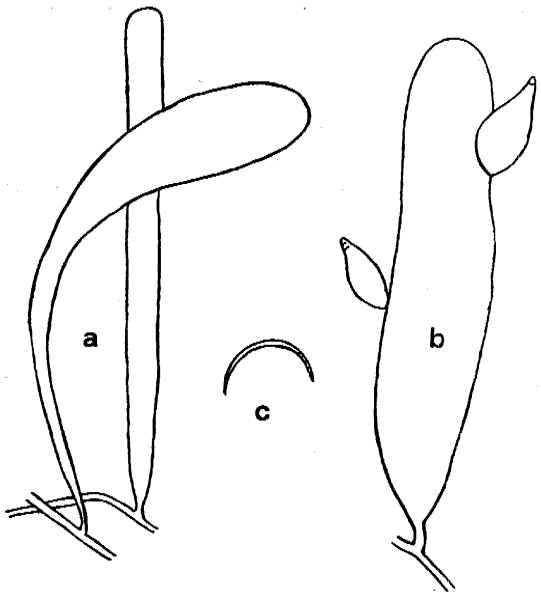

Fig. 32.—Utricles of *Codium spongiosum*; (a) sterile utricles; (b) fertile utricle; (c) tip of utricle.

whole of its broad base. The interior is composed of a tangle of much branched threads lying loosely in a gelatinous slime. The green palisade surface layer is composed of the vertically placed utricles. The utricles are large, varying in shape from cylindrical to pear-shaped, sometimes of equal diameter throughout, sometimes narrow below and expanded above. Their length may be from 1.5 to 6 mm., and the breadth from 200 μ to even 1,000 μ (= 1 mm.). The tips are rounded or somewhat flattened, with a thin bounding membrane 3 μ to 5 μ thick. The gametangia are obovate, about 250 μ long and 100 μ wide. In this species not infrequently 2, 3, or even more gametangia are borne on the same utricle.

Owing to the abounding fluid content and easy dissolution it is difficult to preserve satisfactorily in dried specimens.

Abundant on the coasts of Western Australia, from Geraldton to Albany, it seems to be rarer or to have escaped general notice in South Australia, though it has been collected at Denial Bay by Dr. G. A. Chambers, and at Grange near Adelaide by Dr. J. B. Cleland. I have not seen it in Victoria but found it on the north coast of Tasmania. It is common again all up the east coast of Australia and occurs in New Caledonia.

Section Bursae.

Globular forms.

Two species of globular *Codia* are met with in South Australia, *C. pomoides* and *C. mamillosum*. Both are irregularly spherical or rounded in shape, and grow attached to rocks by a considerable base. We occa-

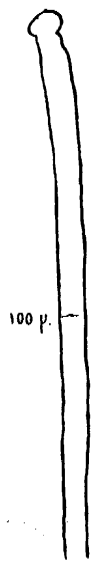

Fig. 33.—Utricle of *Codium pomoides*.

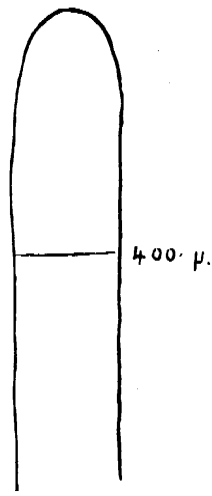

Fig. 34.—Utricle of *Codium mamillosum*.

sionally come across numbers of them of all sizes adhering like anemones to the under face of an overhanging ledge of rock but they are not confined to such situations. They grow in the close neighbourhood of low-water mark. Full grown plants may attain a diameter of three or four inches. Broken away by storms they can often be gathered on the beach out of the masses of cast-up weeds. Both have very long utricles but in neither have gametangia been as yet observed, though they have been noted in the allied *C. bursa*.

C. pomoides J. Ag. is of a darker colour, and of denser structure so that the ball is firm and hard to the touch. The utricles are narrow, cylindrical, about 100 μ in diameter, and may be from 10 to 20 times as long. Each is constricted a little below the apex, giving a capitulate appearance. The external membrane is thin, and but little thicker on the tip. Adult plants show an internal cavity filled with liquid.

It is found in South Australia, Victoria, and Tasmania. It is closely allied to *C. bursa* (L.) Ag. of European waters, and was looked upon by Harvey as identical with that species.

C. mamillosum Harv. is of a lighter colour and looser texture, and the ball is soft to the touch. The utricles vary from cylindrical to clavate or pear-shaped, 1 mm. to 7 mm. long and from 400 μ to 2.5 mm. in diameter. The tips are rounded or flattened, and there may be a constriction below the apex. The membrane is thin but may be somewhat thickened over the tip.

This species has a wider range than the preceding, being found in Western and South Australia and in western Victoria. It also occurs in Tasmania, New Zealand, and Japan, according to O. C. Schmidt.

Since the utricles of *C. mamillosum* have four times the width of those of *C. pomoides*, the two species can be easily distinguished by the coarser pile of the former.

Dichotomous Forms.

These consist of erect, deep-green, many times forked, thickened fronds, attached by a somewhat expanded flattened base to the rocks on which they grow. They may reach a height of 30 cm., or even 60 cm. when growing in deep water, but are usually of less stature. They are sublittoral plants

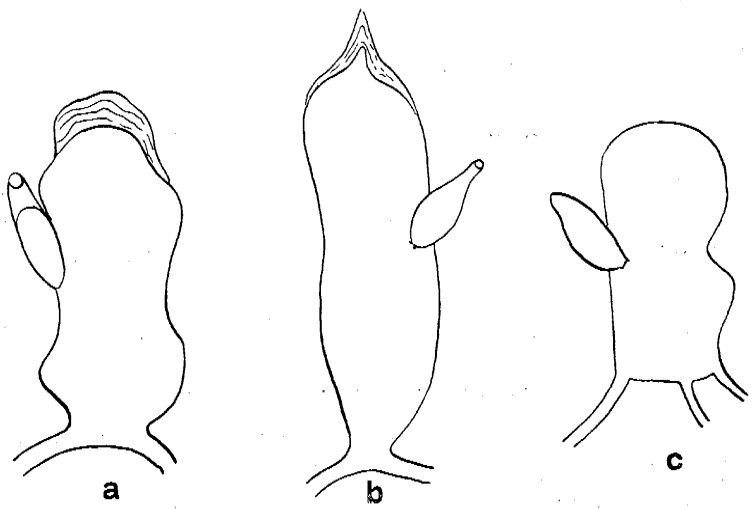

Fig. 35.—Utricles of Dichotomous Codiums; (a) *C. galeatum*; (b) *C. fragile*; (c) *C. Muelleri*.

but may extend seawards to a depth of two or even more fathoms. They are firmly affixed to rocks or large stones, and give the appearance of slim green fingers floating in the water. There are at least four specific forms to be found on the South Australian coasts.

KEY TO THE SPECIES.

a. Fronds cylindrical terete.
  b. Tips flattened or rounded, vesiculose, the membrane not conspicuously thickened ... *C. Muelleri* Kuetzing.
  bb. Tips with a much thickened half-moon shaped cap ... *C. galeatum* J. Agardh.
  bbb. Tips ending in a sharp or blunt point (mucro) ... *C. fragile* (Suringar) Heriot.
aa. Fronds compressed, more or less flattened (tips flattened or rounded, as in *C. Muelleri*) ... *C. decorticatum* (Woodward) Howe.

Codium Muelleri Kuetzing.

Of varying height, stoutness and depth of colour. Utricles 2 or 3 times as long as broad, 600 μ to 1,200 μ long by 180 μ to 650 μ broad.

Gametangia one-third to one-half as long as the utricles, 300 μ to 420 μ long by 140 μ to 170 μ broad.

Distributed round Australia, Tasmania, New Zealand, and the Sandwich Islands. The Indo-Pacific representative of the more specially Atlantic species, *C. tomentosum* (Hudson) Stackhouse.

Codium galeatum J. Agardh.

Usually tall, probably frequenting deeper water. Utricles 2 or 3 times as long as broad, 1,000 μ to 1,500 μ long by 350 μ to 700 μ broad.

Gametangia about one-third to one-half as long as the utricle, 420 μ to 480 μ long by 100 μ to 180 μ broad.

So far known from the south coast of Australia and from Kerguelen.

Codium fragile (Suringar) Heriot.

Usually coarser and of a dark green. Utricles 2 to 4 times as long as broad, 330 μ to 1,500 μ long by 100 μ to 480 μ broad.

Gametangia one-third to one-half as long as the utricle, 170 μ to 450 μ long by 50 μ to 170 μ broad.

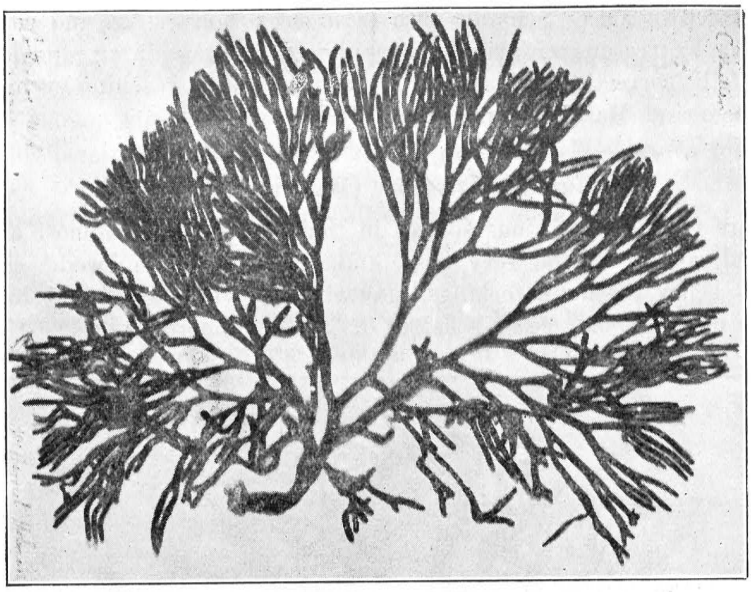

Fig. 36.—*Codium Muelleri.*

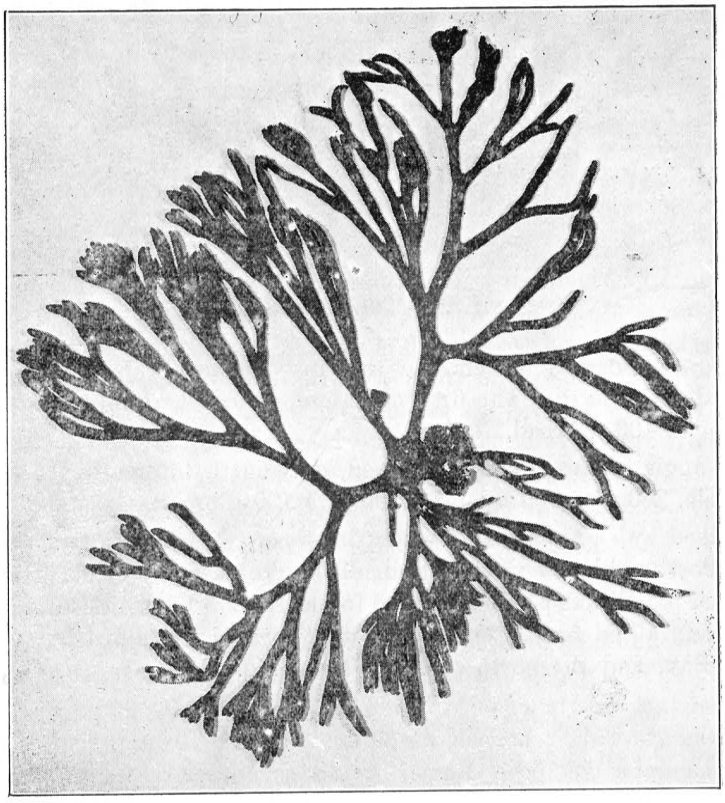

Fig. 37.—*Codium fragile.*

Identified by O. C. Schmidt with *C. mucronatum* J. Ag. and retaining its name by reasons of priority of publication. Assuming this identification to be correct, it is distributed in all the oceans, reaching even Tierra del Fuego and Magellan Straits.

Codium decorticatum (Woodward) Howe.

Differs from the previous species in that the thallus is almost entirely flattened, except at the very base, and, in the cuneate (wedge-shaped) sections below the main forkings, may attain a width of from 1 to 5 cm. or even more. It may reach a height of 30 cm. or more.

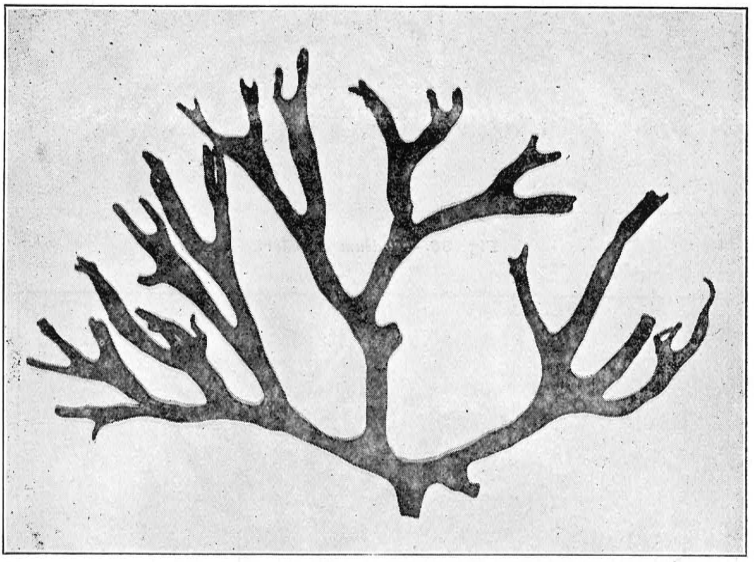

Fig. 38.—*Codium decorticatum.*

Utricles rounded or flattened at the tips, the membrane thin, not much thickened over the tips, 4 to 6 times as long as broad, 700 μ to 1,700 μ long by 120 μ to 400 μ broad.

Gametangia ovate or spindle-shaped, one-fourth to one-third as long as the utricle, 260 μ to 450 μ long by 90 μ to 150 μ broad.

Identified by O. C. Schmidt with *C. elongatum* Ag. Schmidt assigns to it an almost world-wide distribution. Though not yet recorded from South Australia, it will almost certainly be found there. I have collected it, or a very closely allied form from such distant localities as Lord Howe Island, Botany Bay, and the north coast of Tasmania.

PHAEOPHYCEAE. (Brown Seaweeds.)

Olive-brown Algae, mostly multicellular, containing in their cells true Chlorophyll mingled with and masked by peculiar yellow-brown pigments, of which the most general has been termed Phycoxanthin ($C_{40}H_{54}O_6$). The colouring matter is disposed in small definitely limited bodies (phaeophores).

Multiplication is either non-sexual or sexual. The former is effected by propagation of detached portions of the plant, or by means of directly germinating zoospores; in the Dictyotaceae tetrasporangia occur, single cells dividing into four spores capable of independent germination. These resemble the tetrasporangia characteristic of the Red Seaweeds. The latter, or truly sexual, reproduction is by zygotes resulting from the union of male and female cells.

Attachment.—Seaweeds have no roots in the proper sense of the term as applied to land plants. They obtain all their food supplies from the surrounding sea-water. As, however, the algae of the Littoral Flora are fixed throughout life, they provide themselves with organs of attachment. These are termed "attachments" or "holdfasts," and vary considerably in form. Some are flat or conical discs which grow closely to the supporting substratum of rock or shell, so closely as to preclude the possibility of air or water penetrating between holdfast and rock surface. Consequently the great pressure of the superincumbent water and atmosphere is sufficient to keep the plant in place, despite fairly violent lateral movement of the waves. Even *Sarcophycus,* the Bull Kelp, though its home is on the rocks amid surf and breakers, is not often detached, notwithstanding the tremendous stress caused by the waves pressing on the wide blades of the huge frond. The diameter of the disc varies from a few millimetres in the smaller forms up to 200 mm. or more in *Sarcophycus.* In *Phyllospora* the disc is an inch or two in diameter, smooth and concave above, and attached by numerous stout radicles which spring from its under-side. In other forms the base of the stem sends out stouter branches, each of which terminates in an adhesive disc, as in *Macrocystis.* In yet others, which grow in mud or shelly débris, the base gives off many finer fibrils which do not terminate in discs, but obtain a foothold in the substratum in much the same way as do the fibrous roots of terrestrial grasses. In a very few cases, as in *Notheia,* the rhizoid grows into and becomes continuous with the tissues of the host, and the plant would appear to be actually parasitic.

Structure.—Marine Algae differ from the terrestrial Phanerogams not merely in their simpler plan of life but also in consequence of the different environment under which they live. They are normally surrounded by sea water and their tissues never lack the liquid element. They are not subject to droughts. In consequence there is no need of adaptations for

transpiration or for preventing evaporation. Their outer surface is not protected by any special cuticle or corky layer; there are no stomata for the control of air supply. The buoyancy of the sea water, heavier than fresh water, reduces the necessity for undue expenditure in strengthening the tissues of the supporting stems.

The structure is then parenchymatous. The cells in general form a cortical coloured assimilative stratum and a medullary or central colourless supporting and conducting stratum, the former, often included in mucus, causing the slimy feel of many seaweeds. The cells of this layer are usually small, often minute, arranged in a single layer or in simple or branching strings. The mucilaginous character of the cortical tissues of many algae protects the internal cells from drying, while temporarily exposed between tides. Growth in length and width is either apical, effected by divisions of a single apical cell, or of a marginal series of cells, or from a more extensive meristematic group; or is intercalary, as in *Macrocystis* where from a meristem at the junction of stalk and blade additions are made to both, in opposite directions, much as bark and wood on the two sides of the cambium layer in vascular stems.

Vesicles or Floats.—Several of the Brown Seaweeds, of the Families *Sargassaceae, Fucaceae,* and *Laminariaceae,* form bladder-like organs which contain gas. These, especially in the genera *Sargassum* and *Cystophora,* are berry-like and are consistently regarded as fruits by the casual observer, but their purpose is quite other than reproduction. They serve as floats to assist the support of the frond in a vertical position. The walls of the floats are solid and continuous, impervious to air or water, and there are no canals connecting the gaseous interior with the outside medium. The floats vary in size in the various species, and also grow from small beginnings in the same individual. In *Sargassum* and *Cystophora* they are rarely larger than a pea (*Pisum*) and terminate stalklets. In *Phyllospora* and *Macrocystis* they are oval and are formed in the lower parts of the fronds; in *Phyllospora* they are about one inch and in *Macrocystes* four to five inches long. In *Nereocystis,* a North American Pacific plant, with heavy fronds 40 feet or more in length, the vesicles are gigantic, each having a final gaseous capacity of a litre.

The gas of the floats is derived from the gases "dissolved" in the sea water. Usually it is found on analysis to consist of nitrogen and oxygen only, but not in the proportions in which they occur in atmospheric air, still less in the proportions in which they occur in the gases obtained by boiling sea water. In common air we have 79 per cent. of nitrogen to 21 per cent. of oxygen with traces of carbon dioxide. In the gases obtained from sea water there is more variation especially in the amount of carbon dioxide present. A typical analysis of the gases of ocean water from off Coogee on the coast of New South Wales gave in 100 vols. of sea water gas, nitrogen 58.33, oxygen 30.55, carbon dioxide 11.11.

The following is a table of the results of five analyses of the gases in the floats of *Phyllospora comosa*:—

	Percentage of Nitrogen.	Percentage of Oxygen.		Percentage of Nitrogen.	Percentage of Oxygen.
1	86	14	4	82.3	17.7
2	89.4	10.6	5	83.2	16.8
3	88.9	11.1			

Thus it will be seen that the proportion of oxygen is less than if air had been taken directly into the cavity, and notably much less than in the gas content of sea water. Also the carbon dioxide of the latter has disappeared. Hence it would appear that the plants, having obtained their gases from the sea water, had made use of the carbon dioxide and part of the oxygen for purposes of metabolism and had stored up the useless nitrogen and the excess of oxygen beyond their requirements to serve the mechanical purpose of a float.

Relation to Adjacent Floras.—The coasts of the south-west and south of Western Australia form a region which is occupied by a very definite assemblage of marine algae. Similarly the coasts of Victoria and Tasmania, which face one another on the opposite sides of Bass Strait, possess a marked but different assemblage. The flora of the interlying coasts of South Australia possesses elements of both. On the whole, the Bass Strait forms predominate, some of them, as *Macrocystis,* reaching their western limit here. Western Australian forms, on the other hand, have spread over the shores of the Great Bight, and have invaded the western half of South Australia, though they do not reach Victoria. Among the Brown Seaweeds the most noticeable of these forms are *Scytothalia, Sargassum cristatum, S. fallax, Cystophora racemosa, C. Brownii, C. Grevillei,* and *Encyothalia. Scytothalia* from the west and *Seirococcus* from the east overlap in Victor Harbour.

The Brown Seaweeds are classified in three Orders—*Cyclosporinae, Tetrasporinae, Phaeozoosporinae.*

Order **CYCLOSPORINAE.**

Frond always multicellular of complex structure. Propagation by detached fragments. Generation by immobile oospheres fertilised by means of bi-ciliated mobile antherozoids, and then transformed into oospores. The antheridia and oogonia, often accompanied by hair-like paraphyses, are produced in rounded hollows in the frond, with an opening on the surface, the conceptacles.

The *Cyclosporinae* are divided into four Families—*Sargassaceae, Fucaceae, Durvilleaceae,* and *Splachnidiaceae.*

Family SARGASSACEAE.

Frond or thallus differentiated into organs. The vegetative part consists in attachment (or hold-fast), stem and branches and leaf-like organs, and is often provided with floats (vesicles). The reproductive part consists in special organs, the receptacles proper, in which the conceptacles are formed. The conceptacles are more usually hermaphrodite. The oogonia are monosporous. The receptacles sometimes occur as scarcely modified portions of the thallus.

KEY TO THE GENERA.

a. Certain segments of the frond transformed into separate receptacles.

b. Receptacles, or bunches of receptacles, arising from the transformation of the upper part of proper branches.

c. Stem abbreviated (2.5 to 5 cm.), not vesicular, giving off long branches. Leaves flat modified branches . . . . . *Sargassum* C. Agardh.

cc. Stem elongated, exceeding the branches in height. Leaves flat, marginal . . . . . *Carpophyllum* Greville.

ccc. Stem elongated. Leaves stipitate, turbinate, confluent with the vesicle . . . . . *Turbinaria* Lamouroux.

bb. Receptacles marginal.

d. Receptacles marginal, several in series.

e. Receptacles fringing the margin of the laciniae, slender, linear, moniliform . . . . . *Seirococcus* Greville.

ee. Receptacles marginal, supra-axillary, flat, mostly ovate-acuminate . . . . *Scytothalia* Greville.

dd. Receptacles single, arising from transformation of an entire ramulus or proliferation.

f. Vesicles distinct from other organs. Leaves not passing into branches *Cystophora* J. Agardh.

ff. Vesicles not distinct from other organs.
g. Vesicular inflations in terminal leaves . . . . . *Cystophyllum* J. Agardh.

gg. Vesicular inflations in the primary branches . . . . . *Cystoseira* C. Agardh.

aa. Receptacle not specialised from the frond segments.
h. Leaves peltate, fleshy, warted externally, spirally inserted round the stem . . . . . *Scaberia* Greville.

hh. Leaves taking the form of a flattened stem.
i. Cauline vesicles present . . . . . *Phyllospora* C. Agardh.

ii. Vesicles absent.
j. Leaves not ribbed . . . . . *Carpoglossum* Kuetzing.

jj. Leaves ribbed . . . . . *Myriodesma* Decaisne.

The genera *Carpophyllum* and *Turbinaria* are not known from South Australia. *Carpophyllum* flourishes in New Zealand, *Turbinaria* in tropical and subtropical seas.

SARGASSUM C. Agardh.

Frond consisting of a vertical branched axis, with a much abbreviated stem or main stipes (2.5 to 5 cm. long), and bearing long branches with leaves, vesicles and receptacles developed as distinct organs. Leaves

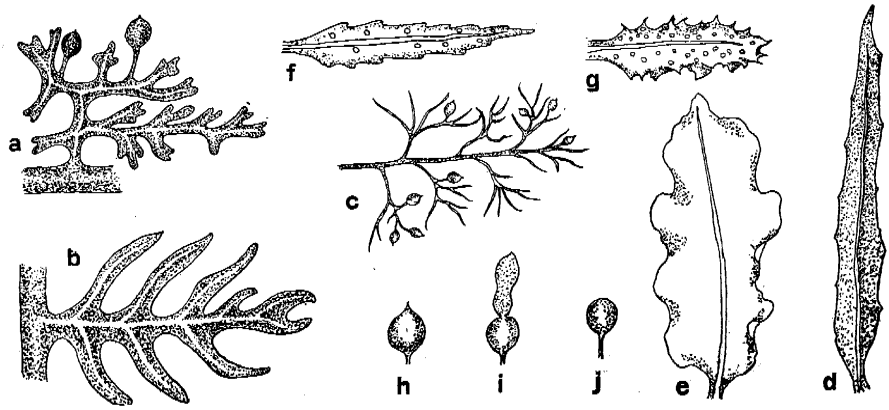

Fig. 39.—Foliage and floats of *Sargassum*—**(a)** *S. (Phyllotricha) decipiens;* **(b)** *S (Phyllotricha) varians;* **(c)** *S. (Phyllotricha) Sonderi;* **(d)** *S. (Arthrophycus) foliax;* **(e)** *S. (Arthrophycus) undulatum;* **(f)** *S. (Eusargassum) cristatum;* **(g)** *S. (Eusargassum) berberifolium.* **(h-j) Floats of** *Arthrophycus;* **(h) aristate; (i) leaf-bearing; (j) mutic.**

usually horizontal, mostly flat, with a midrib. Vesicles formed by modification of a single small leaf, spherical or ellipsoidal, naked or crowned by a mucro or leaflet. Receptacles formed by morphosis of a single leaf in the axil of another supporting leaf, and when mature carrying the conceptacles. Conceptacles excavated beneath the surface of the receptacle but communicating with the surface by a canal, mostly hermaphrodite. Antheridia small, rounded, racemose. Oogonia monosporous.

A genus of world-wide distribution including nearly 80 Australian species, grouped in three subgenera—*Phyllotricha, Arthrophycus,* and *Eusargassum.*

Subgenus Phyllotricha (Areschoug) J. Agardh.

Fronds formed by the evolution and repeated division of a primordial pinnate leaflike axis, the parts of which by transformation bear proper leaves, vesicles and receptacles. Leaves pinnatifid, the lower segments broader, the upper narrow, often ramelliform. Vesicles minute ellipsoidal-like swellings in the lamella and beaked (aristate), or larger terminal rounded and unbeaked (mutic). Receptacles terminal, smooth, at length racemose on a ramulus.

There are four Sections of *Phyllotricha—Heteromorphae, Cladomorphae, Phyllomorphae,* and *Pteromorphae.* All are confined to Australia-Tasmania.

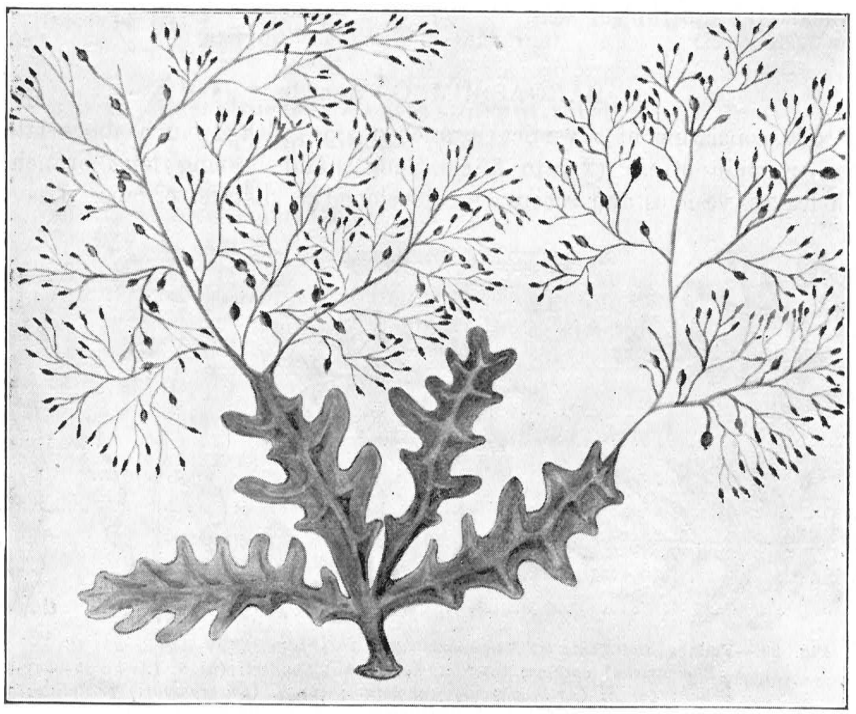

Fig. 40.—*Sargassum heteromorphum.*

Section Heteromorphae.

Fronds arising from a short common rounded stem, some merely pinnatifid leaves, others heteromorphous, the lower part forming a pinnatifid leaf, the upper passing into a terete branching rachis, bearing filiform leaves, vesicles, and receptacles. The broader leaf-like parts carry numerous small glands (cryptostomata). Vesicles minute, ellipsoid, beaked.

KEY TO THE SPECIES.

a. Lobes of leaves and lower portions simple, oblong and obtuse . . . . . *S. heteromorphum* J. Agardh.

aa. Lobes of leaves and lower portions bipinnatifid, sublanceolate, acuminate . . . . . *S. halitrichum* (Aresch.) J. Agardh.

Section Cladomorphae.

Common caulis compressed, rugged; lower fronds in the junior stage of the plant resembling a pinnatifid leaf, later, as the upper fronds, developing into branches themselves ramulose, the ramuli bearing leaves, vesicles and receptacles. Vesicles minute, ellipsoid, aristate.

KEY TO THE SPECIES.

a. Leaves all normally mature, compound pinnatifid-dichotomous.

b. Vesicles petiolate, minute, ellipsoidal, apiculate . . . . . *S. Sonderi* J. Agardh.

bb. Vesicles absent . . . . . *S. muriculatum* J. Agardh.

aa. Leaves, inferior pinnatifid, superior simple sublinear . . . . . *S. linearifolium* (Turn.) J. Agardh.

Section Phyllomorphae.

Common stem (caulis) rounded; fronds all distichously decompound, the rachides of the branches flat with a midrib, and winged, emitting on both margins alternate pinnate leaves, the upper segments narrow, part subfiliform, some transformed into vesicles and receptacles. The vesicles, the size of a pea, spherical and mutic.

Tropical and subtropical, confined to Australia and New Caledonia, not very likely to be found in South Australia. The four species, *S. Peronii* (Mert.) Ag., *S. decurrens* (R. Br.) Ag., *S. Boryi* Ag., and *S. scabripes* Ag., are very similar in appearance. In fact Sonder united *S. Boryi* with *S. decurrens*, not even admitting it to the rank of a variety.

Section Pteromorphae.

Earlier fronds resembling trichotomous-pinnate leaves; later fronds above changed into spreading branches with much divided compound leaves, at first trichotomous then more vaguely dichotomous-pinnate, all the segments (laciniae) filiform. Vesicles spherical, mutic.

KEY TO THE SPECIES.

a. Primary caulis compressed; rachides of the branches flattened below. Lower leaves conspicuous and conjoined with the ala of the rachis. Upper leaves more or less trichotomous with filiform laciniae.

b. Lower leaves pinnatifid. Receptacles oblong . . . . . *S. varians* Sonder.

bb. Lower leaves bipinnatifid. Receptacles lancoid . . . . . *S. decipiens* (R. Br.) J. Agardh.

aa. Primary caulis rounded; rachides of branches angulate-rounded. Lower leaves inconspicuous with narrow segments. Upper leaves more or less trichotomous with filiform laciniae. Vesicles large as a pea.

c. Laciniae of the leaves smooth . . . . . *S. trichophyllum* J. Agardh.

cc. Laciniae of the leaves warted (verruculose) from presence of cryptostomata. Vesicles very large and numerous . . *S. verruculosum* (Mert.) J. Agardh.

Subgenus Arthrophycus J. Agardh.

Frond consisting of an elongated branching axis bearing simple leaves without cryptostomata, vesicles crowned by a mucro or leaflet, and unarmed or dentate receptacles variously grouped.

This subgenus is dominant in the southern parts of Australia and Tasmania; two species are found in South Africa and one in New Zealand. There are 18 Australio-Tasmanian species, of which but three have so far been recorded from South Australia, but probably several of the others will be found here when the coast has been subjected to a more rigorous search. They are all conspicuous plants reaching a height of two, three, or more feet.

In 1889 J. G. Agardh published his magnificent Monograph on the Australian species of Sargassum. He himself instituted the majority of them.

To make a correct determination of any given plant requires great care and the possession of full-grown fruiting specimens. The main differences are in the leaves and receptacles. I give Agardh's schemes of diagnosis (with slight modification) which are based on these characters separately.

LEAVES.

a. Lower leaves flat, more membranaceous; almost entire (without teeth on the margins).	
b. Elongate linear	*S. fallax.*
bb. Shorter lanceolate	*S. laevigatum.*
aa. Lower leaves flat coriaceous; almost entire.	
c. More obovate	*S. globulariaefolium,* *S. robustum.*
cc. More lanceolate	*S. vestitum.*
aaa. Lower leaves flat, coriaceous, dentate or crenulate.	
d. Nearly entire	*S. bracteolosum.*
dd. All serrate	*S. tristichum,* *S. ensifolium,* *S. Amaliae.*
ddd. Lower entire, upper serrate	*S. Gunnianum,* *S. erosum.*
aaaa. Lower leaves very large (3 to 6 inches), crowded at the base, oblong-lanceolate.*	
e. Entire	*S. membranaceum.*
ee. Sharply toothed	*S. grande.*
eee. Deeply serrated	*S. lacerifolium.*
eeee. More or less undulate	*S. biforme.* *S. paradoxum.* *S. undulatum.*

RECEPTACLES.

a. Leaves acting as bracts to the receptacles often conspicuously differing from the others.	
b. Receptacles terete, unarmed with teeth.	*S. robustum,* *S. bracteolosum,* *S. laevigatum,* *S. fallax,* *S. paradoxum.*

*The lower leaves of *S. rhynchophorum* have not been observed.

bb. Receptacles terete angulate or two-edged, beset with small scattered teeth .. *S. globulariaefolium,*
S. vestitum,
S. rhynchophorum,
S. Gunnianum,
S. grande.
S. undulatum

bbb. Receptacles triquetro-prismatic with prominent acute-angled edges.

c. Not armed with teeth .. .. *S. ensifolium,*
S. erosum.

cc. With small teeth .. .. *S. lacerifolium,*
S. biforme.

ccc. Sharply serrate .. .. *S. tristichum,*
S. Amaliae.

aa. Bracteating leaves little different from the others .. .. *S. membranaceum.*

I append descriptions of the three species as yet known from South Australia.

Sargassum bracteolosum J. Agardh.

Common caulis short rounded, rachides of the branches triquetrous, branchlets retrofract (bent downwards). Leaves emerging from the plane surfaces, coriaceous, of a dark chestnut colour when dry, the lowest up to 10 cm. long and 2.5 cm. wide, oval to oblong-lanceolate, petiolate, with midrib, some obsoletely toothed, others quite entire. The receptacles in a long panicle (to 60 cm.), with extremely numerous leaves or bracts which are very narrow and nerveless—about 2.5 cm. long. Vesicles often wanting, when present smaller than a pea, obovate-spherical and obtusely mucronate. Receptacles minute, single or few in the axils of bracts, rounded-oblong and unarmed.

Tasmania and southern coasts of Australia.

Sargassum lacerifolium (Turn.) C. Agardh.

Axis sharply four-sided, flexuous, pinnately compound, 60-90 cm. long. Branches reflexed at their insertion, springing from the flat side of the stem. 15 to 30 cm. long. Leaves of two kinds, those at the base of each branch, lanceolate or linear lanceolate, 2.5 to 10 cm. long, 6 to 12 mm. wide, midribbed, deeply and sharply inciso-serrate or lacerate; those above (or "bracteate") very narrow-linear, sharply serrate, with or without an obsolete midrib, 2.5 to 3.8 cm. long, 1 to 2 mm. wide. Vesicles few, one at the base of each branch or branchlet, on a flattened petiole, ovoid or subglobose with a narrow wing-like border, and crowned with a nerved and serrate leaf.

Receptacles in alternate stipitate clusters of 2-3, each subtended by a bract; each receptacle 2 to 4 mm. long, thickened upwards, blunt, three-ridged, the ridges toothed.

King George's Sound, Western Australia; Holdfast (Glenelg) and Guichen Bays, South Australia. Turner described it from a specimen picked up by R. Brown at the mouth of the Tamar, Tasmania.

Sargassum biforme Sonder.

Common caulis short rounded, rachides of the branches acutely triquetrous, branchlets reflexed. Leaves emerging from a flat surface of the rachis, the lowest lanceolate oblong, much undulate crisped toothed on the margin, to 10 cm. long and 2.5 cm. broad; upper leaves lanceolate-linear serrate, bracteoles of the panicle very narrow. Vesicles large, subspherical crowned by a mucro or leaflet. Receptacles prismatic oblong, acute angled, the margins toothed.

Western Australia; Le Fevre Peninsula (Port Adelaide), South Australia.

Subgenus EUSARGASSUM J. Agardh.

A short common caulis bears several elongated branching fronds. Leaves simple, usually midribbed, with conspicuous cryptostomata (glandules). Vesicles spherical, mutic, on longer or shorter petioles. Receptacles more or less compound, smooth or toothed according to the Subdivisions, and arranged in cymes, panicles or racemes.

The most typical subgenus, of world-wide distribution and including about 140 described species of which 47 are Australian. In Australia they abound in the warmer waters of the north, replacing *Arthrophycus* predominant in the south. To this subgenus belongs the floating *Sargassum* of the Sargasso Seas of the Atlantic and North Pacific, but it does not occur in Australia.

Only three species have so far been recorded from South Australia, and it is therefore convenient here to omit the general classification of the subgenus and to give some account of these three species.

Sargassum cristatum J. Agardh.

Stems of fronds slender, like twine, smooth. Leaves lanceolate-linear, rather pointed, midribbed, with conspicuous scattered cryptostomata, serrate at the edges; the basal leaves 3 to 4 cm. long and to 8 to 9 mm. wide, the upper much shorter and narrower. Vesicles when adult mutic, about the size of a peppercorn, borne on a petiole as long as their diameter. Receptacles, junior compressed, mature rounded-cylindrical, thickened in the middle, and with each margin ending in a winged fimbriated crest.

Western Australia and South Australia.

Sargassum Merrifieldii J. Agardh.

Stems of the fronds angular, rounded rough. Leaves narrowly linear, almost entire, with a single row of cryptostomata on each side of the midrib, to 5 cm. long and about 2 mm. wide. Vesicles rather few, larger than in preceding, mutic, on a petiole about as long as the diameter. Receptacles, compound when mature, then subracemose on a very short ramulus, singly ovate-lanceoid, smooth, warted.

Only known from South Australia.

Sargassum spinuligerum Sonder.

Stems of the fronds compressed, above subangulate, firm, of the thickness of a pigeon's quill, often muriculate with minute spines. Lower leaves less toothed, to 5 cm. long and 8 mm. wide, with scattered cryptostomata; upper lanceolate, serrate-dentate, with a single row of cryptostomata on each side of the midrib. Vesicles spherical, mutic, of moderate size, on a petiole as long as the diameter. Receptacles lanceoid, smooth, 4 to 7 mm. long, at length racemose on a rather elongated ramulus.

On all the coasts of Australia except the north, and extending to New Zealand.

SEIROCOCCUS Greville.

There being but one species, genus and species have the same characters.

Seirococcus axillaris Greville.

Attachment a disc, throwing out numerous branching and clasping fibres. Frond 90 to 180 cm. long, flat, distichously branched, traversed by a flat immersed midrib; the branches issue from the sharp edges, are flat, ribbed and pinnatifid with strap-shaped falcate lobes or laciniae, 10 to 15 cm. long and 12 mm. or so wide. There are no vesicles. Receptacles, 4 mm. long, moniliform when ripe, appearing on the opposing margins of the rachis and the laciniae sometimes making a long fringe. The hollowed conceptacles are connected by a pore or canal with the surface, and are lined with long simple filaments (paranemata), among which are found bright yellow small antheridia in racemes and narrow obovoid oospores.

The colour is a dark olive-brown. The substance is firm and leathery, and the plant does not give off a slimy mucus when steeped in fresh water.

Victoria and South Australia east of Cape Northumberland; and Tasmania. Growing at no great depth in the Laminarian Zone.

SCYTOTHALIA (Turner) Greville.

As the characters of the genus were based on those of the single Australian species, it will be sufficient to describe the species.

Scytothalia dorycarpa (Turn.) Greville.

Attachment a flat disc, throwing out lateral branching fibres. Fronds 30 to 90 cm. high, linear, flat, coriaceous, distichous and alternately decompound, nowhere distinctly midribbed. The ultimate pinnules or laciniae are 7 to 14 cm. long, flat, linear-falcate, tapering at the point. There are

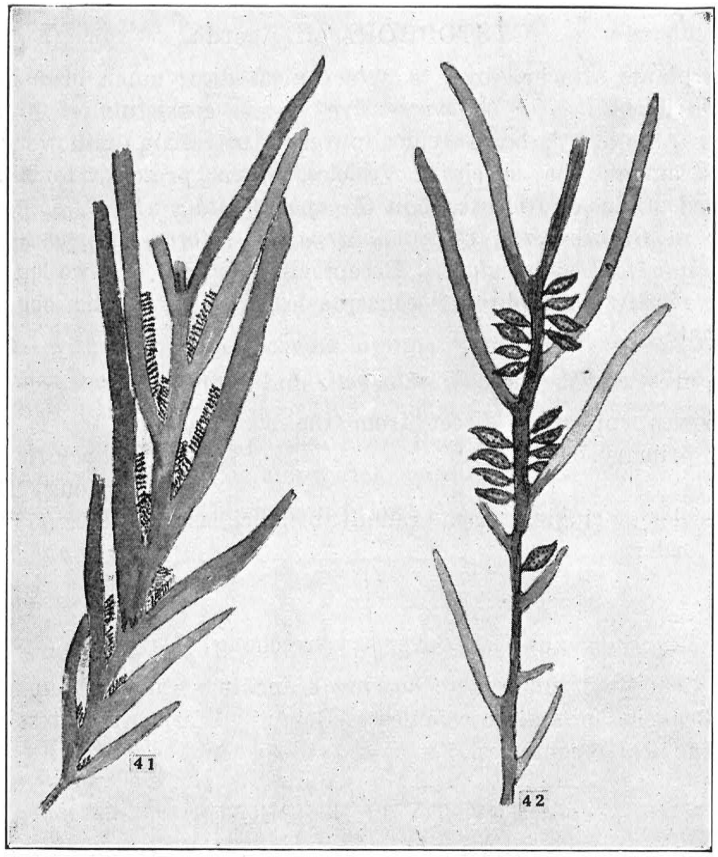

Fig. 41.—*Seirococcus axillaris.* **Fig. 42.**—*Scytothalia dorycarpa.*

no vesicles. The receptacles form series springing from the margin of the secondary and tertiary branches, flattened, generally ovate beaked; they are densely covered on both surfaces with tubercles, pierced with a pore, covering the conceptacles. The conceptacles contain antheridia, oospores and paranemata. The oospores are ovate with a wide transparent perisperm. The colour is a greenish-olive, darkening when dried. The substance is leathery; when steeped in fresh water the plant exudes a slimy mucus.

Common in Western Australia from Geraldton south, and on the south coast extending into South Australia, where it meets the more eastern *Seirococcus*. Both can be gathered together at Victor Harbour. It has not been found in Victoria but strange to say was recorded by R. Brown from Tasmania, and Mrs. Irvine gathered a specimen at the Tamar Heads. Probably the Tasmanian records are of drifted material.

CYSTOPHORA J. Agardh.

Large plants attached by a simple conical disc; much branched. No true, midribbed leaves; the vegetative system consisting of broader or narrower ramuli. A large genus, purely Australian, with very varied contours among the species. Vesicles, when present, forming true specialized organs, mutic except in *C. cephalornithos* and *C. polycystidea;* wanting in *C. pectinata, C. xyphocarpa, C. retorta, C. spartioides, C. thysanoclada?, C. paniculata.* Receptacles formed of swollen ramuli, carrying mostly hermaphrodite conceptacles, with antheridia, oogonia and paranemata.

There are two subgenera—*Caulocystis* and *Eucystophora.*

a. Vesicles springing direct from the stem or primary branches . . . . . *Caulocystis* (Areschoug) De Toni.

aa. Vesicles springing from ramuli of the last order . . . . . *Eucystophora* De Toni.

Subgenus CAULOCYSTIS (Areschoug) De Toni.

Main stem stout, undivided, bearing branchings radiating in all directions. Branches pinnulate ramulose. Ramuli filiform, the latest growing into cylindrical receptacles.

KEY TO THE SPECIES.

a. Vesicles spherical mutic . . . . . *C. uvifera* (Ag.) J. Agardh.

The southern part of Australia, Tasmania, New Zealand.

aa. Vesicles cylindro-elliptical, apiculate . . . . . *C. cephalornithos* (Labill.) J. Agardh.

South Australia and Victoria to Twofold Bay; Tasmania (Labillardière).

Subgenus EUCYSTOPHORA De Toni.

a. Conceptacles in two more regular series.

b. Whole plant subdistichously pinnate, the pinnae flattened, pinnatifid.

Cystophora platylobium (Mert.) J. Agardh.

Robust but shapely plant. Stem and branches flattened, pinnate along the edges. Ultimate pinnules pedicellate, lanceolate, passing into broad flat receptacles. Vesicles stalked, as large as a sloe or bird-cherry, spherical, mutic. To 90 cm. or more high.

Southern coast of Australia, Tasmania, New Zealand.

Cystophora pectinata (Greville and Agardh) J. Agardh.

Stem angular, terete, nearly as stout as a goose quill. The ultimate pinnules lanceolate, pinnatifid with flattened linear segments, the rachis winged, pinnules 7.5 cm. long, segments 2 cm. No vesicles. Receptacles have not been seen. At least 60 cm. high.

Western Australia, from Fremantle south, extending along the Great Bight into South Australia (Clare Bay, Dr. G. A. Chambers).

Cystophora racemosa Harvey.

Stem flat with sharp edges bearing bipinnate branches from the flat faces. The rachides become gradually denuded below, the fallen pinnules leaving a ladder-like (scalariform) series of stumps. Vesicles spherical, mutic, pedicellate, of the size of a garden pea. Receptacles flattened, lanceolate, with a series of conceptacles along each margin.

Elegant plants up to 4 metres in height.

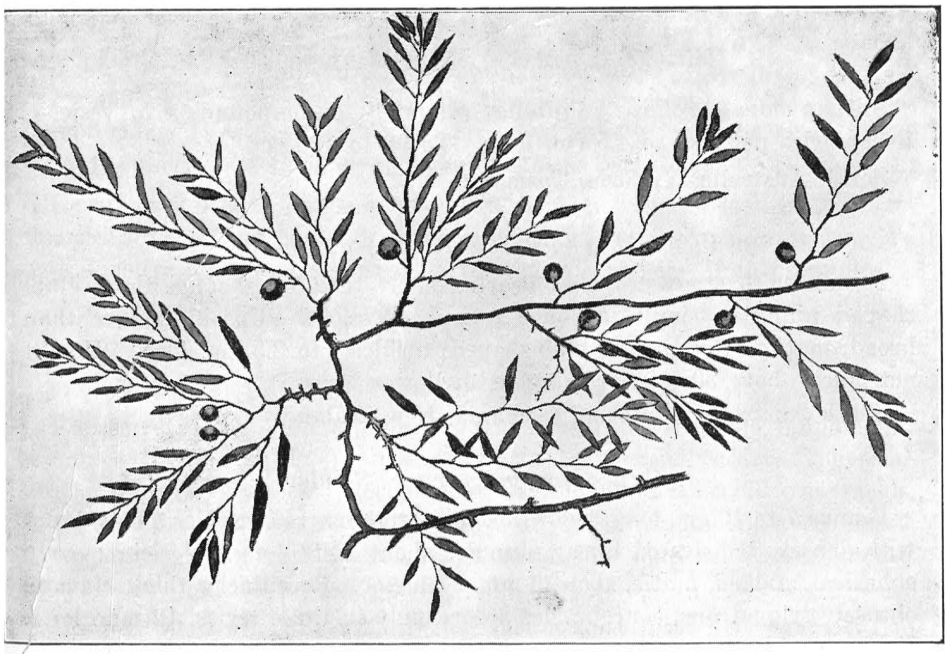

Fig. 43.—*Cystophora racemosa.*

Western Australia, from Bunbury south, extending like the preceding around the Great Bight into South Australia (Denial Bay, Dr. G. A. Chambers) and into Spencer Gulf and around Encounter Bay, even to Portland in Victoria.

bb. Frond pinnately divided, the branches emerging from the flat faces of the rachis, generally bent back near the base (retrofract), the ramuli terete not conspicuously compressed.

Cystophora retorta (Mert.) J. Agardh.

Pinnules several times dichotomous with rounded axils. No vesicles. Receptacles pod-like (siliquaeform) with distant swellings (torulose). To 90 to 120 cm.

Western and South Australia, Victoria, Tasmania, New Zealand (Laing).

Cystophora retroflexa (Lab. 1806) J. Agardh (1848).

The commonest and most variable species. Pinnules pinnately decompound with subrounded axils. Vesicles numerous, stalked, of the size of a pea, elliptic-obovoid then spherical, mutic. Receptacles podlike, compressed to 4 cm. long, at length somewhat torulose. Tall, to 2.4 to 2.7 metres.

Western and South Australia, Victoria, southern New South Wales, Tasmania, New Zealand.

Cystophora siliquosa J. Agardh.

Stem quadrate robust. Pinnules pinnately decompound. No vesicles. Receptacles pod-like to 4.5 cm. long. To 90 to 120 cm.

South Australia, Victoria, Tasmania.

Cystophora torulosa (R. Br.) J. Agardh.

Fronds with stout branches bearing short to 2.5 cm. long, thick club-shaped pinnules, simple or once forked. Vesicles ellipsoid, longer than broad, mutic. Receptacles club-shaped, torulose, to 2.5 cm. long. Height not much above 30 cm., growing in shallower water.

South Australia, Victoria, Tasmania, New Zealand.

Cystophora botryocystis Sonder.

Pinnae 7 to 10 cm. long, below loaded with clustered vesicles, above beset with densely imbricated linear pinnules about 1 cm. long. Vesicles nearly spherical, stalked, mutic, about 5 mm. diameter. Receptacles thick, clavate, obtusely triquetrous, conceptacles accordingly in three series, 12 mm. long. To 90 cm. high.

Western and South Australia and Victoria.

Cystophora Grevillei (Ag.) J. Agardh.

Stem terete, compoundly pinnate. Pinnae less evidently retrofract. Vesicles singly on a pinna stalked, as large as a garden pea, or larger, spherical, mutic. Receptacles pod-like, to 5 cm., even exceptionally 12 cm., long and 23 mm. wide, compressed, incurved, with antheridia and oogonia in distinct conceptacles. Tall, to over 1 metre high.

Western and South Australia, Victoria?, Tasmania.

aa. Conceptacles more scattered, not confined to two linear series.

c. Stem flattened, the rachis dorso-ventrally compressed, giving off pinnate much divided branches from the sharp edges of the rachis.

Cystophora spartioides (Turn.) J. Agardh.

Developing in one plane. Pinnules dichotomously pinnate. No vesicles.

Receptacles 1 to 2.5 cm. long cylindraceous, warted, with scattered conceptacles. Several feet high.

South Australia, Victoria, Tasmania, and southern New South Wales.

cc. Stem flattened laterally, the pinnae emerging from the plane faces.

Cystophora Brownii (Turn.) J. Agardh.

Pinnae retrofract, pinnulate, the ultimate divisions of the pinnules dichotomous. Vesicles "extremely rare, and chiefly from the lower parts, obovate-spherical of the size of seeds of *Abrus precatorius*"—De Toni.

Receptacles unique in the genus, very short, less than 4 mm. long, ovate-lanceoid gradually attenuated at the apex, with scattered conceptacles. To over 1 metre high, distinguished by the delicate tracery of the pinnules.

Western and South Australia.

Cystophora monilifera J. Agardh.

Pinnae retrofract, 30 cm. long, lax and flaccid, decompound pinnate, the pinnules dichotomously pinnate. Vesicles numerous, nearly spherical, mutic, the size of a pea. Receptacles very slender with a filiform rachis, to 2 cm. long, moniliform with swellings at greater or less distances, much thicker than the thread-like rachis. Conceptacles numerous, approximate. Several feet high.

Western Australia, South Australia, Victoria, southern New South Wales, Tasmania, New Zealand.

Cystophora subfarcinata (Mert.) J. Agardh.

Stem flat, decompound, densely pinnate. Pinnae retrofract, bearing abbreviated intricately pinnate pinnules, 2.5 cm. long. Vesicles rare among the pinnules, obovoid, the junior apiculate, small to 2 mm. long. Receptacles forming the ultimate ramuli of the pinnae, filiform as in *C. monilifera*, with three or four distant toruli which bear the few, irregularly grouped conceptacles. The rachis of the receptacle is produced into a sterile terminal beak or awn. 90 cm. or more high.

Western Australia, South Australia, Victoria, Tasmania.

Cystophora polycystidea Areschoug.

Stem flat. Pinnae emerging from the plane face, retrofract. Pinnules slender, dichotomous-pinnate, the ultimate segments filiform. Vesicles numerous, elongate-ellipsoid, acute at both ends, about 4.5 mm. long, borne mostly near the base of the rachides of the branches in racemes. Receptacles filiform, distantly torulose, ending in a sterile beak, about 1 cm. long. 90 to 120 cm. high.

South Australia, Victoria, Tasmania, extending to Jervis Bay in New South Wales.

Cystophora paniculata (Turn.) J. Agardh.

Stem terete, decompound branching. Pinnae and pinnules emerging on all sides. Ultimate pinnules crowded, filiform, simple or forked. No vesicles. Receptacles in a panicle at the apex of the ramuli; cylindrical, warted, distinct from the vegetative ramuli. Several feet high.

Abundant in South Australia, Victoria, and Tasmania, and on the East coast as far as Sydney.

CYSTOPHYLLUM J. Agardh.

A genus very near to *Sargassum*, with short caulis, emitting many branches, some shorter bearing alternate midribbed leaves with cryptostomata, others longer pinnately much branched bearing vesicles and ultimately receptacles. The vesicles are not independent organs but are formed as swellings in the upper leaves.

Cystophyllum muricatum (Turn.) J. Agardh.

Rachides bristling with glandular growths. Lower leaves linear, entire, with a row of cryptostomata on each side of the midrib, narrow, to 7.5 cm. long, pointed. Upper leaves filiform, to 2.5 cm., with the vesicles swelling like beads on a thread. Vesicles, usually three, but occasionally one, two, up to seven, the extremity of the leaf projecting beyond the

uppermost, ovoid. Receptacles borne on the interior side of terminal leaves, racemose, each stipitate, cylindraceous-lancoid, about 4.5 mm. long. Plants to 60 cm. high.

Frequenting harbours all round the coasts of Australia. New Caledonia and the Admiralty Islands.

CYSTOSEIRA C. Agardh.

Vesicles developed in the primary branches. Receptacles hermaphrodite. Oogonia monosporous. Chiefly Atlantic and Mediterranean.

Cystoseira abrotanifolia Agardh var. *macrocarpa* (Kuetz.) De Toni.

Distinguished by the very large vesicles to 8 mm. long.

It occurs in Western Australia, but may be found in South Australia.

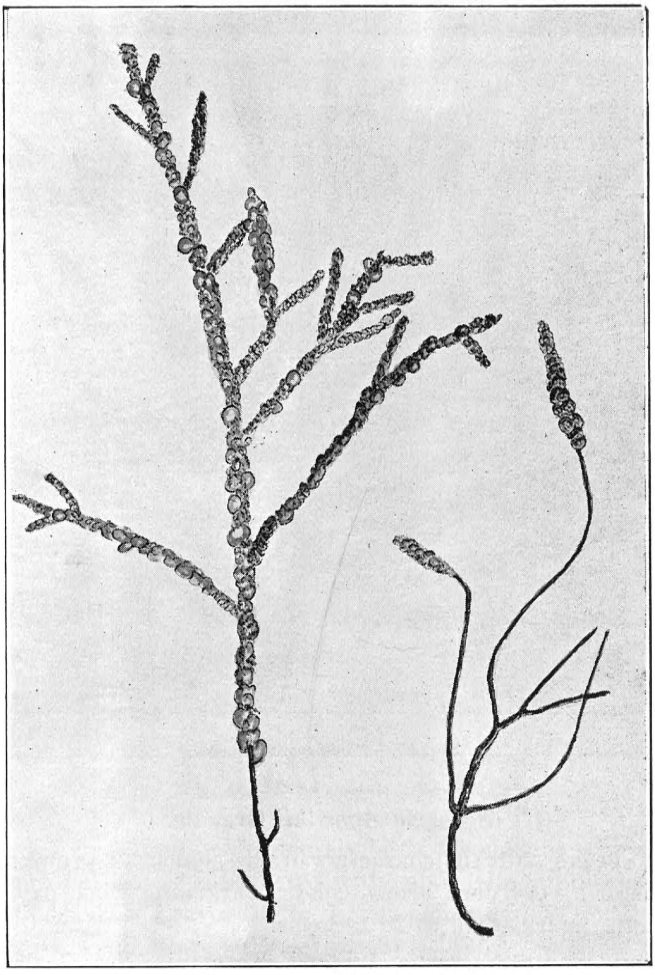

Fig. 44.—*Scaberia Agardhii.*

SCABERIA Greville.

Frond dendroid, irregularly branched, having stem, leaves, and vesicles as distinct organs, but no special receptacles. Leaves peltate, fleshy, warted externally, spirally inserted round the stem. Vesicles formed from an inflated leaf and inserted as the leaves. Conceptacles immersed in the leaves, hermaphrodite. Oogonia monosporous.

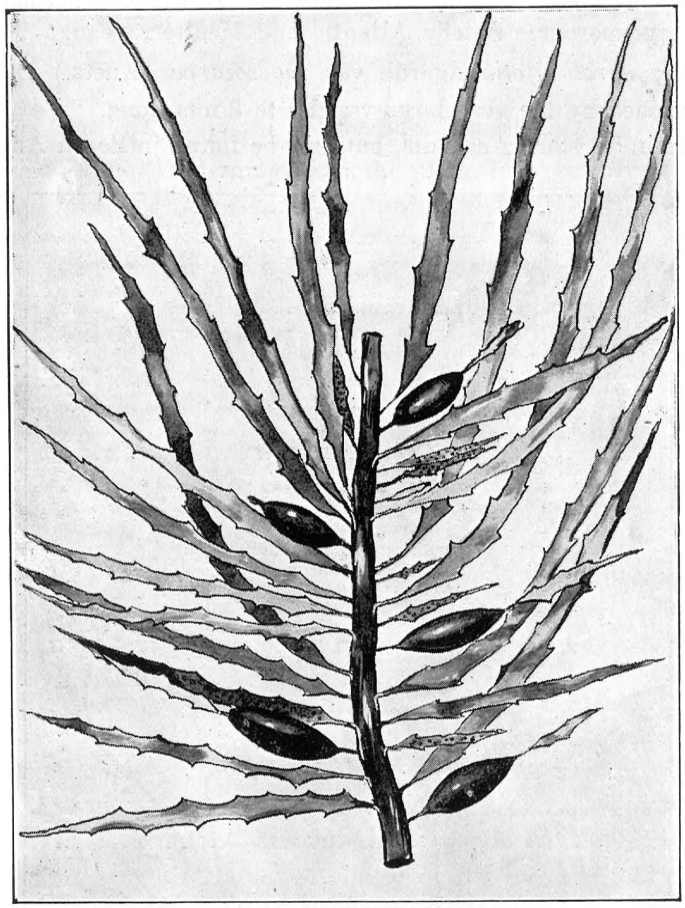

Fig. 45.—*Phyllospora comosa.*

Scaberia Agardhii Greville.

The only species with the characters of the genus. It grows several feet high, and is of a very dark brown colour, darkening when dry. It grows from low water mark to 10 to 20 fathoms.

Western and South Australia, Victoria, Tasmania, New Zealand. There is a fine bed alongside the Causeway to Granite Island, South Australia.

PHYLLOSPORA C. Agardh.

Attachment large, conico-hemispherical, composed of a large number of robust, simple, closely imbricating, obtuse processes, radiating from a central naked concave disc, from the middle of which starts the solitary stem. Frond 3 to 9 metres long, pinnately divided. Stem and branches

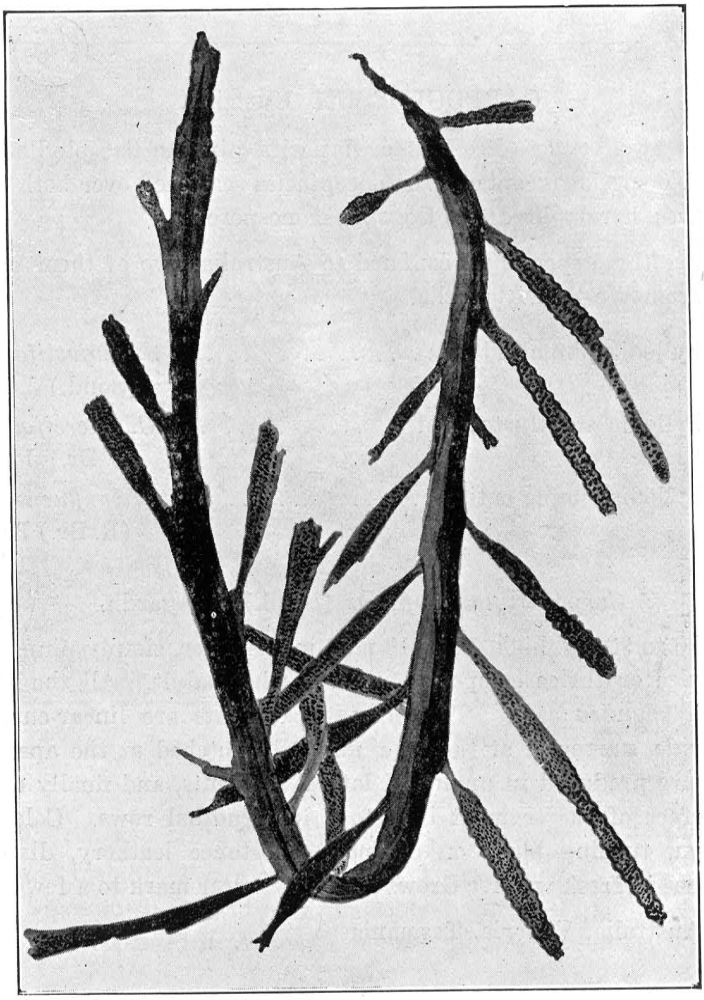

Fig. 46.—*Carpoglossum confluens.*

strap-shaped, 6 to 12 mm. wide, densely beset throughout with scattered or crowded marginal leaves, intermixed with small ciliary processes that may develop into leaves. Leaves 10 to 15 cm. long and 2 to 12 mm. wide, tapering to each end, more or less coarsely toothed. Vesicles elliptical to 2.5 cm. long, bearing a terminal leaflet. Fruit-leaves similar but shorter. Conceptacles numerous, immersed, dioecious. Oogonia monosporous.

Phyllospora comosa (Labill.) C. Agardh.

The only species, with the characters of the genus. Colour dull and olive brown, darkening on drying. Substance very tough, leathery.

Probably South Australia, Victoria, southern New South Wales, Tasmania, New Zealand.

CARPOGLOSSUM Kuetzing.

Attachment a conical disc. Stem flat with pinnate flat phyllodia. No vesicles. No special receptacles. Conceptacles scattered over both surfaces of the leaves, hermaphrodite. Oogonia monosporous.

There are three species all confined to Australia, two of them known as yet only from Western Australia.

a. Phyllodia pinnatifid . . . . . *C. angustifolium* (Sond.) J. Agardh.

aa. Phyllodia stoutly toothed . . . . . *C. quercifolium* (R. Br.) J. Agardh.

aaa. Phyllodia simple entire . . . . . *C. confluens* (R. Br.) Kuetzing.

Carpoglossum confluens (Sond.) J. Agardh.

Frond 30 to 90 cm. high, 12 to 19 mm. in diameter, simply pinnate when young, twice or thrice compound pinnate when adult. All the divisions erect with rounded axils. The ultimate segments are linear-cuneate, to 12 mm. wide, narrowed at the base, minutely notched at the apex. Conceptacles are produced in unaltered lateral segments, and finally cover the whole surface of the segment in 4 to 6 longitudinal rows. Colour dark olive-brown, turning black on drying. Substance leathery, discharging much mucus in fresh water. Grows from low water mark to a few fathoms.

South Australia, Victoria, Tasmania.

MYRIODESMA Decaisne.

Frond dichotomous, caulis terete, leaves flat. No vesicles. Conceptacles scattered over both faces of the leaf, hermaphrodite. Oogonia monosporous. Seven species have been described, all purely Australian. Only one has so far been recorded from South Australia.

Myriodesma integrifolium Harvey.

Caulis at base terete, winged above. Leaves distichous decompound pinnatifid, laciniae ribless, linear, obtuse, with entire margins. Conceptacles very numerous, scattered. Colour light olive-brown. Substance membranaceous.

Western and South Australia, Victoria, Tasmania.

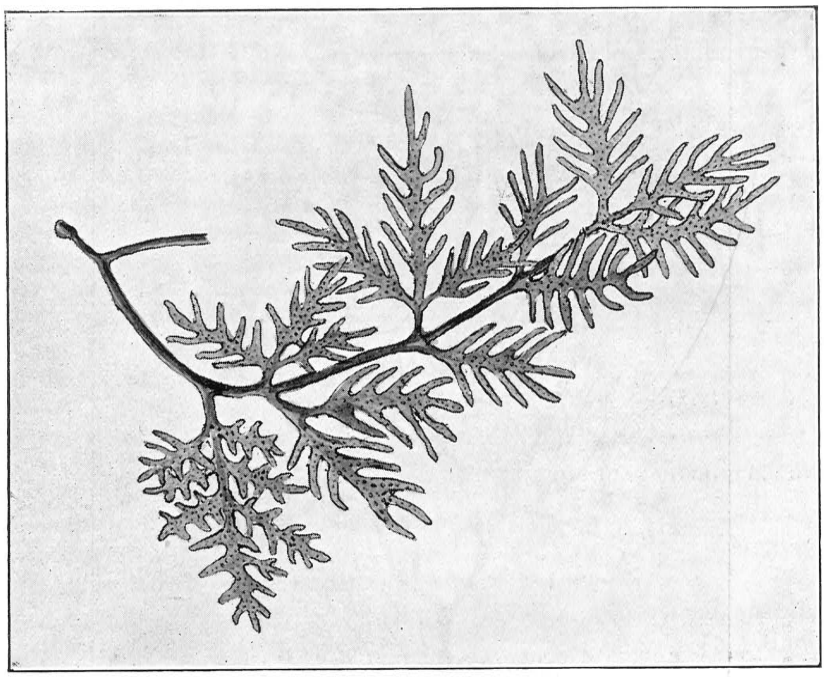

Fig. 47.—*Myriodesma integrifolium.*

Family FUCACEAE.

Oogonia forming 2 to 8 oospores (in Australian genera 4). The family is most abundantly spread over the colder regions of the Northern Hemisphere. It is replaced in Australia mainly by members of the Sargassaceae.

KEY TO THE GENERA.

a. Frond branching on all sides, terete. With vesicles . . . . . *Hormosira* Endlicher.

aa. Frond with branches expanded in one plane. Without vesicles . . . . . *Xiphophora* Montagne.

HORMOSIRA Endlicher.

Frond filiform with swollen vesicated internodes carrying the conceptacles, grouped necklace-wise on the axis. No leaves. Conceptacles dioecious. Oogonia dividing into 4 oospores.

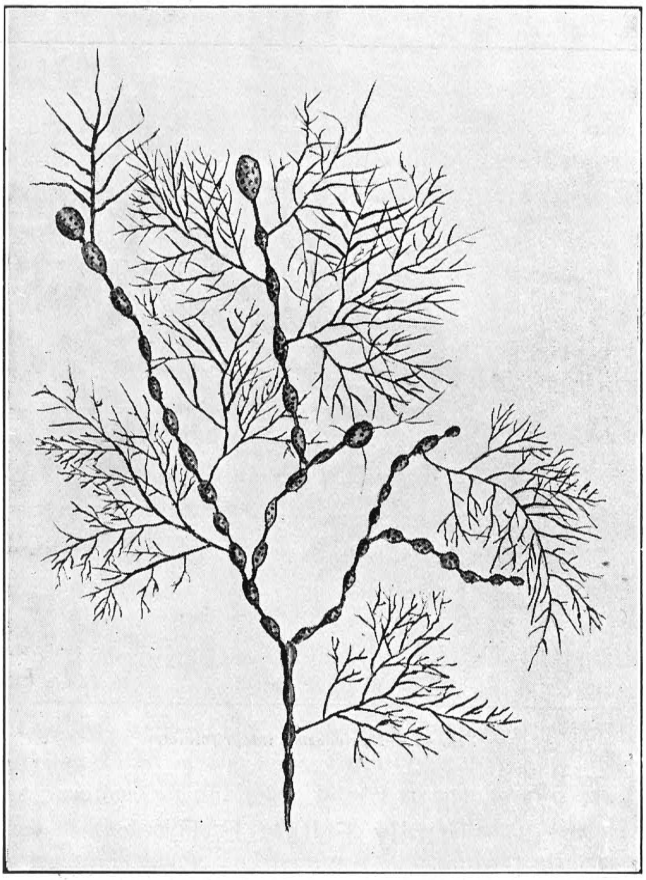

Fig. 48.—*Hormosira Banksii* **with parasitic** *Notheia anomala.*

Hormosira Banksii (Turn.) Decaisne.

Attachment a minute disc. Fronds divaricate-dichotomous, from 5 to 60 or 90 cm. in length, according to whether they grow on reefs exposed at low tide or in deeper water. The vesicated internodes vary greatly in shape and size, spherical, oblong, ovoid, obconical, occasionally prolonged into cylinders 5 to 7.5 cm. long, the centre hollow, the periphery coriaceous and filled with scattered conceptacles. Colour olivaceous, black on drying.

Sundry forms have been described by authors as distinct species, but Harvey is probably right in uniting them into one. These are:—

1. *H. Labillardieri* (Bory) Montagne. Frond very long, di-trichotomous, vesicles large, ovoid, the terminal one sometimes cylindrical. From deeper water.
2. *H. Sieberi* (Bory) Decaisne. Frond short, dichotomous, fastigiate, vesicles obconic, truncate at the extremity, terminal ovoid.
3. *H. gracilis* Kuetzing. Very slender, barren, the internodes fusiform, tapering at each end. On exposed reefs.

From Albany in Western Australia, South Australia, Victoria, Tasmania, New South Wales and Lord Howe Island, New Zealand.

XIPHOPHORA Montagne.

Frond flattened dichotomous. No vesicles. Conceptacles scattered on the upper terminal parts of the frond, hermaphrodite. Oogonia dividing into 4 oospores.

KEY TO THE SPECIES.

a. Receptacles prolonged into a sword-like growth, up to 15 cm. long	*X. Billardieri* Montagne.
aa. Receptacles narrowly linear, similar in shape and size to the sterile segments	*X. chondrophylla* (R. Br.) Harvey.

Both are common in Victoria, Tasmania, and New Zealand, and may very well occur in South Australia.

Family DURVILLAEACEAE.

Allied to *Fucaceae* by the formation of conceptacles producing 8-spored oogonia, but with a homogeneous frond and no separate organs.

KEY TO THE GENERA.

a. Frond flat, solid, pinnatifid or subdigitate ..	*Sarcophycus* Kuetzing.
aa. Frond terete, solid, vaguely branched. (Truly parasitic on other algae)	*Notheia* Bailon and Harvey.

SARCOPHYCUS Kuetzing.

Conceptacles scattered over the whole frond, hollowed out in the cortical stratum, communicating with the surface by a pore, dioecious. Both antheridia and oogonia borne on branching filaments.

Sarcophycus potatorum (Labill.) Kuetzing.

Attachment a thick scutate disc, 10 to 15 cm. in diameter. Stipes soon compressed, and widening and flattening upwards till lost in the base of the lamina, 15 to 30 cm. long. Lamina 3.5 to 7 metres long or more and 6 mm. thick, simple or once or twice forked, the segments strap-shaped of great length, 15 to 30 cm. broad. Margins undulate. Colour dark olive.

The largest and coarsest of all the Kelps—Bull Kelp of Tasmania—extremely tough and leathery, rejoicing in the most boisterous turmoil of the surf.

From Cape Northumberland to Cape Howe; Tasmania, all coasts.

NOTHEIA Bailon and Harvey.

Frond filiform, irregularly branched, solid. Parasitic on *Hormosira,* the haustoria penetrating the base of the conceptacles of the host. Conceptacles scattered over the whole frond, hollowed out in the cortical stratum, opening on the surface by a pore, dioecious. Antheridia and oogonia borne on branched filaments.

Notheia anomala Bailon and Harvey.

Fronds solitary from each conceptacle of *Hormosira,* 7.5 to 20 cm. long, at first simple, then multifariously pinnately branched and bushy, the branches proliferous. Stipes cylindrical, ramuli linear-fusiform, narrowed at each end. The axis is solid, composed of longitudinal interwoven filaments; the periphery of parallel, radiating, coloured filaments. Colour a yellowish-olive or pale brown, turning dark on drying. The substance, when fresh, is cartilagino-coriaceous.

South Australia, Victoria, Tasmania, New South Wales to Port Stephens, New Zealand, following *Hormosira Banksii.*

Family SPLACHNIDIACEAE.

Frond homogeneous, no special organs, cylindrical tubulose with fluid within, pinnately branched on all sides, branches similar cylindrical very obtuse at apex. The outer wall consists of two layers of cubical epidermal cells, and three layers of polygonal to ovate cortical cells. Within these are strands of filaments longitudinal in direction and traversing the periphery of the mucilaginous mass which fills the interior of the frond. Conceptacles are scattered over the whole frond. No antheridia observed. The unilocular sporangia at a later stage are divided into zoospores, 500

to 600 in each sporangium, whose active motion has been observed. Apparently nothing more is known of them. The genus, of which there is only the one species, seems to share certain characters of the *Durvilleaceae* and *Laminariaceae*. It is quite unique.

SPLACHNIDIUM Greville.

Splachnidium rugosum (L.) Greville.

Attachment a small conical disc. Fronds one or several from the same base, cylindrical, truncate at the apex, bearing similar branches on all sides. Very slimy. Colour pale-green changing to brown when adult. Total height 10 to 20 cm. It grows on flat reefs adjacent to deeper water, and themselves overflowed at high tide.

Victoria, Tasmania, New South Wales as far as Newcastle, New Zealand. It will probably be found on the coast of South Australia adjacent to Victoria.

Order **TETRASPORINAE**

Olive-brown plants, of moderate size, with thin flat membranaceous fronds, never fleshy or cartilaginous. The cells of the thallus are superimposed in layers. They are mostly rectangular, easily adjusted in longitudinal and transverse rows. The outer cells are deeply coloured, rich in chromatophores and smaller; the inner cells are colourless and larger. The reproductive cells are superficial, scattered over the surface or grouped together in sori.

Non-sexual and sexual plants are distinct. The non-sexual propagating cells usually divide into four, and have hence received the same name as the tetraspores which are characteristic of the *Rhodophyceae*. No observation has been made of the process of fertilization, but in the sexual plants there occur sori of small cells and of large cells, which have been tentatively designated antheridia and oogonia respectively. All the cells of the tetraspores and of the antheridia and oogonia are immobile, totally destitute of cilia.

There is but one Family, Dictyotaceae.

Family DICTYOTACEAE.

The characters are those of the Order.

KEY TO THE GENERA.

a. Fronds flabellate, zoned with conspicuous lines of innovation.
  b. No independent tufts of paranemata on the frond.

c. Frond composed of several layers of cells (Pleiostromatic).

d. Striae of cortical cells radiating fanwise in pairs as if twinned.

e. Sori naked. No paraphyses *Gymnosorus* J. Agardh.

ee. Sori protected by an indusium. Paraphyses present . . . *Zonaria* (Drapar.) J. Agardh.

dd. Striae of cortical cells radiating fanwise singly. Sori without indusium but with paraphyses *Homoeostrichus* J. Agardh.

cc. Frond composed of two layers of cells (Distromatic) . . . . . *Chlanidote* J. Agardh.

bb. Independent tufts of paranemata on the fronds. Cortical cells spaced equidistant from one another. (Fronds flabellate; ecostate; flat.)

f. Fronds flat with entire margins, similar lobes prolificating from the upper surface of the frond. Spores forming interrupted zones . . . . . *Lobophora* J. Agardh.

ff. Frond erect, sub-dichotomous or palmatifid. Spores in sori, tetraspores forming transverse zones . *Taonia* J. Agardh.

fff. Frond reniform-orbiculate, the edges involute, the lamina sometimes split into lobes. Spores and tetraspores forming transverse zones . *Padina* Adanson.

aa. Fronds erect, nowhere zoned with lines of innovation.

g. Terminal cells of the frond numerous, radiating fanwise.

h. Fronds without midrib (ecostate). Fronds subpalmate-dichotomous. Spores single or twinned evolved on both faces of the frond . . . *Spathoglossum* Kuetzing.

hh. Fronds with prominent midrib (costate). Fronds dichotomous. Spores scattered over each face of the frond. Tetraspores collected into sublinear sori . . . . . *Haliseris* Targ. Tozz.

gg. Terminal cells of the frond converging towards a central initial cell.

i. Frond ecostate.

j. Reproductive cells borne on the frond proper.

k. Frond consisting of a median monostromatic layer of large colourless cells covered on each face by a cortical layer of small coloured cells . . . *Dictyota* Lamouroux.

kk. Frond consisting of a median monostromatic layer of large colourless cells, an intermediate stratum of several layers of cells, and a cortical monostromatic layer of small coloured cells . . . . . *Pachydictyon* J. Agardh.

kkk. Frond consisting of a median di- or poly-stromatic stratum, covered on each side by a cortical layer of small coloured cells . . . . . *Dilophus* J. Agardh.

jj. Reproductive organs borne in numerous tongue-like proliferations from the whole frond *Glossophora* J. Agardh.

ii. Frond coalescent, the lower divisions ribbed . . . . . *Lobospira* Areschoug.

GYMNOSORUS J. Agardh.

Frond flat, prostate below, then ascending, fan-shaped with lobes. Sori on the upper face subzonate, naked, without accompanying paraphyses. Stupose at the base. Both Australian species are 5 to 7.5 cm. high and of the same or greater breadth. They are gregarious and often cover a considerable face of rock.

1. Variegately pale-brown .. .. *G. variegatus* (Lamour.) J. Agardh.
2. Very dark, turning black on exposure or drying *G. nigrescens* (Sond.) J. Agardh.

ZONARIA (Draparn.) J. Agardh.

Frond stipitate, flabellate, decumbent below. Spores (oogonia) nidulating under a hyaline indusium. Tetraspores and antheridia not observed.

1. Frond to 5 cm. high, stupose on under-surface, cuneate-flabellate. In colour and substance it resembles *Gymnosorus variegatus* .. .. *Z. Diesingiana* J. Agardh.
2. Frond rather erect, a few cm. high, branching with cuneate-flabellate segments. Margins coarsely crenate. Sori not seen .. .. .. *Z. crenata* J. Agardh.
3. Erect, stem terete or winged, 10 to 15 cm. high, much divided, in general outline flabellate. Branches ending in deeply parted, basally woolly laminae, whose segments are narrow-linear, truncate, sparingly toothed or incised. Sori oblong, scattered .. .. *Z. Turneriana* J. Agardh.

West and south coasts of Australia, Tasmania, New Zealand.

HOMOEOSTRICHUS J. Agardh.

Fronds erect with strongly stupose stems. Ultimate divisions fan-shaped. Sori prominent, the spores naked accompanied with paraphyses. Pleiostromatic.

1. Stem terete, slender, brown, woolly (stupose), much branched. Branches ending in narrow wedge-shaped flat segments free from stupa. Sori oblong or linear, directed longitudinally. 10 to 13 cm. high .. .. *H. Sinclairii* (H. and H.) J. Agardh.

   The eastern species, New South Wales and New Zealand.
2. As in preceding, but shaggy with brown wool (stupa) to the upper segments .. .. .. *H. stuposus* (R. Br.) J. Agardh.

   South Australia and Victoria.
3. Segments very narrow, linear, channelled .. .. *H. canaliculatus* J. Agardh.

   South Australia and Victoria.
4. All branches twisted in a regular spiral .. .. *H. spiralis* J. Agardh.

   Western and South Australia.

CHLANIDOTE J. Agardh.

There is but one species, found in South Australia and Victoria.

Chlanidote microphylla (Harv.) J. Agardh.

Frond erect, dendroid, with a stout stipes (to 6 mm. in diameter), branched on all sides. The stipes is coated with foxy curled hairs. The branches break up into very numerous flabellulate, lacerate glabrous segments. These segments or laciniae are very narrow, the terminal ones truncate, the lateral subulate acute. Oogonia single, scattered near the margin, obovate-globose; antheridia (?) in the same individuals form oblong-linear sori directed longitudinally on the frond, dividing at length into sets of 4 cells. Height of plant 7.5 to 15 cm. Colour dark-brown.

LOBOPHORA J. Agardh.

Lobophora nigrescens J. Agardh.

With one species only, gathered by J. Bracebridge Wilson at Dromana in Port Phillip.

Frond flat, ribless, flabellate, sub-lamellate with similar lobes prolificating from the upper surface.

TAONIA J. Agardh.

Frond erect, flat, ribless, splitting into palmatifid or subdichotomous laciniae; constituted of two strata of rectangular cells, the inner consisting of usually 4 layers, the outer of a layer of densely coloured small cells. Oogonia, antheridia, tetraspores all in different individuals, the oogonia in scattered sori, the antheridia also in sori, the tetraspores (sporangia) approximate in concentric flexuose lines.

Taonia australasica (Sond.) J. Agardh.

Frond irregularly split into lobes, to 15 cm. high, fenestrated with rectangular areas between thick cross bars. Colour a yellowish green.

South Australia and Victoria.

PADINA Adanson.

Fan-shaped fronds, entire or split into sections, membranaceous, often cucullate, concentrically zoned. Thallus of two strata of rectangular cells, the inner consisting of two or more layers of parallelepipedal cells, the outer of a single layer of coloured cells. Oogonia and antheridia on the same plant, tetraspores on separate plants; oogonia in sori of few large cells, antheridia in sori of many large cells, tetraspores scattered along the margins of the zones. Often indehiscent.

Padina Fraseri (Grev.) J. Agardh.

Frond subcoriaceous, fan-shaped, stupose below, above many times split, dark-brown but pruinose. Has a spread of 5 to 13 cm.

Generally around Australia, but not observed in Tasmania.

SPATHOGLOSSUM Kuetzing.

Frond erect, flat, ribless, subpalmate-dichotomous. Thallus of 2 strata of cells, the inner of empty angular cells in several layers, the outer of cubical cells scarcely smaller but coloured. Oogonia scattered singly or in pairs over the frond; antheridia in sori on different individuals; tetraspores unknown.

Spathoglossum cornigerum J. Agardh.

Much resembling *Haliseris Muelleri*, but ribless and with squared apices and conspicuously rounded sinuses. To 60 cm., much branched.

New South Wales.

Spathoglossum grandifolium J. Agardh.

Frond sparingly dichotomous. Taller than the preceding and stouter.

Port Phillip Heads.

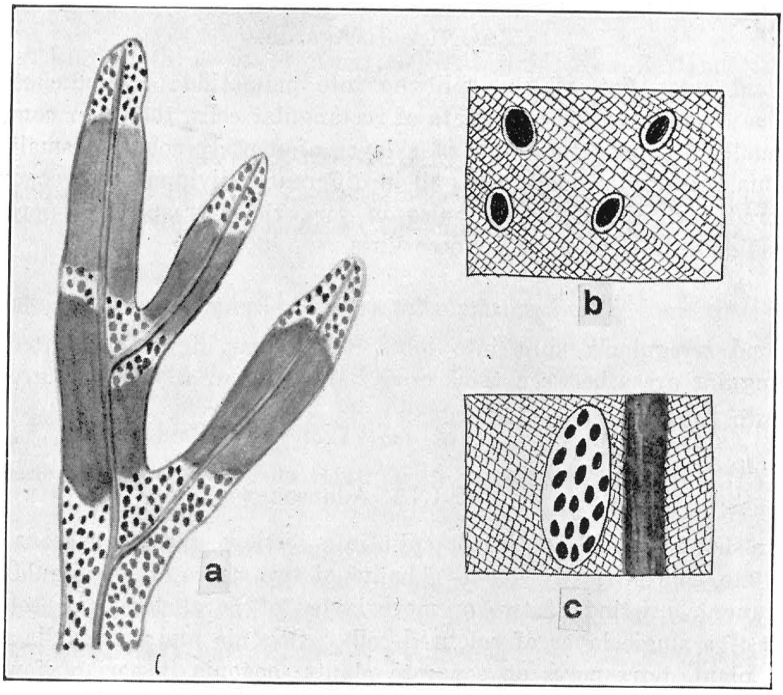

Fig. 49.—(a) *Haliseris Muelleri*; (b) and (c) *H. polypodioides*; (b) scattered spores; (c) sorus of spores.

HALISERIS Targ. Tozz. 1819.

(= *Neurocarpus* Web. and Mohr. 1805, and *Dictyopteris* Lamour. 1809.)

Frond erect, flattened, many times dichotomous. Two strata of cells, the inner more or less rectangular, empty and colourless, the outer (cortical) cubical and densely coloured; to form the midrib the inner stratum is thicker and compacted. There are present spores, often in great profusion, but their nature has not been sufficiently determined.

KEY TO THE SPECIES.

a. No veins running from the midrib to the margin.

b. Spores scattered over the frond.

c. Segments entire . . . . . *H. polypodioides* (Desf.) Agardh.
Tasmania.

cc. Segments denticulate . . . . . *H. Woodwardia* R. Brown and J. Agardh.
North Queensland.

bb. Spores forming a cloud-like patch, continuous from midrib to margin. Muciferous glands scattered over the surface . . . . . *H. Muelleri* Sonder.
South coast of Australia, Tasmania.

bbb. Spores forming a linear band on each side of the midrib as in *Blechnum*. Muciferous glands arranged in recurved arches from midrib to margin . . . . . *H. aerostichoides* J. Agardh.
Victoria, Tasmania, east coast of Australia.

bbbb. Spores in sori disposed in arches curving obliquely backwards from the midrib to the margin. To 30 cm. . . . . *H. pardalis* Harvey.
West and North-west Australia.

bbbbb. Spores as in preceding. Very near to *H. pardalis*, with stouter midrib, and more evolved. To 60 cm. . . . . *H. crassinervia* Zan.
Lord Howe Island.

aa. Veins running from midrib to margin.

d. Veins extremely numerous, crowded fine and delicate (spores not observed) *H. australis* Sonder.
South Australia (Lefevre Peninsula, Mueller), North Queensland.

dd. Veins conspicuous (spores in linear sori on each side of the midrib, 15 to 20 cm. high). . . . . *H. plagiogramma* Montagne.
Lord Howe Island, Brazil, West Indies, and the Sandwich Islands.

DICTYOTA Lamouroux.

Frond flattened, ribless, dichotomous. Two strata of cells, the inner (medullary) of parallelepipedal large empty cells in a single layer, the external (cortical) of minute cubical or elongate cells, stuffed with dark-brown endochrome. All the reproductive cells derived from the cortex, oogonia in spot-like sori, of larger cells; antheridia minute in sori of hyaline cells arranged perpendicularly to the surface; tetraspores scattered,

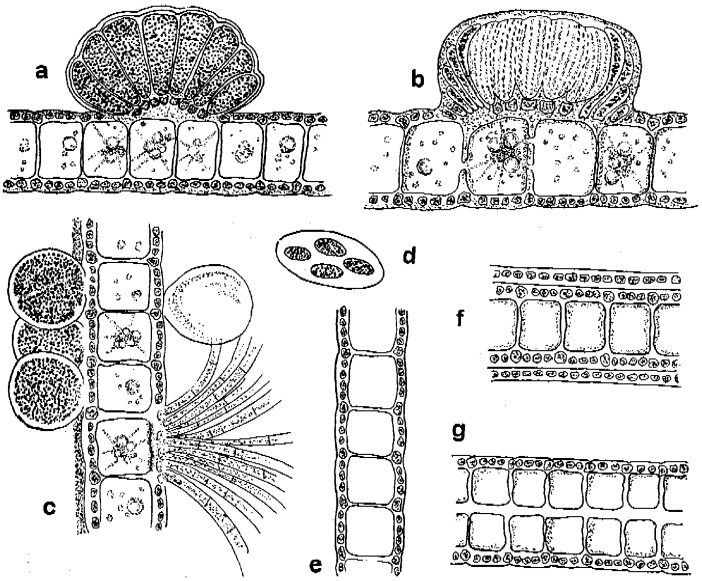

Fig. 50.—(a-e) *Dictyota*; **(a) female sorus; (b) male sorus; (c) Sporangia and hairs; (d) tetraspore; (e) cross section of** *Dictyota*; **(f) cross section of** *Pachydictyon*; **(g) cross section of** *Dilophus*

cruciately divided—all on different individuals. Colour olive-brown, becoming verdigris green when exposed to the air and sun or fresh water.

There are 19 known Australian species. Of these the following are selected as occurring, or likely to occur, in South Australia.

Dictyota latifolia J. Agardh.

Frond about 30 cm. high, dark-brown coloured, inclined to blacken when dried, with filiform attachment, cuneate stipes and few dichotomous lobes 2.5 to 5 cm. wide, at length covered on the surface by tongue-like prolifications. Spores scattered over the surface.

Investigator Strait.

Dictyota vittarioides J. Agardh.

Like the preceding but with long narrow and rather simple divisions.

Encounter Bay.

Dictyota dichotoma (Huds.) Lamouroux.

Frond scarcely stupose at the base, dichotomous, spreading, apices forked. Spores scattered over the disk of the frond, leaving a clear border on the margin. Surface smooth without prolifications.

World-wide.

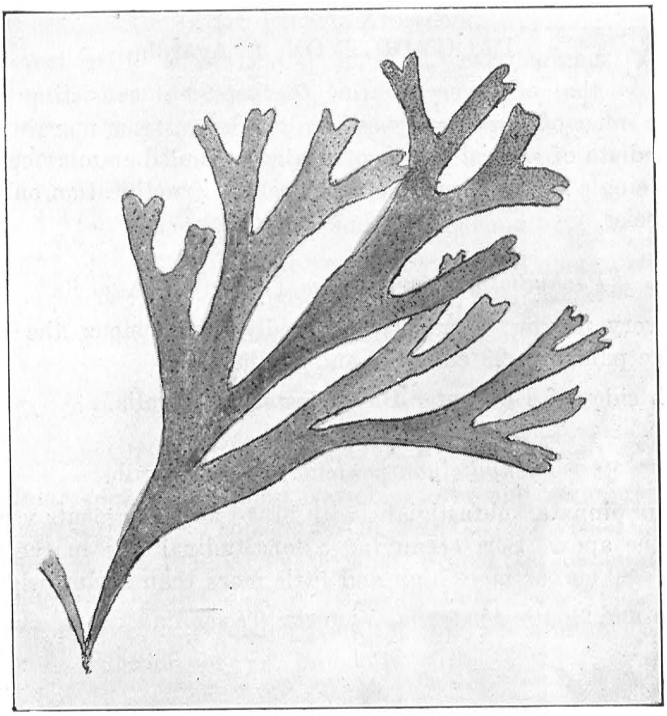

Fig. 51.—Branch of *Dictyota dichotoma.*

Dictyota ocellata J. Agardh.

Stipes stupose, frond dichotomous, rather thick and firm, segments linear. Spores scattered over the frond.

Investigator Strait.

Dictyota radicans Harvey.

Attached by many long simple thread-like fibres, proceeding partly from the base of the frond, and partly from the lower parts of the principal rachides, the fibres as thick as hogs' bristles and from 2.5 to 7.5 cm. long. Frond irregularly dichotomous with blunt axils and tips, markedly fenestrate. Sori of spores linear, longitudinal.

Western Australia, South Australia (Encounter Bay), Tropical Australia and Tongatabu.

Dictyota polyclada Kuetzing.

Frond small, supradecompound, below linear, with lateral fastigiate-dichotomous pinnae; segments numerous, very short, close together, capillary, patent.

Spencer Gulf, collected by Tepper.

PACHYDICTYON J. Agardh.

Frond like that of a very narrow *Dictyota,* but consisting in 3 strata of cells, an inner of large empty cells in one layer, from margin to margin, an intermediate of several layers of similar rounded-angular cells, and an outer of a single layer of small coloured cells. Fructification only observed in one species.

Pachydictyon furcellatum (Harv.) J. Agardh.

Frond very narrow, regularly repeatedly dichotomous, the axils wide, the laciniae patent to 25 cm. long and 2 mm. wide.

On both sides of Encounter Bay, Western Australia.

Pachydictyon paniculatum J. Agardh.

Frond subpinnate, subfastigiate, with broad axils, segments very narrow, zoned at the apex. Sori occupying a longitudinal line in the middle of the frond. 30 cm. or more high and little more than 2 mm. wide.

Western and South Australia, Victoria, Tasmania.

DILOPHUS J. Agardh.

Resembling *Dictyota* but constituted of two strata, the interior of 2 or more layers of squared colourless empty cells, and the outer of a single layer of small coloured cells. Spores scattered or in minute sori.

Of the eleven species found in Australia, two only have been recorded from South Australia.

Dilophus marginatus J. Agardh.

Frond caespitose, attached by radicles to shells or stones near low water mark, decompound dichotomous with linear erect segments, the terminal rounded obtuse. To 9 cm. high. The adult fronds are marked with conspicuous transverse wrinkles. Small spores grouped in quadrate sori arranged in a broad broken median series. The margins of the frond are thickened, the inner stratum of the lamina there consisting of four layers.

South Australia, Victoria to Twofold Bay in New South Wales.

Dilophus fastigiatus (Sond.) J. Agardh.

Frond stupose at the scutate base, broadly linear with distant dichotomies, segments erect, spreading, not wrinkled, apices obtuse. Spores solitary, scattered. To 15 cm. high.

Western Australia, South Australia, Victoria.

LOBOSPIRA Areschoug.

Frond erect with a branching holdfast, cartilaginous, compressed, spirally twisted, alternately pinnate, linear, the ultimate segments bicuspid. Spores scattered over the faces of the segments, round, each contained in a hyaline perispore. The one species.

Lobospira bicuspidata Areschoug.

To 45 cm. high. Wiry, spirally much twisted. Colour greenish-olive, becoming verdigris green on exposure to air or fresh water.

Western and South Australia and Victoria.

Order **PHAEOZOOSPORINAE.**

Multicellular plants of a most variable form and structure including many diverse Families. Propagation by vegetative division of the cells, by fragments of the thallus, by peculiar propagula, or by active cells (phaeozoospores).

Generation by zygotes resulting from the copulation of phaeozoogonidia, or by the fecundation of an immobile oosphere by a smaller male phaeozoogamete.

Family LAMINARIACEAE.

(Australian.) Large plants with a stout stem and broad lamina. The growing point, which is not situated in the apex of the lamina, consists of an intercalary meristem situated at the junction of blade and stem, which accordingly increase in opposite directions. The structure is elaborate; the epidermal layer consists of slightly elongate cells containing chromatophores and forms the assimilative tissue, as well as the meristem for secondary growth; within this, forming the greater part of the lamina and much of the stem, is a parenchymatous layer of thin-walled cells; bordering this internally there occurs in the stalk another layer of elongate cells with pitted walls, recalling the wood cells of trees, and the inner wall of this develops sieve-tubes; in the central axis of the stem there is a dense plexus of branching anastomosing fibres, which probably acts as a conducting tissue (Murray).

The reproductive cells are zoospores produced in elongate sac-like unilocular sporangia grouped in more or less localized sori accompanied by paraphyses. The sporangia appear on the surface of the thallus and not in conceptacles as in the Cyclosporinae.

The Order is represented by multitudes of genera and species in the colder Northern Hemisphere. In Australian waters only three genera occur—*Ecklonia, Macrocystis,* and *Lessonia* (Tasmania only).

The plants are useful from the supply of iodine which they afford.

ECKLONIA Hornemann.

Attached by a much-branched holdfast. Stipes simple, elongate; lamina pinnatifid, ribless, broad. Unilocular sporangia, elongate-ellipsoid, accompanied by inarticulate simple club-shaped paraphyses, forming sori in the lower parts of the pinnae.

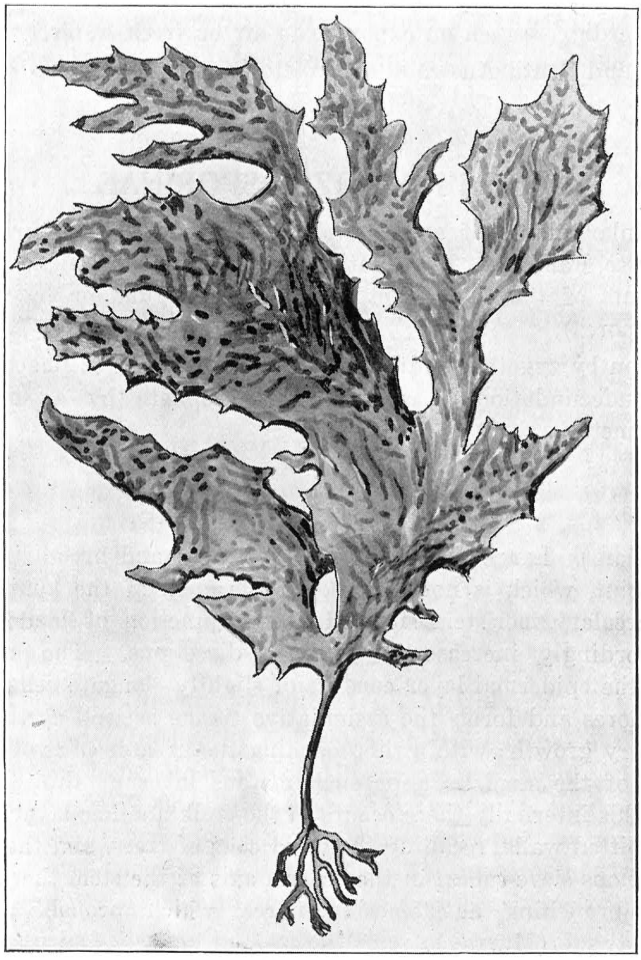

Fig. 52.—*Ecklonia radiata.*

Ecklonia radiata (Turn.) J. Agardh.

Stipes 8 to 50 cm. long, to 1 cm. thick, having beneath the cortex a circle of muciferous lacunae; lamina to 8 cm. long, the apex decaying, the median part to 8 cm. wide, with numerous linear pinnae, narrowed at base and apex, the upper ones to 55 cm. long, all armed at the margin with triangular spines. In harbour forms the surface is smooth, in ocean forms (var. *exasperata*) the surface is prickly with spines similar to those of the margins.

All Southern Australia, Tasmania, New Zealand.

Ecklonia lanciloba Sonder.

Stipes slender, lamina elongate bearing horizontal linear-lanceolate pinnae, undivided with spinose-dentate margins.

Rivoli Bay (F. v. Mueller).

MACROCYSTIS C. Agardh.

The giant among the Kelps, and indeed of all plants, the stems growing to hundreds of feet in length. Attached by a much branched holdfast with a sucking disk at the end of each branch. The cylindrical stems come off from the upper part of the base, at first a little branched, then simple spreading in long trails through the water. The plants are caespitose and form submarine forests or thickets. The long stems bear leaves formed by the splitting of a broad primary terminal leaf, and developed in one-sided (secund) order along the lengthening stem. Each leaf with a petiole, inflated above into an elongated vesicle and bearing at its apex a long simple often plicate-rugose flattened lamina. The terminal growing segment of the stem splits at the base into a succession of leaves with petiole and vesicle below and lamina above. The splitting continues upward till the leaves are freed. Each lamina tapers at base and apex, and is bordered with rather distant cilia. The structure of the stem shows a thin cortex, an intermediate zone hollowed out into muciferous lacunae, and a medulla of stouter and slenderer filaments intermixed. The sporangia occur in submerged leaves near the holdfast, forming spots or sori of varying form; they are accompanied by unicellular club-shaped paraphyses.

Macrocystis pyrifera (Turn.) Agardh.

Stem, as observed in Australia, 9 to 30 metres long, slender, to 4 mm. in diameter, bearing leaves on one side, spaced at distances of from 5 to 30 cm., 60 to 120 cm. long and 5 to 7.5 cm. wide, undulate-furrowed. Vesicles ultimately 10 to 13 cm. long. From whatever depth the plants vegetate,

the stem grows obliquely to the surface, where its leaves are buoyed by their vesicles, and it often stretches horizontally along the waves for many fathoms.

The southern coast of Australia, especially in the east, Tasmania. Widely distributed in the colder waters of the Pacific, California to Cape Horn.

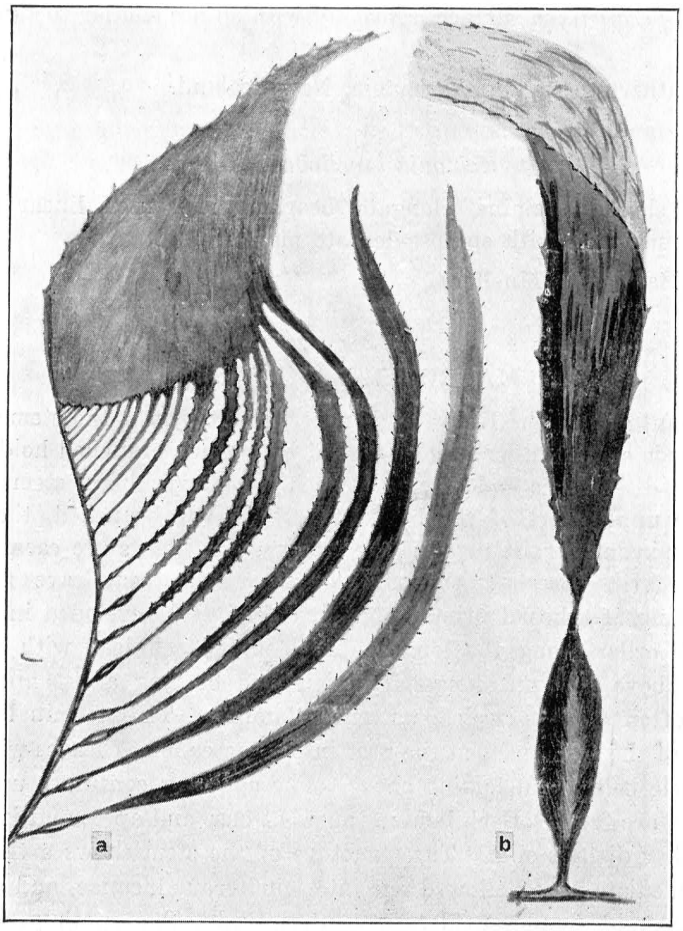

Fig. 53.—*Macrocystis pyrifera*—(a) terminal primary segment, splitting into lateral leaves; (b) lateral adult leaf with float.

Family SPOROCHNACEAE.

The most elegant members of the Brown Seaweeds, with a filiform thallus of considerable size, diversity and beauty of form. The lower part of the frond is parenchymatous, but the upper cells in rows free from one another. The reproductive organs occur in clusters (sori) as obovate or ellipsoid unilocular sporangia, borne on slender branching filaments.

KEY TO THE GENERA.

a. Sporangiferous threads girding definite regions of the thallus ringwise. These regions appear in consequence swollen.

b. Frond umbellately branching, the extremities bearing loose heads of pencils .. *Bellotia* Harvey.

bb. Frond racemosely branched, the extremities bearing tufted pencils. Sporangiferous regions along the main rachides in long patches .. .. *Encyothalia* Harvey.

bbb. Frond racemosely branched, coarse, forming a horsetail. Sporangiferous regions terminating the axes, elongate . .. .. *Perithalia* J. Agardh.

aa. Sporangiferous threads rising under the tips of the branches.

c. Sporangiferous regions cylindrical, globose or club-shaped, beneath pencils of deciduous hairs .. .. *Sporochnus* C. Agardh.

cc. Sporangiferous regions shortly conoid or mitriform. No pencils of plumes . .. *Carpomitra* Kuetzing.

BELLOTIA Harvey.

Frond filiform, solid, repeatedly umbellately branched, the branches crowned with a tuft of penicillate filaments. Sporangiferous receptacle solitary in each branch, cylindrical, surrounding the middle portion of the branch, composed of simple vertical, densely crowded filaments. Spores borne laterally on the filaments, oblong, transversely striate.

Bellotia eriophorum Harvey.

Fronds many from the same base, 30 to 60 cm. high, twice as thick as a hog's bristle, twice or thrice umbellately decompound. Umbels with 20 to 30 rays each 5 to 10 cm. long, the summits crowned with a dense globular penicillate tuft of slender jointed filaments, the tuft 12 to 19 mm. in diameter.

It grows in deeper water but is often cast up by storms. It occurs on both sides of Bass Strait. I have not seen it from west of Port Fairy, but it is to be hoped that it will be met with off Cape Northumberland.

Curiously, during the last year I have received specimens of what must be a second species, quite simple, 10 cm. high, with no trace of branching but with the structure and fructification of *Bellotia*, including the fluffy terminal heads. The plants were dredged by Mr. F. A. McNeill in eight fathoms of water, on the Barrier Reef.

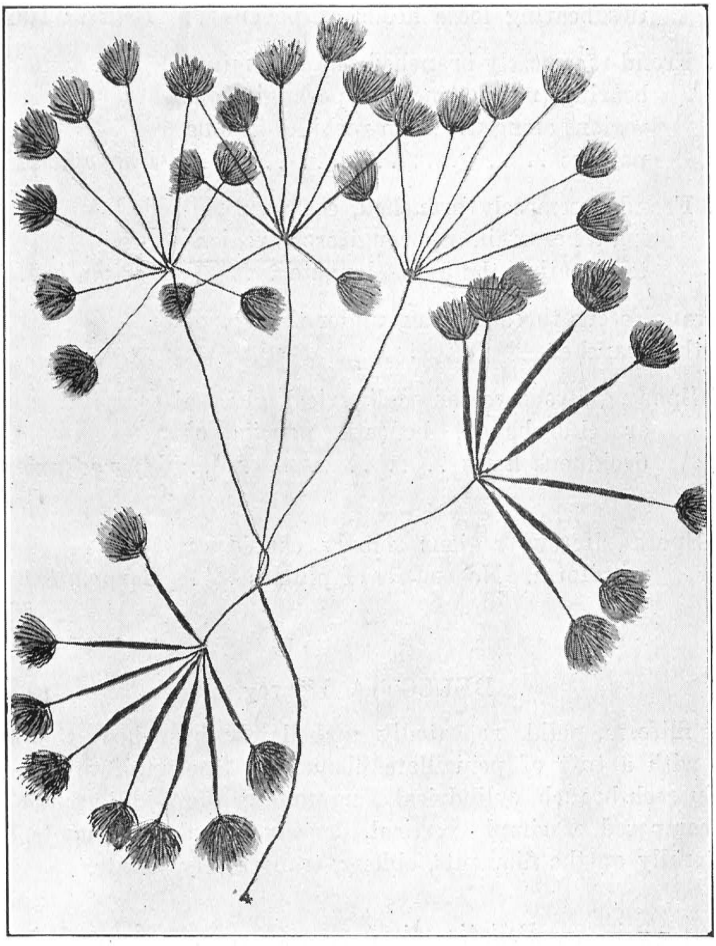

Fig. 54.—*Bellotia eriophorum.*

ENCYOTHALIA Harvey.

Frond filiform, solid, alternately branched; branches beset with penicillate setaceous ramuli. Receptacles one or two in each branch, cylindrical, investing median sections of the branch, and consisting of simple, vertical, densely crowded filaments, bearing unilocular sporangia laterally. Sporangia oblong, transversely striated.

Encyothalia Cliftoni Harvey.

The single species. Fronds 30 to 60 cm. long, closely beset with racemosely arranged setaceous ramuli, 6 to 12 mm. long, crowned with a dense pencil of very slender, jointed, soft filaments, which at length fall away. Colour of branches and fruit dark-olive, of the confervoid filaments paler.

Western and South Australia.

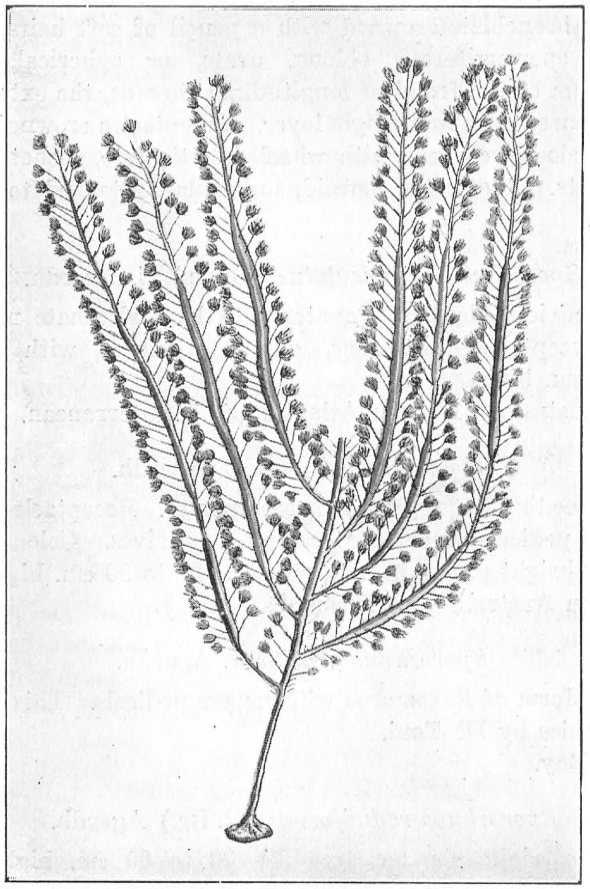

Fig. 55.—*Encyothalia Cliftoni.*

PERITHALIA J. Agardh.

Frond caulescent, filiform, alternately branched, branches long, virgate, crowded with setaceous ramuli not crowned with tufts of hairs. Receptacles evolved in ultimate ramuli, like the spike of *Typha,* oblong-cylindrical, composed of crowded sporangiferous filaments. No plumed heads. In another stage the filiform ramuli end in minute unplumed heads.

Perithalia inermis (R. Br.) J. Agardh.

Frond 30 to 60 cm. high, bushy, resembling a disciplinary birch. Stems clothed near base with brownish woolly filaments, and rough from remains of broken-off branches. Colour a clear brownish olive. Substance wiry.

South Australia, Victoria, Tasmania.

SPOROCHNUS C. Agardh.

Frond filiform, solid, pinnately decompound. Holdfast a conical disk. Apices of the branchlets crowned with a pencil of soft hairs, later transformed into sporangiferous oblong, ovate, or spherical, receptacles. Interior stratum of the frond of longitudinal threads, the exterior stratum of minute coloured cells in a single layer. Receptacles crowned with a tuft of hairs, and closely covered with whorled, articulate, dichotomous, sporiferous filaments. Sporangia obovoid, unilocular, attached to the sides of the filaments.

Sporochnus pedunculatus (Huds.) C. Agardh.

Frond cylindrical, densely pinnate, with long alternate mostly simple branches. Receptacles numerous, obovate-ellipsoid, with rather long pedicels. 20 cm. high.

Southern Australia. Eastern Atlantic and Mediterranean.

Sporochnus comosus C. Agardh.

Like the preceding but repeatedly decompound. Receptacles club-shaped cylindrical on pedicels much shorter than themselves. Colour olive-green, of the plumes bright green, in both species. 30 to 90 cm. high.

All Southern Australia and Tasmania.

Sporochnus gracilis J. Agardh.

A slenderer form of *S. comosus* with longer pedicels. This is not recognised as a species by De Toni.

Encounter Bay.

Sporochnus radiciformis (R. Br.) Agardh.

Frond terete, rigid, slender, tree-like, 30 to 60 cm. high. Branches decompound spreading every way. Receptacles spherical or oval, on pedicels much longer than themselves.

West and South coasts of Australia, Tasmania.

Sporochnus scoparius Harvey.

Frond terete, rigid, robust, coated to a considerable degree with velvety hairs, tree-like with stiff erect branches, 30 to 90 cm. high. Receptacles as in *S. radiciformis*. A much coarser plant than the preceding, with a large hairy attachment.

Western and South Australia, Victoria.

CARPOMITRA Kuetzing.

Frond filiform, compressed, midribbed, irregularly dichotomous. Axis of the frond of three strata, an interior of smaller cells forming the midrib, an intermediate of larger cylindrical empty cells running longitudinally, an outer of minute coloured cells in a single layer. Fruit formed on the thickened apex of the midribs of the branches, mitriform, minutely capitate, having a densely cellular cylindrical central axis, round which branching horizontal articulated filaments are whorled. The lower joints of the filaments slender, the upper beaded, and the terminal oblately ellipsoidal contains minute bodies (? antheridia). Unilocular sporangia pedicellate, linear-eliptical, are borne towards the base of the whorled filaments.

Carpomitra mitriformis.

Tasmania, ? South Australia, and Victoria. New Zealand. Mediterranean.

Family STILOPHORACEAE.

STILOPHORA J. Agardh.

Frond filiform, gelatinous-cartilaginous, irregularly branched. Structure radial, growth apical. A central axis formed of 4 or 5 series of cells, all tending to the apical growing point; the cortex investing the axis parenchymatous of few layers. The frond clothed with tufts of olive-green assimilating filaments. Sporangia of two kinds, unilocular obovate or clavate, plurilocular filiform with locellae in a single row.

Stilophora australis Harvey.

Frond to 20 cm. high, 1 mm. thick. Stem elongate, carrying branches alternately and distichously to the apex. Sporangiferous warts elliptical, scattered. Olive-green.

Encounter Bay, Victoria, Tasmania.

Family CHORDARIACEAE.

A rather ill-defined Family, an assemblage of very varied forms, which, however, agree in the possession of a markedly slimy thallus, in the formation of both unilocular and plurilocular sporangia. Some have semiglobose thalli and others are lubricous erect thick worm-like fronds. The former group includes *Corynophloea* and *Leathesia,* both met with in South Australia, and the latter, *Eudesme, Bactrophora, Cladosiphon,* and *Chordaria,* which are not uncommon on the southern coasts of Australia, and Tasmania but have not yet been recorded from South Australia.

Of the rope or worm-like genera it will be sufficient to say that they consist of an axis of elongated colourless cells surrounded by a cortex of horizontally radiating branching coloured cells, which serve as assimilators, and among which are produced both unilocular and plurilocular sporangia.

CORYNOPHLOEA Kuetzing.

Frond subglobose, constituted of a shortened axis and peripheric radiating threads. The axis of cylindro-oblong roughly parallel compacted longitudinal cells. The peripheric threads, emerging from rounded cells of the axis, elongated, beaded, serving the purposes of assimilation, and some transformed into plurilocular sporangia. Unilocular sporangia obovate-oblong at the base of the peripheric threads.

Corynophloea cystophorae J. Agardh.

Greenish-yellow globules of the size of a pea, epiphytic on the branches of *Cystophora*.

South Australia (Encounter Bay).

LEATHESIA Gray.

Thallus growing centrifugally, at first globose and solid, later irregularly lobed and hollow, fleshy gelatinous, composed of an inner short axis of oblong cells radiating into decompound forked threads, and peripheric threads proceeding from the smaller outer cells of the axis, immersed in mucus, and with club-shaped apices. Plurilocular sporangia ellipsoid or pear-shaped, unilocular sporangia filiform, jointed, of one column of locelli, both at the base of the peripheric threads.

Leathesia difformis (L.) Areschoug.

Metallic green, shining, irregularly globose, hollow sacs of varying size up to 5 cm. in diameter, scattered over rocks exposed at low water.

South coast of Australia, Tasmania.

It is doubtful if our Australian plants conform with the Linnean species which, however, is of wide distribution, in the North Atlantic of both Europe and America, in the Pacific, in Japan, and doubtfully the same at the Cape of Good Hope. It is a striking green colour.

Family ENCOELIACEAE.

An assemblage of remarkably diverse forms, filamentous, laminate, frondose, club-shaped, intestinal, saccate, tubular or hollow or retiform, but all of parenchymatous structure and intercalary growth with no definite growing point. They reproduce from unilocular and plurilocular sporangia arising by the differentiation of a superficial cell or of an outgrowth from one.

PUNCTARIA Greville.

Thallus leaf-like, unbranched, stipitate, of 4 to 7 cellular strata, with a pile of hairs. Unilocular sporangia scattered, plurilocular sporangia collected in spots, shortly prismatic, papillose at the apex, with several series of locelli in the column.

Punctaria latifolia Greville.

Fronds from a minute disc, often caespitose, up to 30 cm. high, to 7.5 cm. wide, lanceolate or oblong, membranaceous and semi-pellucid, green or olivaceous. Sori in spots.

South Australia and Victoria. World-wide.

SCYTOSIPHON C. Agardh.

Frond cylindrical, simple, unbranched, tubular, of two strata, of interior cylindrical and exterior rounded-angular cells. Plurilocular sporangia occupying now a continuous area, now forming spots, cylindrical of one row of locelli.

Scytosiphon lomentarius (Lyngb.) J. Agardh.

Frond intestiniform, sometimes articulately constricted (*i.e.*, with swollen interstices), 15 to 25 cm. or more long, narrow, 1 to 4 mm. wide. Pale brown. Sporangia accompanied by paraphyses.

World-wide in distribution. Around the coast of Australia from at least Fremantle to Sydney.

COLPOMENIA Derbes and Solander.

Frond saclike, hollow, the walls of the sac composed of two strata, the inner of a few layers of larger rounded cells, the outer of a single layer of minute angular cells. Plurilocular sporangia forming small sori dotted over the surface, cylindrical-prismatic, accompanied by one-celled paraphyses. Unilocular not observed.

Colpomenia sinuosa (Roth) Derbes and Solander.

Pale-brown bladders growing without stipes by a broad attachment to rocks near low water. They may reach the size of a man's head, and attached to young oysters may lift them and float away to distant quarters, so as at times to be a serious pest to oyster culture.

In all seas except the coldest.

HYDROCLATHRUS Bory.

Frond as in *Colpomenia,* not continuous but forming an open meshwork. Plurilocular sporangia not in sori but scattered over the whole frond.

Hydroclathrus cancellatus Bory.

Dark-brown nets, stipitate below, widely expanded, to 15 cm. in diameter.

It prefers warmer seas but occurs in South Australia and Victoria, though not in Tasmania. Common in the tropics.

ASPEROCOCCUS Lamouroux.

Frond hollow, intestiniform or flattened, stipitate. The wall of the frond consisting of a few layers of cells decreasing in size outwards. The interior space is traversed here and there by jointed slender filaments. Unilocular sporangia globose, accompanied by few-jointed paraphyses, densely distributed over the surface. Plurilocular sporangia ovoid or ellipsoid, crowded in sori.

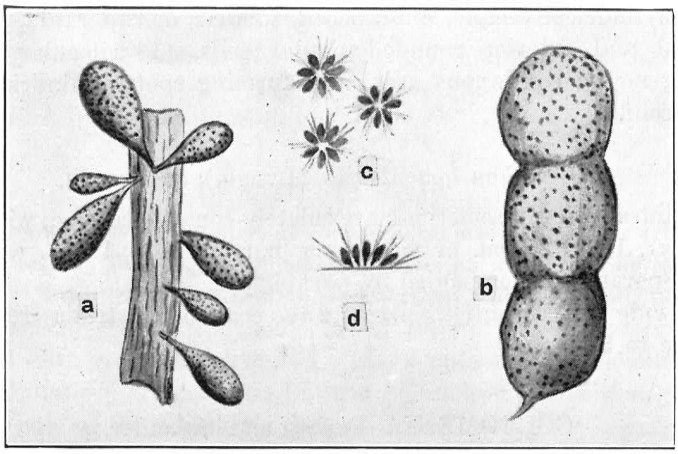

Fig. 56.—*Asperococcus bullosus*—(a) young plants growing on *Posidonia* with sori; (b) adult plant with sori; (c) three sori; (d) section of sorus.

Asperococcus bullosus Lamouroux.

Fronds attenuated at base, swelling out into gut-like elongated sacs, often constricted into segments. Sori small dotted over the surface. To 30 cm. high and 2.5 cm. in diameter. Dark greenish-olive.

World-wide. All the southern coast of Australia, Tasmania.

Family SPHACELARIACEAE.

Fronds caespitose, erect, polysiphonious. Parenchymatous structure, lengthening by divisions of an apical cell. Sporangia formed in place of ramuli, or of the joints of ramuli. Unilocular sporangia ovate or subglobose, plurilocular obovoid or cylindrical with several rows of locelli. Occasional propagation by gemmae, short detached branches.

SPHACELARIA Lyngby.

Small plants 5 to 20 mm. high, attached to rocks or shells by a basal disc, or parasitic on other algae. Both unilocular and plurilocular sporangia, without paraphyses.

Sphacelaria furcigera Kuetzing.

Densely caespitose, 2 to 10 mm. high, epiphytic, axes irregularly branching. Propagula (gemmae) repeatedly forked. Globose unilocular sporangia, ovoid-cylindrical plurilocular sporangia borne on a pedicel.

Red Sea, Indian and Pacific Oceans. Dirk Hartog Island, Western Australia. Cape York, Queensland. South Australia, determined by Reinbold.

CLADOSTEPHUS J. Agardh.

Frond filiform, virgate, branching, clothed with verticils of short, articulate, polysiphonious ramuli, composed of three strata of cells, an axial of longitudinally prismatic cells, an intermediate of larger rounded-angulate cells, and a cortical of minute rounded cells. Unilocular sporangia globose, plurilocular ovoid.

Cladostephus spongiosus (Lightf.) J. Agardh.

Frond irregularly decompound-dichotomous; ramuli short, simple, not regularly whorled, densely imbricate. Height to 15 cm.

Cladostephus verticillatus (Lightf.) J. Agardh.

Frond decompound forked, ramuli strongly incurved, more or less distantly whorled. Height to 13 cm.

Both widely distributed. The former recorded from South Australia, and the latter may be confidently expected.

STYPOCAULON Kuetzing.

Frond stiff, treelike; below densely corticated with descending radical filaments, much branching. Structure parenchymatous, formed by divisions of an apical cell. Fertile branches evolving from an axillary cell a multicellular branch from which both kinds of sporangia grow, which become congested in a dense sorus.

Stypocaulon paniculatum (Suhr.) Kuetzing.

Frond notably stupose, to 20 cm. or more high, harsh and stiff. Fruits, 3 or 4, aggregated in the axils.

All southern Australia and Tasmania, New Zealand, Cape of Good Hope.

Stypocaulon funiculare (Mont.) Kuetzing.

Frond stupose, coalescent, naked near the base. Dioecious, pedicellate sporangia, unilocular subglobose, plurilocular ovoid, larger. Not so tall as preceding.

Southern coasts of South America. New Zealand. Recognised by Reinbold in Dr. Engelhardt's material from Guichen and Rivoli Bays, South Australia.

Family ECTOCARPACEAE.

Frond filiform, more or less branching, mostly of one row of cells, the growth in length produced by intercalary division of the cells. Mostly epiphytic but sometimes attached to rocks. Reproductive organs, unilocular and plurilocular sporangia, occupying the place of ramuli, or immersed and formed from the vegetative cells.

ECTOCARPUS Lyngby.

Fronds filiform, branched, articulated (something of the habit of *Cladophora*). Sporangia external, occupying singly the place of lateral

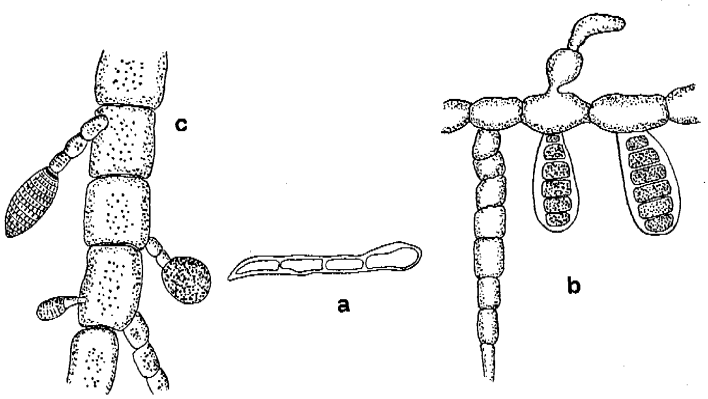

Fig. 57.—*Ectocarpus*.—Germination of swarmspores from plurilocular sporangium—(a) shoot of five days' growth; (b) part of shoot after eighteen days (after Kylin); (c) portion of mature plant of *Ectocarpus confervoides* with one unilocular and one plurilocular sporangium. All much enlarged.

ramuli. Unilocular sporangia globose or ellipsoid, with an apical pore. Plurilocular sporangia ovoid or pod-like, with several longitudinal rows of locelli.

Ectocarpus siliculosus (Dillw.) Lyngby.

Fronds flaccid, at first affixed, then free floating. Dull green. Unilocular ovoid, sessile or with a short pedicel of one joint. Plurilocular conoid-subulate, often terminating in a hair. To 30 cm. high, yellowish brown olive in colour. Monoecious.

Ectocarpus confervoides (Roth) LeJol.

Very like the preceding and hard to distinguish from it. Always affixed. Plurilocular sporangia not terminating in a hair, shortly subulate or fusiform.

Both species are cosmopolitan and may be found anywhere.