Setchall, Wm. Albert. 1925

THE MARINE ALGAE OF THE PACIFIC COAST OF NORTH AMERICA

PART III

MELANOPHYCEAE

BY

WILLIAM ALBERT SETCHELL

AND

NATHANIEL LYON GARDNER

UNIVERSITY OF CALIFORNIA PUBLICATIONS IN BOTANY
Vol. 8, Part III, pp. 383-898, plates 34-107

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY, CALIFORNIA
1925

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BOTANY.—W. A. Setchell and R. M. Holman, Editors. Price per volume, $3.50 (vol. 5, $6.00); beginning with volume 6, $5.00. Volumes I, II, III, IV, V, VI, VII, and IX completed. Volumes VIII, X, XI, XII, and XIII in progress.

Cited as Univ. Calif. Publ. Bot.

Vol. 5. 1912–1922.

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University of California Publications in
BOTANY

VOLUME VIII

PART III

1925

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R. M. HOLMAN

EDITORS

UNIVERSITY OF CALIFORNIA PRESS

BERKELEY, CALIFORNIA

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Vol. 8, Part III, pp. 383–898, plates 34–107
Issued June 26, 1925

The University of California Press
Berkeley, California

The Cambridge University Press
London, England

CONTENTS

The third part of the Marine Algae of the Pacific Coast of North America, comprising an account of the Melanophyceae or Brown Algae, succeeding the accounts of the Myxophyceae and Chlorophyceae, is presented without introduction or explanation, pending the publication of the final part, which is in advanced preparation. It is intended to issue with the completed volumes a statement as to the principles followed, methods used, territory covered, sources of information, material, etc., as well as to make acknowledgment to the various authorities, students and collaborators who have been of the greatest assistance in carrying out the long and laborious task.

W. A. Setchell and N. L. Gardner.

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SUBCLASS 3. MELANOPHYCEAE STIZ.

Multicellular thallophytes containing the green pigment, chlorophyll (including xanthophyll), and the brown pigment, phycophaein; thallus varying from simple or slightly branched filaments of a single row of cells and simple membranes varying from a single layer to several layers of similar cells, to solid plant bodies of varying form, e.g., membranous, crustaceous, globular, hemispherical, filamentous, etc., and with differentiated internal and external tissues; cells with distinct cell walls, cytoplasm, at least the outer cells containing definite chromatophores, carrying the pigments, and typically uninucleate, although at times becoming multinucleate; assimilation products various carbohydrates and oils, but never true starch; internal cells in more complex forms elongated and forming definite mechanical conducting and storage systems as distinct from the outer tissues of absorbing and assimilating cells; multiplication by splitting and by gemmae of more or less distinctive form; reproduction by both motile and non-motile cells, motile cells with one or two lateral, or at least subapical, cilia; non-sexual reproduction by 2-ciliated zoospores or by aplanospores (Dictyotales): sexual reproduction by the fusion of two equal, or of two unequal, motile gametes, or by the fusion of a smaller motile 2-ciliated sperm and a larger non-motile egg (Laminariales and Fucales) or by the fusion of a smaller 1-ciliated sperm and a larger non-motile egg (Dictyotales); an antithetic alternation of generations present in many, if not all, species; gametophytes usually unisexual, similar to, up to extremely different from, the sporophytes.

Melanophyceae Stizenberger, Dr. Ludwig Rabenhorst's Algen Sachsens, 1860, p. 36; Rabenhorst, Flora Eur. Alg., vol. 3, 1868, p. 393. *Fucoideae* Agardh, Syn. Alg. Scand., 1817, p. IX. *Melanospermeae* Harvey, *in* Mackay, Flora Hibern., part III, 1836, p. 157;

Gen. So. African Plants, 1838, p. 393. *Phaeophyceae* Kjellman, *in* Engler and Prantl, Die natürl. Pflanzenfam., Teil 1, Abt. 2 (Lief. 60), 1891, p. 176.

The Melanophyceae, or Brown Algae, are, with very few exceptions, marine and are, properly, all multicellular. We feel convinced that the termination *-phyceae* should be retained for the subclasses of the class Algae, or Phycophyta. Since Stizenberger's Melanophyceae, 1860, applies to the same group of plants as does Kjellman's Phaeophyceae, 1891, and since Stizenberger's term seems equally applicable, we have chosen it in preference to Kjellman's, even though Phaeophyceae is at present in general use. The Melanophyceae are much more complex in both structure and reproductive processes than are the Chlorophyceae or the Myxophyceae. In size, they range from minute disks to plants of considerable size, reaching among the kelps to a length of possibly 100 meters or longer. It has seemed the more natural to restrict the Melanophyceae to the multicellular forms than to include the unicellular forms with chlorophyll and a brown pigment. The Bacillariales, or Diatoms, and the Peridiniales, as well as certain groups of the Flagellates, even if they may be regarded as belonging to the vegetable kingdom, seem to have no characters that would associate them with the Melanophyceae except the possession of a similar brown pigment.

The Melanophyceae are, with few exceptions, viz., *Phaeosaccion* Farlow and *Omphalophyllum* Rosenvinge, provided with specialized zoosporangia or with gametangia or with both. In one order, viz., Dictyotales, the non-sexual spores are always motionless.

There is an antithetic alternation of generations in most of the groups of the Melanophyceae, the Fucales being the only order in which it is certainly absent, where the sporophyte generation of this order is considered as represented by the products of the division of the oogonial cell. In the Sphacelariales and the Ectocarpales it is not so clearly proved as yet, but Kylin (1918) has demonstrated reduction divisions of the primary nucleus of the zoosporangium in certain species. The two generations in both of these orders are alike in size. We find species, however, in which the gametophyte is microscopic, in striking contrast to the large, often even gigantic, sporophyte. The same relation between gametophyte and sporophyte is suspected, but not yet observed, in the Desmarestiales, Chordariales, and Dictyosiphonales. In the Cutleriales the two generations may be similar or dissimilar, while in the Dictyotales they are similar in size and vegetative structure.

The classification of the Melanophyceae is in a very unsatisfactory condition, that of Kjellman (1891) and that of Oltmanns (1904) seeming very imperfect, especially since the later studies of Sauvageau, Kylin, and others have changed our views in so many important respects. The more recent classifications of Kylin (1917), of Oltmanns (1922) and of William Randolph Taylor (1922) have assisted greatly toward a more natural arrangement. We have therefore adopted many of the views of Kylin (1917) and of Oltmanns (1922) and have incorporated some additional ideas of our own. Oltmanns has divided the subclass into seven orders. In this, we are inclined to follow him, but think it better to regard some of the other divisions also as of equal rank with these. According to our scheme, the Melanophyceae of the Pacific Coast of North America are arranged in the following manner:

Key to the Series

1. Reproduction sexual only........3. **Cyclosporeae** (p. 662)
1. Reproduction both sexual and non-sexual........2
    2. Aplanospores present........2. **Aplanosporeae** (p. 649)
    2. Aplanospores absent........1. **Phaeosporeae** (p. 389)

Series 1. PHAEOSPOREAE thuret

Thallus composed of simple or branching filaments either of a single row of cells (monosiphonous) or solid with diverse tissues or of simple or solid membranes, or cushion form, branched or unbranched, sometimes hollow, variously aggregated; non-sexual reproduction (where known) by zoospores with 2 lateral cilia produced in unilocular zoosporangia; aplanospores never present; gametangia plurilocular, or in one order (Laminariales) unilocular, male gametes motile, biciliated, female gametes motile and biciliated or non-motile; gametophyte and sporophyte similar or more or less dissimilar.

Phaeosporeae Thuret, Rech. sur les zoosp. I, 1850, p. 233 (p. 24, repr.); Kjellman, *in* Engler and Prantl, Natürl. Pflanzenfam., Teil 1, Abt. 2 (Lief. 60), 1891, p. 180 (in part); Oltmanns, Morph. und Biol. der Algen, vol. 1, 1904, p. 348. *Phaeozoosporeae* De-Toni, Syst. Uebers. Fucoid., 1891, p. 175. *Phaeosporales* Oltmanns, *loc. cit.*, p. 348.

The Phaeosporeae of Thuret have generally been regarded as constituting an order, but they seem to us rather to represent a series under the subclass Melanophyceae composed of the orders Sphacelariales, Ectocarpales, Cutleriales, Dictyosiphonales, Desmarestiales, and possibly also the Laminariales. The general characteristic is the occurrence of the typical brown zoospores of the Melanophyceae. These are, as yet, unknown in some genera and species of the series, while in others they occur but seldom. What our increasing knowledge may teach us concerning these seemingly exceptional forms must be left for future consideration. The typical members of the Phaeosporeae possess unilocular zoosporangia and plurilocular gametangia and have the gametophyte and sporophyte of very closely similar size and structure. Some scattering genera and species are only known to produce the unilocular zoosporangia, while others produce only the plurilocular gametangia, but, considering seemingly close affinities in these puzzling cases, it seems undesirable for the present, at least, to refer either elsewhere than to the Phaeosporeae. They may be found to represent either imperfect, or perhaps even dimorphic forms, when their development shall have been carefully studied. The Laminariales, which we still include under the Phaeosporeae, were long known only with unilocular sporangia producing biciliated zoospores, but have recently been found also to possess a microscopic gametophyte with decidedly modified (unilocular) gametangia producing either non-motile egg cells (or oospheres) or biciliated sperms. The Phaeosporeae may be distinguished from the Acinetosporeae by the lack of aplanospores, and from the Fucales by the possession of either known zoosporangia or plurilocular gametangia or both.

Key to the Orders

1. Gametangia present on macroscopic plants (zoosporangia known or unknown).... 2
1. Only zoosporangia present on macroscopic plants (gametangia known, or suspected of being, on microscopic plants)........ 3
    2. Terminal cell present and conspicuous........1. **Sphacelariales** (p. 390)
    2. Terminal cell, if present, at least not conspicuous..2. **Ectocarpales** (p. 398)
3. Growth of zoosporangial frond, strictly terminal...... 5. **Dictyosiphonales** (p. 586)
3. Growth of zoosporangial frond not strictly terminal........ 4
    4. Growth of zoosporangial frond trichothallic......3. **Desmarestiales** (p. 554)
    4. Growth of zoosporangial frond not trichothallic........ 5
5. Growth apical, from subapical cells........4. **Chordariales** (p. 570)
5. Growth never apical, either intermediate or near the base..6. **Laminariales** (p. 590)

Order 1. SPHACELARIALES Oltmanns

Filamentous, generally tufted and branched Phaeosporeae, rarely monosiphonous throughout, usually monosiphonous near or at the tips, becoming polysiphonous below through longitudinal walls, and in some cases corticated slightly or considerably by descending filaments, attached by horizontal rhizoids often cohering to form a disk, or, in some cases, arising early and forming a more or less complex horizontal thallus giving rise to the erect filaments; growth of each erect filament from a more or less conspicuous apical cell; older cell walls becoming dark colored when treated with eau de javelle; chromatophores numerous in each cell, usually disk-shaped; zoosporangia unilocular, large; gametangia plurilocular, similar or with some distinction as to size and number of loculi (mega- and meio-gametangia); zoosporangia and gametangia borne on separate (macroscopic) plants differing little, if at all, in size or complexity and formed from the transformed apical portions of usually short branchlets; propagula present and characteristic in certain species of Sphacelaria, arising from the transformation of lateral branchlets, producing a short stalked body with longer or shorter radiate terminal branches, the whole separating from the branch bearing it and developing into a new plant.

Sphacelariales Oltmanns, Morph. und Biol. der Algen, vol. 2, 1922, p. 83. *Sphacelariaceae* Reinke, Ber. d. deut. bot. Gesell., vol. 8, 1890, p. 203.

The Sphacelariales form a natural group, coördinate but distinct from the Ectocarpales in that all the species included take their growth from a conspicuous and very characteristic apical cell. The species are, also, more or less polysiphonous through longitudinal division walls, producing fronds unlike those of any of the species we have included under Ectocarpales. The cell wall is said to differ in composition, or constitution, from that of any of the species of Ectocarpales, in that, when older, it darkens when treated with eau de javelle, turning black in mature cells. The members of the Sphacelariales resemble those of the Ectocarpales in having unilocular zoosporangia and plurilocular gametangia on macroscopic plants closely resembling one another in size and structure. In some species the gametangia are differentiated into two types, megagametangia or oogonia with few and large loculi, and antheridia with numerous and small loculi. Oltmanns (*loc. cit.*, p. 85) divides the order into three families; Sphacelariaceae, Cladostephaceae, and Stypocaulonaceae, of which only the first, so far as we know, is represented on the west coast of North America.

FAMILY 1. SPHACELARIACEAE REINKE, EMEND. OLTMANNS

Thallus of erect filaments from a discoid or thalloid base, monosiphonous at the tip or throughout, polysiphonous and, at times, corticated below; apical cell short, but conspicuous, not giving rise directly to the initials of the branches, but these arising from the apical portion of a cell already segmented, and usually situated at some distance below the apical cell; branches variously arranged, alternate and distichous or polystichous, or, at times, opposite and distichous, occasionally distinguished into two sets, long (indefinite) axes and short (definite) axes, but the latter never in regular whorls; otherwise as in the order; propagula formed on certain species of this family.

Sphacelariaceae Reinke, Ber. d. deut. bot. Gesell., vol. 8, 1890, p. 203 (in part); Oltmanns, Morph. und Biol. der Algen, vol. 2, 1922, p. 85.

On the west coast of North America are to be found few of the Sphacelariales and none is frequent. The specimens which have been found belong to the Sphacelariaceae. The *Cladostephus verticillatus* (Lightfoot) Ag., referred to the coasts of the Russian American possessions on the North Pacific Ocean (Postels and Ruprecht, 1840, p. 21) and apparently not in typical form, has not been seen since, so that it does not seem best to continue to include it as belonging to our flora.

Key to the Genera of the Sphacelariaceae

1. Zoosporangia and gametangia borne on the regular branches from the axis .... 1. **Sphacelaria** (p. 392)
1. Zoosporangia and gametangia borne on special branches arising from the corticating filaments .... 2. **Chaetopteris** (p. 397)

1. **Sphacelaria** Lyngb.

Fronds forming relatively small, usually profusely branched, more or less spherical or irregular tufts attached to the surface of rocks or to other algae by small disk-like or thalloid holdfasts, or penetrating into the substance of other plant bodies; the main axes and the branches terminated by an apical growing cell which divides crosswise, the resultant segments sooner or later dividing lengthwise and more or less obliquely, building up a polysiphonous frond, the surface layer of which consists of transverse bands of rectangular cells obscured below in corticating species; reproduction by unilocular zoosporangia and by plurilocular gametangia, and vegetative, by the formation and separation of propagula, or bulblet-like portions of the frond, produced on different individuals from the sporangia; zoosporangia and gametangia arising from the regular branches from the axes of the plant, not from special branches produced from corticating filaments.

Lyngbye, Hydrophyt. Dan., 1819, p. 103.

The genus *Sphacelaria* is composed of species attached in various ways to the substratum or host, but which lacks any pronounced dimorphism such as is to be found in some genera of the Sphacelariaceae. The erect filaments are always more or less branched and with one exception show primary vertical partitions of the cells over the greater extent of their axes and in certain species also show secondary transverse partitions. Hairs may be present or absent and simple or geminate. Rhizoids may, or may not, be present and may form cortications. Certain species produce propagula of distinctive form while others may lack them. The sporangia and gametangia are borne on the axes, never on the rhizoids as in *Chaetopteris*. The gametangia are plurilocular and all alike or differentiated into oogonia and antheridia.

Our species are few and not at all abundant or well known. Careful search for additional material is much to be desired. We have relied particularly upon Sauvageau's different papers collected under the general title of Remarques sur les Sphacélariacées (1900–1914) for guidance in the determination of our west coast forms. We have arranged the material accessible to us under six species, awaiting further opportunities for study and verification.

Key to the Species

1. Erect plants showing both primary transverse and longitudinal and regular secondary transverse partitions .... 1. **S. racemosa** (p. 393)
1. Erect plants showing, regularly, only primary transverse and longitudinal partitions 2
  2. Propagula stout with short or no projecting rays 3
  2. Propagula slender with elongated rays 4
3. Rays of propagula of 2–3 short cells, attenuated outwards .. 2. **S. brevicornis** (p. 394)
3. Rays of propagula usually of a single cell, broad .... 3. **S. californica** (p. 395)
  4. Rays of propagula simple 5
  4. Rays of propagula bifurcate .... 6. **S. didichotoma** (p. 397)
5. Rays of propagula strictly two .... 5. **S. furcigera** (p. 396)
5. Rays of propagula in twos and threes in same individual .... 4. **S. subfusca** p. 395)

1. Sphacelaria racemosa Grev.

Erect filaments forming tufts 1–7 cm. high, dark brown, irregularly branched above, arising from a very small, prostrate thallus; joints showing several longitudinal and more or less regular secondary transverse partitions 55–70μ diam. below; propagula unknown; zoosporangia 40–50μ long by about 40μ diam. (''60–70μ x 52–60μ''), borne on short (1 or 2 celled) pedicels irregularly racemosely arranged on small lateral branchlets; gametangia (not seen in our specimens) ovate-cylindrical or cylindrical racemosely arranged.

Growing on rocks, shells and, at times, on other algae, in the lower littoral or upper sublittoral belts. Alaska (Port Clarence, Kjellman; Prince William Sound, Yakutat Bay and Wrangell, Saunders) to west coast of Whidbey Island, Washington, Gardner.

Greville, Scot. Crypt. Flora, vol. 2, 1824, pl. 96. *Sphacelaria racemosa* var. *arctica* Saunders, Alg. Harriman Exp., 1901, p. 419; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 239. *Sphacelaria arctica* Kjellman, Beringh. Algfl., 1889, p. 51.

We have only the specimens from Whidbey Island to guide us as to the occurrence of this species on our coast and these are scanty with very few zoosporangia and covered by epiphytes of the *Dermocarpa*-type. The irregular (never pinnate) branching, the regular divisions of the outer cells of the joints by a secondary transverse partition as well as the irregularly racemose arrangement of the sporangia indicate the position of the Whidbey Island specimen under the species and not under the var. *arctica* (Kjellm.) Reinke. It may be that the Alaska specimens belong to the var. *arctica*. The few zoosporangia found in our specimens are small (as indicated in our description) but are probably not well developed. The racemose arrangement in our specimens is not so regular or luxuriant as that shown in Greville's figures (*loc. cit.*).

2. **Sphacelaria brevicornis** S. and G. (Orothog. mut.)

Erect filaments 1–1.5 cm. high, sparsely and strictly branched, attached by small, penetrating filaments; joints showing only primary longitudinal partitions, 35μ diam. below, 22–30μ near the tip; hairs arising near the tips composed of 6–8 cells; zoosporangia and gametangia unknown; propagula stout, obovate, tricornute, about 120μ long and about 70μ wide (below the rays), composed of a few large cells and on 2–3-celled pedicels, rays ("horns") short, of 2–3 cells, blunt, attenuate outwards.

Growing on *Sargassum polyacanthum* f. *americanum*. La Paz, Lower California.

Sphacelaria brevicornis Setchell and Gardner, Mar. Alg. Gulf of Calif., 1924, p. 725, pl. 19, figs. 59, 60.

S. brevicornis is very close to *S. cornuta* Sauv. of New Caledonia, but the propagula are provided with shorter horns from a more robust basal portion.

3. **Sphacelaria californica** Sauv.

Plate 37, figs. 23–27

Erect filaments forming light olive brown tufts, up to 3 cm. or more in height, naked for about 1 cm. below, attached by a small disk; joints with primary vertical and occasional, but irregularly placed, secondary transverse partitions, up to 120μ diam.; hairs and rhizoids absent; propagula broad, 140–160μ long, 80–120μ broad, without projecting rays or a single large cell projecting slightly at each of the upper 3 corners; zoosporangia short, ellipsoidal to obovate, 75–150μ long, 50–70μ wide; gametangia unknown.

Growing on rocks, in pools, in the middle littoral belt. Southern California (San Pedro to San Diego).

Sauvageau, Remarques sur les Sphace., 1901, p. 92 (with ?). *Sphacelaria plumula* var. *californica* Sauvageau, *loc. cit.*, p. 91, fig. 21; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1694, 1910. *S. tribuloides* Saunders, Phyc. Mem., 1898, p. 158, pl. 26 (not of Meneghini).

Sphacelaria californica was suspected to be a distinct species by Sauvageau who described it (*loc. cit.*) under *S. plumula* var. *californica*. He published, however, the binomial, *Sphacelaria californica?* (*loc. cit.*), and it seems proper to attribute this combination to him. The species, while close to *S. plumula* Zan., differs in having the lower portion of the axis (for a centimeter or more) free from branches, in having a basal disk and a straighter axis. Sauvageau's plants were more slender than those of *S. plumula*, but ours equal them in measurement (up to 120μ); many of our plants, however, have the smaller measurements of those of Sauvageau. Secondary transverse partitions occur in the joints of this species but they are occasional and irregularly placed. The type locality is San Diego, California.

4. **Sphacelaria subfusca** S. and G.

Plate 37, fig. 28

Erect filaments forming brown tufts about 0.5 mm. high, or slightly higher, alternately but irregularly branching, penetrating slightly among the superficial cells of the host by short thick rhizoids, not forming a distinct disk; joints with primary vertical partitions only, 24–40μ high, 40–50μ wide; hairs uniformly present and abundant, single, seriate, opposite or secund, up to 8 cells in length, about 15μ diam.; propagula slender, with 2 or 3 slender rays, pedicel 8–12 cells, with 3–4 of the upper cells showing longitudinal septa, 24μ diam., slightly attenuate toward the point of attachment, rays 4–9 celled, tapering slightly, if at all, towards the tip; zoosporangia and gametangia unknown.

Growing on various algae. Alaska (Sitka) to southern California (Redondo).

Setchell and Gardner, Phyc. Cont. VII, 1924, p. 1.

Sphacelaria fusca Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1693, 1910 (not of Agardh). *Sphacelaria cirrhosa* Saunders, Alg. Harriman Exp., 1901, p. 419 (?).

Sphacelaria subfusca might ordinarily be referred to *S. fusca* (Huds.) Ag., to which, undoubtedly, it is closely related. It differs from *S. fusca* in its basal portion, in its much lower stature, smaller diameter, and in certain details of structure of the propagula. In the last, the stalk tapers little and the rays are barely perceptibly attenuated toward their apices. In addition, the occurrence of frequent bifurcate, along with the trifurcate, propagula, so characteristic of *S. fusca*, leads us to consider our plant as a distinct species. It is intermediate between *S. fusca* (Huds.) Ag. and *S. furcigera* Kuetz. While we have not seen Saunders' *S. cirrhosa* from Annette Island, his description of its habit corresponds so well with that of a specimen from Sitka, that we refer it here provisionally.

5. **Sphacelaria furcigera** Kuetz.

Plate 37, fig. 29

Erect filaments a few millimeters (up to 5 mm. or perhaps more) high, forming small tufts, arising from short, closely intertwined creeping filaments often also penetrating the host, sparsely branched, with lateral and subterminal hairs, the latter, at times, pushing aside the terminal cell and taking its position; joints with 1–3 primary vertical partitions, 16–30μ (in ours, but up to 45μ, fide Sauvageau) in diameter and up to 50μ or more high; hairs abundant, few-celled (4–6), cells 10–14μ wide, up to 50μ long; propagula slender, bifurcate with an umbo between the rays, stalk with 6–9 joints, the upper with 2–3 vertical partitions, slightly attenuated below, about 20μ diam.; rays with 5–8 cells, not at all attenuated toward the apices; zoosporangia spherical (fide Sauvageau), 50–70μ diam., short (1 cell) pedicellate; gametangia (fide Sauvageau) of 2 sorts, antheridia, cylindrical, 45–65μ long, 24–28μ wide, with loculi about 3μ diam. and oogonia more irregular, 30–45μ (up to 60μ) long, 28–40μ broad, with large loculi.

Epiphytic on other algae. Gulf of California.

Kuetzing, Tab. Phyc., vol. 5, 1855, p. 27, pl. 90, fig. II; Reinke, Beitr. zur vergl. Anat. u. Morph. der Sphac., 1891, p. 14, pl. 4, figs. 5–13; Sauvageau, Rem. sur les Sphace., 1901, p. 156; Setchell and Gardner, Mar. Alg. Gulf of Calif., 1924, p. 724, pl. 19, fig. 58.

Kuetzing founded this species on a plant from the Island of Karak, in the Persian Gulf. Reinke (*loc. cit.*) and Sauvageau (*loc. cit.*) have interpreted it, the former confining it to the Indian and Pacific oceans, the latter extending it to the Atlantic Ocean and adjacent European seas. According to Sauvageau's interpretation our scanty material may very well be included under the form cycle of *S. furcigera,* but we doubt its conforming exactly to the type of Kuetzing. Our specimens show scanty propagula and seemingly young oogonia.

6. **Sphacelaria didichotoma** Saunders

Erect filaments up to 4 mm. high, forming dense tufts, with probably a penetrating base, irregularly branched; joints with as many as 3 vertical partitions, 25–35μ diam., and slightly longer than broad; hairs not known; propagula slender, bifurcate, with each ray again furcate, stalk slightly attenuated at the base, 200–300μ long, main branches 100–200μ long; sporangia and gametangia unknown.

On other algae, including Melobesieae. Central and southern California.

Saunders, Phyc. Mem., 1898, p. 158, pl. 27. *Sphacelaria variabilis* Sauvageau, Rem. sur les Sphace., 1901, pp. 160–162, fig. 37?.

The species noted above is known to us chiefly from descriptions and figures. A specimen from Clifton, California, collected by Carl Epling, seems referable here. It is very uncertain (cf. Sauvageau, *loc. cit.,* p. 160) as to whether *S. didichotoma* is identical with *S. variabilis* Sauv., or with *S. divaricata* Mont., or is distinct from both.

2. **Chaetopteris** Kuetz.

Frond arising from a solid parenchymatous base, cylindrical, filiform, solid, parenchymatous throughout, irregularly divided into longer and shorter branches, which in turn are pinnately branched; reproduction by unilocular zoosporangia and plurilocular gametangia borne on special branchlets arising from the corticating pseudo-parenchyma; perennial.

Kuetzing, Phyc. Gen. 1843, p. 293.

Chaetopteris plumosa (Lyngb.) Kuetz.

Frond terete, 7–11 cm. high, the lower portion stipe-like and undivided, arborescent above, with the principal branches alternate or opposite; the stipe and principal branches nude; the primary branches closely beset with pinnate branches; pinnae distichous, strict, unbranched, 5–8 mm. long; branches arising from the medulla; color of main branches dark, of the pinnae, olive brown, turning green on drying; unilocular sporangia spherical, plurilocular gametangia cylindrical, both borne on short lateral pedicels.

Growing in the sublittoral belt. St. Lawrence Island and Pt. Clarence, Alaska.

Kuetzing, Phyc. Gen., 1843, p. 293; Tab. Phyc., vol. 6, 1856, pl. 6, fig. I; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 239; Kjellman, Om Beringh. Algfl., 1889, p. 51. *Sphacelaria plumosa* Lyngbye, Hydrophyt. Dan., 1819, p. 103, pl. 30*c*.

The occurrence of this species on our coast is known to us only from the reference of Kjellman.

Order 2. ECTOCARPALES S. and G.

Confervoid (monosiphonous) or solid Phaeosporeae of varying dimensions, habit and complexity, typically possessing unilocular zoosporangia and plurilocular gametangia and with no portion of the cell membranes turning black with eau de javelle; growth in length strictly subapical, often "trichothallic," or more or less intermediate between typical forms of either; both unilocular zoosporangia and plurilocular gametangia in the same individual in some species, but, most commonly, borne on different individuals, thus pointing toward an alternation of generations, reduction division taking place in the primary nucleus of the unilocular zoosporangium; gametangia all similar or slightly differing in number and size of loculi; gametophyte and sporophyte practically indistinguishable as to size and complexity.

Ectocarpales Setchell and Gardner, Phyc. Cont. VI, May 16, 1922, p. 403 (lim. mut.); Oltmanns, Morph. und Biol. der Algen, vol. 2, 1922, p. 2 (lim. mut.). *Ectocarpaceae* Oltmanns, Morph. und Biol. der Algen, vol. 1, 1904, p. 350 (in part). *Ectocarpineae* Taylor, Recent Studies of Phaeophyceae, etc., Dec., 1922, p. 436 (in part).

It seems more consistent with the present usage in other subclasses of the thallophytes to consider the extended Ectocarpaceae of Oltmanns as an Order rather than as a Family. Oltmanns in the last edition

(1922) of his "Morphologie und Biologie der Algen" (p. 2 *et seq.*), has come to the same conclusion. Our present conception of the Ectocarpales differs from that of Oltmanns in limiting it to families in which plurilocular gametangia are present on gametophytes slightly, if at all, different from the sporophyte, or at least definitely macroscopic. While the families under Ectocarpales, as limited by us, present a very considerable variety in the details of structural differences, they have in common the possession of plurilocular gametangia giving rise to nearly similar gametes (isogamy) and an identity in size and structure of both gametophyte and sporophyte. The Ectocarpales are closely related to the Cutleriales, but in the latter there is distinct oogamy and in some species considerable differences between the two generations. From the Sphacelariales, the Ectocarpales differ in the absence of the conspicuous apical cell of the first mentioned and the very different cell wall. The cell wall, or the older layers of it, changes to black in the Sphacelariales when treated with eau de javelle, but does not show this reaction in any of the Ectocarpales. The macroscopic plants of the members of the Dictyosiphonales, Desmarestiales and Laminariales are known only with unilocular zoosporangia. The first and last of these orders are known to have greatly reduced gametophytes. From analogy the Desmarestiales may be suspected of being similar to the other two orders in this respect.

Key to the Families

1. Fronds prostrate, discoid, crustaceous, or pulvinate, never hollow nor carnose, seldom gelatinous 2
1. Fronds erect, membranaceous or filamentous, when globular or prostrate, either hollow or carnose 4
    2. Fronds wholly discoid, composed of a basal disk of 1 or more layers of cells giving rise to erect free filaments 3
    2. Fronds crustaceous or pulvinate, consisting of a basal cushion of several layers of cells with penetrating filaments below and erect, free filaments above .... 5. **Elachisteaceae** (p. 502)
3. Fronds small, composed of a disk of 1 or 2 layers of cells all of which give rise to free, erect filaments or reproductive cells .... 3. **Myrionemataceae** (p. 453)
3. Fronds larger (up to several cm. across), composed of a disk of more than 2 layers of cells which give rise to erect, free filaments in sori .... 4. **Ralfsiaceae** (p. 493)
    4. Fronds globular or flattened, carnose .... 6. **Leathesiaceae** (p. 507)
    4. Fronds elongated, erect when globular, not carnose 5
5. Fronds membranaceous or flattened, at times hollow 6
5. Fronds cylindrical, not membranaceous 7
    6. Sori definite, entirely projecting .... 8. **Asperococcaceae** (p. 522)
    6. Sori definite, superficial, at times partially projecting .... 7. **Punctariaceae** (p. 513)
    6. Sori usually indefinite, superficial .... 10. **Scytosiphonaceae** (p. 530)

7. Fronds monosiphonous..2. **Ectocarpaceae** (p. 400)
7. Fronds more complex.. 8
    8. Growth trichothallic.. 9
    8. Growth subterminal, not distinctly trichothallic...10
9. Sori distinct, more or less transversely arranged, superficial or projecting...........
    ....9. **Striariaceae** (p. 528)
9. Without distinct sori, sporangia and gametangia neither superficial nor projecting..11. **Ægiraceae** (p. 543)
    10. Fronds dichotomously much branched.........13. **Chnoosporaceae** (p. 552)
    10. Fronds alternately branched on all sides..
    ....12. **Heterochordariaceae** (p. 549)

FAMILY 2. ECTOCARPACEAE HARVEY

Thallus of monosiphonous filaments, occasionally partially polysiphonous, branched in various ways, arising from creeping, superficial or at times penetrating filaments, occasionally arising from a small superficial disk, usually entirely free from one another, occasionally slightly intertwined or loosely united by a thin jelly; growth proceeding from a subapical cell, often situated at the base of a hair (trichothallic); cells uninucleate with one or more parietal chromatophores of fixed and definite form; zoosporangia unilocular, terminal, either a branchlet transformed wholly or in part, or intercalary; gametangia plurilocular, of various shapes, arising from a branchlet transformed wholly or in part, or intercalary, in some cases differentiated as to size and number of divisions (mega- and meio-gametangia); gametophyte and sporophyte identical in size and structure.

Ectocarpaceae Harvey, Ner. Bor.-Amer., part 1, 1852, p. 132 (in part); Kjellman, *in* Engler and Prantl, Die natürl. Pflanzenfam. Teil 1, Abt. 2 (Lief. 60), 1891, p. 182 (in part); Oltmanns, Morph. und Biol. der Algen, vol. 2, 1922, p. 6 (in part). *Ectocarpeae* Agardh, Syst. Alg., 1824, p. XXX (in part); Oltmanns, Morph. und Biol. der Algen, vol. 1, 1904, p. 353 (in part). Kuetzing, Phyc. Gen., 1843, p. 287 (in part); Oltmanns, Morph. und Biol. der Algen, vol. 1, 1904, p. 353 (in part).

Key to the Genera

1. Zoosporangia and gametangia transformed branchlets or tips of branches or branchlets, strictly terminal.. 2
1. Zoosporangia and gametangia catenate, intercalary.................3. **Pylaiella** (p. 401)
    2. Vegetative filaments superficial or penetrating the host merely by rhizoids..4. **Ectocarpus** (p. 407)
    2. Vegetative filaments deeply penetrating the host, projecting little, if at all, beyond its surface.......................................5. **Streblonema** (p. 440)

1. Pylaiella Bory

Fronds monosiphonous, composed of a creeping, attaching portion and an erect portion; creeping filaments irregular, more or less profusely branched, not penetrating the uninjured host; erect filaments either unbranched or moderately to profusely branched, at times piliferous; chromatophores smooth, regular disks or irregular, more or less united plates, or bands; zoosporangia formed by direct transformation of assimilating cells of the erect filaments, mostly catenate, usually intercalary, rarely terminal; gametangia similar to the zoosporangia in origin and position, both zoospores and gametes escaping through lateral pores.

Bory, *in* Dict. class., vol. 4, 1823, p. 393, vol. 13, 1828, p. 565 (original spelling *Pilayella*); Leman, "*Pylaiella*," *in* Levrault, Dict. sci. nat., vol. 44, 1826, p. 127.

The genus *Pylaiella* was founded by Bory de Saint Vincent in 1823 and redescribed by him in 1828. In the first article, the description of the seriate sporangia tends definitely to diagnose the genus, but in the second article, the type species of the genus is designated as *Conferva littoralis* L., and further indicated as being the *Ectocarpus littoralis* δ *protensus* Lyngbye (1819, pl. 42, C). In every way, therefore, there is little doubt as to the conception of Bory. Bory has the spelling *Pilayella* which seems probably to be a purely orthographic error. It seems best to us to keep the species of *Pylaiella* separate from those of *Ectocarpus* since the seriate, and largely intercalary, zoosporangia differ decidedly from the projecting and solitary zoosporangia of *Ectocarpus*. The gametangia in *Pylaiella* are, in typical form, also very distinct from those of *Ectocarpus*. We, at least, basing our opinion on the development and dehiscence, are inclined to regard the gametangia in *Pylaiella* as seriate, each separate gametangium opening laterally. In *Ectocarpus*, the gametangia are single, since all the loculi open inwardly and the gametes are discharged through the apex, even dislocating the terminal hair in forms of *Ectocarpus siliculosus* which, otherwise, has gametangia at times resembling, superficially, the seriate gametangia of *Pylaiella*. In attempting to arrange the numerous forms of *Pylaiella*, as found on the Pacific Coast of North America, we have come to the conclusion that at least four species are represented.

Three subgenera are described under *Pylaiella*, viz., *Eupylaiella* Born., *Bachelotia* Born., and *Panthocarpus* Scottsb. The first and last are represented by species occurring within our territory, but *Bachelotia* does not seem to have been detected here as yet. The subgenus *Eupylaiella*, whose species are distinguished by their comparatively more frequent opposite or alternate branching, is founded naturally on *Pylaiella littoralis*, some forms of which are very tall, but also includes low forms, such as *P. curta* Foslie and *P. unilateralis* S. and G. *Bachelotia* and *Panthocarpus*, whose erect filaments are either unbranched or sparsely branched, include only forms not over three centimeters in height. In *Eupylaiella*, and probably also in *Bachelotia* (known certainly only with zoosporangia), the gametangia develop simultaneously throughout the series which is, therefore, limited and definite. In *Panthocarpus*, the gametangia develop successively and from above downward. Further and more careful study of gametangial development in a large series of forms and species is necessary to fully sustain these statements.

Key to the Species

1. Branching frequent, opposite, alternate or secund—(**Eupylaiella**) 2
1. Branching none or sparse and opposite—(**Panthocarpus**) 3
    2. Upper branches opposite or alternate ....1. **P. littoralis** (p. 402)
    2. Upper branches regularly secund ....2. **P. unilateralis** (p. 404)
3. Plants up to 15 mm. high, simple or with opposite ramuli above.............................
    ....3. **P. Gardneri** (p. 405)
3. Plants not over 1 mm. high, simple..4. **P. tenella** (p. 406)

1. **Pylaiella littoralis** (L.) Kjellman

Plate 37, fig. 32

Erect assimilatory filaments very profusely branched, either densely caespitose or funiculate, 2 cm. to 6 dm. high, creeping filaments richly branched, somewhat irregular in diameter; color varying from light yellowish brown to dark brown; primary filaments 20–60μ diam., cells 1–6 times as long as the diameter, ramuli more slender, opposite or alternate, strict, patent or even at times recurved, short and subulate or long and gradually attenuated, occasionally piliferous; zoosporangia in each series mostly formed simultaneously, 5–25-catenate, usually one in each joint, rarely 2–4 formed by longitudinal divisions of a single cell, intercalary or terminal, varying in shape from oblate to prolate spheroidal, 25–45μ diam.; gametangia intercalary, in a continuous series up to 1300μ long, 20–35μ diam.; zoosporangia and gametangia usually on separate plants, but occasionally on the same plant.

Growing on other algae, on rocks and on wood in the littoral belt. Bering Sea to southern California (San Pedro).

Kjellman, Skand. Ect. och. Tilopt., 1872, p. 99, Alg. Arctic Sea, 1883, p. 281; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 235; Saunders, Phyc. Mem., 1898, p. 156, Alg. Harriman Exp., 1901, p. 418. *Conferva littoralis* Linnaeus, Spec. Pl. (ed. 1), 1753, p. 1165 (in part); Dillwyn, Brit. Conf., 1803, p. 70, pl. 31 (in part); C. A. Agardh, Syn. Alg. Scand., 1817, p. 65 (in part), Spec. Alg., vol. 2, 1828, p. 40 (in part). *Ectocarpus littoralis* δ *protensus* Lyngbye, Hydrophyt. Dan., 1819, p. 131, pl. 42, C.

We have quoted both Linnaeus and Kjellman as authorities for the name of this species, with a full sense of the uncertainty existing concerning the real sponsorship. The *Conferva littoralis* of Linnaeus, so far as the original founding of the species is concerned, is most uncertain since no definite type specimen is to be found. According to C. A. Agardh (1828, pp. 40, 41), Linnaeus seems to have changed his opinion as the years went on, at certain times having in mind apparently one of the Ectocarpaceae, and at other times a member of the Rhodomelaceae. In the first edition of the Species Plantarum (1753, p. 1165), Linnaeus quotes the first edition of the Flora Suecica (1745, p. 371) and a certain figure of Dillenius (1741, pl. 4, fig. 19). In the Flora Suecica, however, he quotes a figure of Dillenius (1741, pl. 3, fig. 13) to which he did not refer especially in 1753. In the second edition of the Species Plantarum (1763, p. 1635), Linnaeus again excludes the Dillenius figure of plate 3, figure 13, but, later, in the second edition of the Flora Suecica (1755, p. 436), he again quotes only figure 13 of plate 3 repeating the diagnosis of the species published in 1753. The Ectocarpaceous view of the Linnaean species seems to have been general among the earlier phycologists, but, even thus, it remained a mixture of species. Dillwyn (1803, pl. 31) shows under figure C a plant seemingly with seriate gametangia, while figure D has what seems to be a projecting solitary zoosporangium. The idea of C. A. Agardh 1817, p. 65) is also of a mixture, as was that of Lyngbye (1819, pp. 130, 131, pl. 42) as well. By the time the first edition of Harvey's Manual (1841) was issued, the present idea of the species had begun to assume form as to the seriate gametangia being characteristic of it. While it is, therefore, fairly certain that Linnaeus may have included the species now usually assigned under his specific name, but that he had no distinctly concrete conception of the same, it seems best to follow custom and not only to adopt the specific name *littoralis* but also to continue to cite Linnaeus as the author of it. We have quoted Kjellman as authority for the binomial, although, in 1828, Bory distinctly cited the *Conferva littoralis* L. as the type of *Pylaiella*. He did not use the binomial itself and we follow custom in citing as authority the first writer known to us to do so.

Pylaiella littoralis, as usually recognized, is a very variable and widespread species. In height, it varies from a few centimeters up to six decimeters or more; in color, from light yellowish brown to very dark brown; in habit from a feathery frond of loosely entangled filaments, through tufted masses to rope-like aggregations; in branching from very abundant, opposite or alternate, to comparatively scanty and chiefly alternate; and in angle of branching, from narrowly acute to broadly obtuse, erect, ascending or even recurved. There is considerable variation in the diameters of the primary filaments and in the dimensions and position of the zoosporangia and gametangia. It is difficult, or even impossible at present, to determine how much of this variation is due to age and environment and how much may be of genetic significance. There are several varieties described with more or less definiteness, and few to several forms under each. Earlier (1903), we attempted to refer as many of the plants of the northwestern coast as possible to their proper forms. At present, it seems to us undesirable, as well as very unsatisfactory, to attempt this. The var. *opposita* Kjellm., loose in habit and with abundant, chiefly opposite, branching, may be taken as including the normal, or also even the taxonomic, type. The var. *firma* (Ag.) Kjellm. is also lax in habit but with less abundant and more scattered branching. Var. *divaricata* Kjellm. is more commonly funiculose or ropy and with the branches irregularly placed, often incurved and geniculate. The forms of var. *varia* (Kjellm.) Kuck. seem the most distinct in their peculiarly aggregated gametangia and contorted funiculose habit. Forms of all four, and perhaps even of other varieties, occur on our coast and a study of the same plants over a series of weeks or months, or in cultures, would undoubtedly assist much in elucidating the significance of the great variation credited to this species.

2. **Pylaiella unilateralis** S. and G.

Erect filaments attached by creeping, irregular, more or less branched filaments, tufted, slightly clavate, 4–7 mm. high, 19–22μ diam. at the bases, 28–32μ diam. at the apices; branching mostly alternate and sparse below, secund above, and arising from cells divided longitudinally 1–2 times; cells 2–2.5 times as long as the diameter and cylindrical at the base, more or less quadrate and doliiform above; chromatophores thin, irregular plates more or less connected; zoosporangia formed simultaneously, 7–12 catenate, mostly terminal in the ramuli, spheroidal, 24–28μ diam.; gametangia unknown.

Growing on rocks in shallow pools near high-tide limit. Sunset Beach, near the mouth of Coos Bay, Oregon.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 386, pl. 42, figs. 6–8.

The secund branching together with the longitudinal divisions of the cells from which the secund branches arise, forming a polysiphonous region, are the chief distinguishing characteristics of this species. The branching below is sparse, alternate or very rarely opposite, and the branches are relatively long and attenuated. These branches may give rise to terminal zoosporangia, or to a few short alternate ramuli which in turn produce the zoosporangia. Many of the main filaments become slightly enlarged towards their outer ends, the cells becoming nearly quadrate, their walls thickened and their contents very dense. An average of about thirty-five, although frequently as many as sixty-five, cells are thus transformed. A few cells of the ends of the filaments are not transformed and soon disintegrate, thus producing decidedly clavate filaments. The region of transformation seems to be a new meristem of a peculiar nature. Many of the cells divide once or, less frequently, twice, by longitudinal planes as a rule, but occasionally the dividing planes are at right angles separating the cell into four parts. The unique feature resulting from these divisions is the lack of further growth of the cells. Usually one of the cells resulting from longitudinal division gives rise to a branch, shorter or longer, but similar to branches arising in the regular manner. The branches are typically secund, but may rarely come from the opposite side of the filament. Many of the main filaments become much curved in this branching region.

3. **Pylaiella Gardneri** Collins

Erect assimilating filaments slightly attenuated when young, unbranched or sparsely forked near the base giving rise above to numerous, short, obtuse, mostly opposite, rigid, patent branches, 10–12 mm. (up to 20 mm.) high; cells at base of filaments 12–15μ diam., twice as long as broad, increasing in diameter slightly upwards, moderately constricted at the joints; creeping filaments 6–10μ diam., cells 1–4 long; chromatophores thick, broken bands nearly filling the cell; zoosporangia unknown; gametangia in terminal, more or less clavate, series, either on the main filaments or on short lateral branches, up to 24μ diam.

Forming low patches on *Postelsia palmaeformis*. Observed only on the coast of central California, but it probably has a much wider distribution.

Collins, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1384. *Pylaiella* (*Panthocarpus*) *Postelsiae* Skottsberg, Notes on Pac. Coast Alg. I, 1915, pp. 153–164, pls. 17–19. *Leptonema fasciculatum* Saunders, New and Little Known Brown Algae, Erythea, vol. 7, 1899, p. 38, figs. 5–7 (not of Reinke).

Saunders (*loc. cit.*) reports the species as growing on the shells of the mollusk, *Mytilus*, in the vicinity of *Postelsia*. We have not seen it growing elsewhere than on the above named host. The gametangia are intercalary rather than terminal. There are always a few terminal, assimilating cells which do not metamorphose into gametangia. The creeping filaments do not seem to penetrate the uninjured host at any point, but if the surface cells of the host become bruised or in any way destroyed, the extending filaments follow the irregularities of the surface, and at times even penetrate a short distance among the cells beneath.

4. **Pylaiella tenella** S. and G.

Fronds widely diffused, attached by small, short, branched, contorted filaments, unbranched, 0.5–0.75 mm. high, long-attenuate upwards, not piliferous; cells 7–10μ diam., 1–2.5 times as long as the diameter; chromatophores, when young, a parietal broken band nearly filling the cell, later separating into several distinct pieces; zoosporangia long-catenate, subterminal, numerous assimilating cells in the series forming two or four zoosporangia by longitudinal divisions; gametangia subterminal.

Growing on *Pleurophycus Gardneri* Setchell and Saunders, the plants forming minute tufts, which later become confluent. Neah Bay, near Cape Flattery, Washington.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 385, pl. 42, figs. 9–11.

This *Pylaiella* is the most diminutive of all the known species of the genus, rarely attaining the length of one millimeter, its nearest rival in this respect being *P. nana* of Kjellman, from the Norwegian Polar Sea. It differs from that species in size, being only about one-half as high, in not being branched and in having subterminal gametangia in a long series, instead of terminal branched ones as described and figured by Kjellman for *P. nana*. The double and quadruple zoosporangia observed in this species, formed by longitudinal and cross-divisions of fructiferous cells have likewise been observed by Börgesen (1920, p. 433) in *P. fulvescens* (Schousb.) Bornet, from the Danish West Indies. We have also observed this condition highly developed in forms of *P. littoralis.*

P. tenella evidently belongs to the Panthocarpus group of the genus as established by Skottsberg (1915). The gametangia are formed by the transformation of vegetative cells, usually beginning relatively few cells back of the apices of the filaments, a considerable number of cells transforming simultaneously. The transformation continues in both directions until one-half to three-fourths of the filament is converted into gametangia. The gametangia vary greatly in size, some producing as many as thirty-two loculi from a single assimilating cell. They may be continuous or discontinuous, certain assimilating cells in the series not being transformed. The cell walls in the formation of loculi frequently are decidedly oblique. Zoosporangia occupy very much the same position in the filaments as the gametangia. They are subterminal, long-catenate, but seem to be formed more nearly simultaneously than are the gametangia.

The plants were fairly abundant on the blade of the host-plant at Neah Bay. They are, however, very inconspicuous, forming small, more or less continuous expansions, barely recognizable when the host-plant is wet. We have not observed the species growing elsewhere, although the host is abundant in the vicinity of the Strait of Juan de Fuca.

4. **Ectocarpus** Lyngb.

Fronds monosiphonous, composed of a creeping attaching portion and an erect portion; creeping filaments irregular, more or less well-developed, and more or less richly branched, usually entirely or largely external to the substratum; erect filaments usually abundantly branched, naked, or corticated by descending rhizoidal filaments, piliferous, or terminating in an acute or rounded cell, growth apical, subapical or trichothallic; chromatophores discoid or band-shaped, with or without pyrenoids; zoosporangia on lateral branchlets, seldom terminal, single, sessile or stalked; gametangia terminal on lateral branchlets, sessile or stalked, exceptionally seriate and seldom even intercalary, in some species dimorphic or polymorphic (mega- and meio- gametangia and antheridia).

Lyngbye, Hydrophyt. Dan., 1819, p. 130 (in part); Bory, *in* Dict. class. d'hist. nat., vol. 6, 1824, p. 63. *Colophermum* Rafinesque, Précis decouv. som., 1814, p. 49.

Lyngbye established the genus *Ectocarpus* on six species, the last two mentioned of which are not even members of the Melanophyceae. The other four are wholly, or in part, members of the genus as limited by Bory, in which sense it has more recently been taken by many writers. The only confusion has been with *Pylaiella* and there may be a question as to the wisdom of segregating that. The first species listed by Lyngbye is *Ectocarpus littoralis* but, as we have already indicated, Lyngbye's conception of this species included a true *Ectocarpus* as well as what we now separate as *Pylaiella littoralis.* Otto Kuntze (1891, p. 888 and 1898, p. 401) has attempted to revive the Rafinesquian name *Colophermum* (1814) for *Ectocarpus*, but the latter name has been included among the "*nomina conservanda*" by the Brussels International Botanical Congress (cf. Briquet, 1912, p. 75).

We have already set forth the distinctive features of the genus *Pylaiella*, separating it from the other genera of the family. *Ectocarpus* differs from *Streblonema* in that the creeping basal filaments either do not penetrate the host-plant at all, or do so only very slightly, or, at least, the greater portion of the frond is free. It is frequently a delicate matter to decide whether a certain species may better be referred to *Ectocarpus* or to *Streblonema*, yet it seems best to keep them separate.

In habit and stature, the species of *Ectocarpus* differ considerably, some being very low and dwarfed, while others are tall; some are tufted, some are feathery, while some have their filaments entangled into ropy masses. The zoosporangia are either more rare or less frequently found than the gametangia and are unknown in many species. The gametangia differ much in the various species, in shape, size and position. In some species they are dimorphic or even polymorphic (Sauvageau, 1896, pp. 27 and 32, 1896*a*, 1896*b*, etc.). In some species there are "megasporangia" (as Sauvageau calls them) with large divisions (loculi), "meiosporangia" (Sauvageau) with medium sized divisions (loculi), and antheridia with very small divisions (loculi). It is supposed that the motile sperms are produced by the antheridia and one or the other of the mega- or meio- gametangia produce the egg cells (cf. Sauvageau, 1896*c*). Much more experience is needed before we may be able to decide the question of the function of these different gametangial structures. They are usually lateral and either sessile or pedicellate. More rarely are they terminal and, at times, even intercalary (e.g., *E. siliculosus* f. *varians* Kuckuck, 1892, p. 256, pl. 13).

The species of *Ectocarpus* are numerous and often very puzzling. The principal accounts, thus far published for our coast, are those of Saunders (1898 and 1901) and that in our own report on the algae of the northwestern coast (1903) as well as in our Phycological Contributions VI (1922). We have subjected all of the material available to us to careful scrutiny in the preparation of the following treatment of our species.

Key to the Species

1. Chromatophores band-shaped 2
1. Chromatophores discoid 20
  2. Fronds forming hemispherical tufts, growth apical or subapical .... 21. **E. chantransioides** (p. 430)
  2. Fronds not as above, growth chiefly intercalary 3
3. Gametangia on both creeping and erect filaments 4
3. Gametangia on erect filaments only (except **E. confervoides f. variabilis**) 5
  4. Erect filaments 8–10μ diam. .... 8. **E. Taoniae** (p. 420)
  4. Erect filaments 12–25μ diam. .... **E. confervoides f. pygmaeus** (p. 415)
5. Fronds usually more than 1 cm. high 6
5. Fronds less than 1 cm. high 14
  6. Fronds tightly twisted into branched, rope-like threads .... 4. **E. tomentosus** (p. 417)
  6. Fronds more or less loosely tufted 7
7. Fronds over 5 cm. high 8
7. Fronds usually less than 5 cm. high 10
  8. Terminal ramuli short and acute .... 3. **E. acutus** (p. 415)
  8. Terminal ramuli long-attenuated 9
9. Gametangia not terminating in hairs .... 2. **E. confervoides** (p. 412)
9. Gametangia frequently terminating in hairs 13
  10. Gametangia usually over 100μ long .... **E. confervoides f. parvus** (p. 413)
  10. Gametangia usually less than 100μ long 11
11. Fronds never corticated 12
11. Fronds corticated .... 5. **E. corticulatus** (p. 418)
  12. Gametangia usually 50–70μ long .... 6. **E. fructuosus** (p. 419)
  12. Gametangia usually 75–90μ long .... **E. confervoides f. variabilis** (p. 414)
13. Fronds loose, up to 20 cm. high .... 1. **E. siliculosus** (p. 410)
13. Fronds tufted, up to 6 cm. high .... **E. siliculosus f. subulatus** (p. 411)
  14. Fronds penetrating the host more or less 15
  14. Fronds not penetrating the host 18
15. Fronds more or less profusely branched 16
15. Fronds mostly simple 17
  16. Gametangia long, attenuated .... 12. **E. Mesogloiae** (p. 423)
  16. Gametangia short, blunt .... 13. **E. commensalis** (p. 424)
17. Fronds over 1 mm. high .... 14. **E. eramosus** (p. 424)
17. Fronds less than 1 mm. high 17a
  17a. Erect filaments terminating in a hair .... 15. **E. luteolus** (p. 425)
  17a. Erect filaments not terminating in a hair .... 33. **E. gonodioides** (p. 439)
  18. Fronds attached by creeping filaments and by rhizoidal filaments from the lower cells .... 11. **E. flagelliferus** (p. 422)
  18. Fronds attached by creeping filaments only 19
19. Fronds forming a velvety stratum .... 9. **E. terminalis** (p. 421)

19. Fronds caespitose..10. **E. simulans** (p. 422)
    20. Fronds 1 cm. or more high..21
    20. Fronds less than 1 cm. high..26
21. Fronds twisted into dense rope-like threads........20. **E. breviarticulatus** (p. 429)
21. Fronds more or less loose and caespitose..22
    22. Ramuli mostly alternate..23
    22. Ramuli mostly secund..25
23. Main filaments 25–40μ diam..24
23. Main filaments 40–60μ diam..19. **E. oviger** (p. 428)
    24. Gametangia broadly fusiform..17. **E. Parksii** (p. 427)
    24. Gametangia ellipsoidal, obtuse..18. **E. Mitchellae** (p. 428)
    24. Gametangia broadly ovoid, mucronate..............7. **E. mucronatus** (p. 419)
25. Gametangia 60–100μ long..16. **E. granulosus** (p. 426)
25. Gametangia 40–60μ long..22. **E. granulosoides** (p. 431)
    26. Fronds penetrating the host..27
    26. Fronds not penetrating the host..30
27. Cells of the main filaments less than 30μ diam..28
27. Cells of the main filaments more than 30μ diam..29
    28. Gametangia fusiform, scattered on the upper parts of the fronds..30. **E. socialis** (p. 437)
    28. Gametangia ovoid to ellipsoid, mostly near the base of the fronds..31. **E. flocculiformis** (p. 438)
29. Gametangia cylindrical, many opposite..... **E. cylindricus** f. **codiophilus** (p. 433)
29. Gametangia globular, mostly alternate..32. **E. globifer** (p. 438)
29. Gametangia fusiform, mostly alternate..34. **E. Bryantii** (p. 440)
    30. Fronds less than 1 mm. high..23. **E. affinis** (p. 432)
    30. Fronds more than 1 mm. high..31
31. Gametangia chiefly cylindrical..32
31. Gametangia not cylindrical..33
    32. Fronds 1–2 mm. high..24. **E. cylindricus** (p. 432)
    32. Fronds 7–10 mm. high.................... **E. cylindricus** f. **acmaeophilus** (p. 433)
33. Fronds in dense hemispherical tufts..34
33. Fronds more or less caespitose..35
    34. Fronds much branched, 2–4 mm. high........25. **E. hemisphericus** (p. 434)
    34. Fronds mostly simple, 1–2 mm. high..**E. hemisphericus** f. **minor** (p. 434)
35. Cells over 20μ diam..26. **E. Saundersii** (p. 434)
35. Cells less than 20μ diam..36
    36. Gametangia long-acuminate, up to 400μ long..27. **E. acuminatus** (p. 435)
    36. Gametangia not long-acuminate, up to 250μ long..37
37. Fronds 9–12μ diam..28. **E. ellipticus** (p. 436)
37. Fronds 14–15μ diam..29. **E. chitonicola** (p. 436)

1. **Ectocarpus siliculosus** (Dillw.) Lyngb.

Fronds tufted, feathery, loose, more or less entangled below, yellowish or brownish, pseudodichotomously branched below, alternately secund above; branches erect or, at times, somewhat recurved, never patent, not fascicled; sporangia ovoid to ellipsoidal, 30–65μ (usually 50μ) long, 20–27μ broad, sessile and erect or diverging on a 1–3-celled pedicel; gametangia usually long subulate-conical, seldom ovoid or curved, often ending in a longer or shorter hair, 500–600μ long and 12–25μ broad, seldom sessile, usually short pedicelled.

Growing in quiet pools attached to other algae. San Francisco Bay, California.

Lyngbye, Hydrophyt. Dan., 1819, p. 131 (in part, as to pl. 43, fig. C); Kjellman, Handb., I, 1890, p. 78; Kuckuck, Beitr. Kennt. Ectocarp. Art., 1891, p. 65; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 2294. *Conferva siliculosa* Dillwyn, Brit. Conf., 1809, p. 69, pl. E (excl. synonym).

We have followed Kjellman and Kuckuck in keeping *Ectocarpus siliculosus* distinct from *E. confervoides* and in laying emphasis upon the presence of elongated slender gametangia, some of which are piliferous, as its chief characteristic. We know full well from our own experience that it is difficult to draw a satisfactory line of demarcation between the two species, but feel that the best we can do is to keep them distinct and draw the line somewhat arbitrarily. The existence of such forms as *Ectocarpus confervoides* f. *parvus* (Saunders) S. and G. indicates that there are perplexing forms whose relationships and origins are perhaps impossible to formulate, but otherwise, so far as the plants of our coast thus far discovered are concerned, there seems little doubt that they conform to the original idea of *E. siliculosus*.

The plants distributed in the Phycotheca Boreali-Americana (*loc. cit.*) are the only characteristic plants of the species known on our coast. These were taken from a quiet pool in a salt marsh on Bay Farm Island, Alameda, California.

Ectocarpus siliculosus f. subulatus (Kuetz.) S. and G.

Fronds 5–25 cm. high, light yellow, fleecy, much branched, not constricted at the joints; branches long, attenuated above, many ending in a long hair; cells of the main filaments 30–36μ broad, 1–1.25 times as long as broad; zoosporangia unknown; gametangia elongated subulate-ovoid, some stouter, some more slender, 200–600μ long, 12–48μ broad, the upper (and as a rule more slender) usually terminating in a hair, on a 2–10 (or 12) celled pedicel.

In brackish pools, on sticks or grasses. Central California (San Francisco Bay).

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 416. *Ectocarpus confervoides* f. *subulatus* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1231. *Ectocarpus subulatus* Kuetzing, Actien, 1836, Phyc. Gen., 1843, p. 287, Sp. Alg., 1849, p. 454, Tab. Phyc., vol. 5, 1855, p. 19, pl. 61, fig. II. *Ectocarpus confervoides β subulatus* Hauck, Meeresalg., 1884, p. 331 (excl. synonymy). *Ectocarpus amphibius* Harvey, Phyc. Brit., vol. 2, 1848, pl. 183, Ner. Bor.-Amer., part 3, 1858, p. 125.

Our plant seems to agree very well with the figures and description of *Ectocarpus amphibius* Harvey and also, although not so perfectly, with *E. subulatus* Kuetz. They are both brackish water forms, as are our plants. Hauck refers to his var. *subulatus* also *Ectocarpus draparnaldiaeformis* Kuetz. and *E. macroceras* Kuetz. Judging from Kuetzing's illustrations, these two species may be forms of *E. siliculosus* but not to be included under f. *subulatus*.

2. **Ectocarpus confervoides** (Roth) Le Jolis

Fronds gregarious, forming expansions or tufts, 0.5–10 cm. high, light yellowish to dark brown, sparingly to frequently branched, branching alternate or secund, never opposite, more or less corticated; branches long or short, gradually attenuated, sometimes ending in a hair; prostrate filaments irregular, branched, closely attached to the substratum, but never penetrating it; chromatophores band-shaped, branched, often provided with pyrenoids; zoosporangia present in some forms; gametangia short-obovoid or longer or shorter fusiform, suddenly or somewhat gradually attenuated toward the blunt apex, never ending in a hair, 30–250μ (commonly 60–150μ) long and 12–35μ thick, solitary or seriate, terminal or intercalary.

Growing on rocks, wood, and larger Melanophyceae, widely distributed in its various forms. Alaska (Yakutat Bay) to Washington (Whidbey Island).

Le Jolis, Liste alg. mar. Cherb., 1863, p. 75 (in part); Kjellman, Handb., I, 1890, p. 77; Kuckuck, Beitr. Kennt. Ect. Arten, 1891, p. 69; Saunders, Alg. Harriman Exp. 1901, p. 418; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 237. *Ceramium confervoides* Roth, Cat. Bot., I, 1797, p. 151, pl. 8, fig. 3. *Ectocarpus siliculosus* Lyngbye, Hydrophyt. Dan., 1819, p. 131, pl. 43B.

Kjellman was the first to segregate *Ectocarpus siliculosus* from *E. confervoides* and limit it in the sense in which it is understood by Kuckuck and most writers since that time. Even in this narrow sense, *Ectocarpus confervoides* includes some eight or ten reasonably distinct forms, some of which may ultimately be found to deserve specific rank. It is to be distinguished from *Ectocarpus siliculosus* by never having the gametangium prolonged into a hair, from *E. acutus* by having blunt or piliferous branches, and from all the species of *Ectocarpus* having band-shaped chromatophores by the shape and dimensions of its gametangia.

KEY TO THE FORMS

1. Gametangia seldom over 100μ long 2
1. Gametangia usually over 100μ long, even up to 400μ long .... f. **parvus** (p. 413)
   2. Fronds frequently branched above, branches long .... f. **typicus** (p. 414)
   2. Fronds sparsely branched above, branches short 3
3. Gametangia frequent above, seldom terminal .... f. **variabilis** (p. 414)
3. Gametangia occasional above, frequently terminal .... f. **pygmaeus** (p. 415)

Ectocarpus confervoides f. parvus (Saunders) S. and G.

Fronds gregarious, forming tufted or extended masses, 1–2 cm. high, more or less alternately branched; erect filaments 21–30μ broad, slightly constricted at the joints, much attenuated at the tips or ending in hairs; cells 1–3 times as long as broad below, shorter above; chromatophores irregularly band-shaped; zoosporangia ovoid or ellipsoid, 35–55μ long, 20–27μ broad, usually sessile, sometimes on the same filament with the gametangia; gametangia narowly lanceolate-conical, gradually long-attenuate above, 120–400μ long, 20–27μ broad, borne on a longer or shorter pedicel, occasionally seriate and intercalary (as in *Pylaiella*).

On sand-covered rocks (type!), logs, or on the larger Melanophyceae. Central California (near San Francisco) and southern California (San Pedro and the type locality, San Diego).

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 414. *Ectocarpus siliculosus parvus* Saunders, Phyc. Mem. 1898, p. 153, pl. 22, figs. 1–9.

The f. *parvus*, as defined above, presents certain resemblances to both *Ectocarpus siliculosus* and *E. confervoides*. Its slender elongated gametangia resemble those of *E. siliculosus* and much might be said in favor of the opinion of Saunders in making it a "variety" of that species. On the other hand, very few, or none, of the typical gametangia end in a hair and we have therefore preferred rather to place it with *E. confervoides*. There are often found in this form, as well as in forms of *E. siliculosus*, very curious elongated intercalary gametangia which seem to be seriate, in that they open laterally in sections, as do those of *Pylaiella*. Such gametangia are very puzzling, but may possibly be regarded as indicating hybridization between *Pylaiella* and *Ectocarpus* or a mutation of some sort. Speculation, however, can scarcely explain such anomalies. The majority of the gametangia are typically of *Ectocarpus* and while approaching in shape those of *E. siliculosus*, yet they are less slender and less elongated than is typical for that species and are not ordinarily prolonged into terminal hairs.

So far as we may judge from the scanty specimen in our copy, no. 358 of Tilden's American Algae (from Pacific Grove) belongs rather under f. *parvus* than f. *variabilis*, although the determination as f. *variabilis* is attributed to Saunders.

Ectocarpus confervoides f. typicus Kuckuck (Orthog. mut.)

Fronds 1–10 cm. (ours 3–10 cm.) high, feathery, profusely branched; primary filament 25–32μ diam., not constricted at the partitions; zoosporangia unknown; gametangia abundant, alternate or secund on the branches, sessile or upon a one to several celled pedicel, 40–80μ (up to 200μ) long, 20–35μ diam.

On wood and rocks. Alaska (Juneau) to California (San Francisco).

Kuckuck, Beitr. Kennt. Ect. Arten, 1891, p. 69, fig. 3; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 237 (excl. spec'n).

It may be doubtful whether the f. *typicus* of *Ectocarpus confervoides* is, as yet at least, to be included in our account. We have referred here three collections, one of which (no. 5197, W. A. Setchell and A. A. Lawson, Juneau, Alaska) was listed by us previously (1903, p. 237) under *E. siliculosus* f. *typicus*. It is a poor and unsatisfactory specimen, but seems to belong here rather than where we referred it. The other specimens are from Oregon and California and are small, but have the more abundant branching of this form.

Ectocarpus confervoides f. variabilis Saunders

Plate 46, fig. 7

Fronds forming more or less extended layers, 0.2–2 cm. high, sparingly branched, branches alternate, distant, gradually attenuated above; main filaments up to 30μ diam., not constricted at the partitions; chromatophores large, band-shaped, few in each cell; zoosporangia ovoid, 60μ long, 40μ broad, single on 1–3-celled pedicels, often on the same plant with the gametangia; gametangia abundant, cylindrico-conical, fusiform to broadly ovoid, 75–225μ long, 16–35μ broad, sessile or on 1-few-celled pedicels, lateral or occasionally terminal on a long pedicel from the basal filament, rarely seriate, terminal or intercalary, on the long erect filaments, and up to 300μ long.

On larger Melanophyceae (*Desmarestia* and the Laminariaceae). Puget Sound to central California (Carmel).

Saunders, Phyc. Mem., 1898, p. 155, pl. 23; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 238 (at least in part). *Ectocarpus confervoides* f. *nanus* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1737 (not of Kuckuck).

Saunders founded his f. *variabilis* on a plant common along the coast from Puget Sound to central California. He named it, however, for the variable structures which he considered to be zoosporangia, but which are, most probably, undeveloped (parasitized or abortive ?) gametangia such as Sauvageau (1896*a*, pp. 41–45) has shown to exist in *Ectocarpus confervoides* and other species of Europe. The form, however, seems otherwise distinct and is fairly readily recognized by the characters given above and indicated in the key to the forms of *E. confervoides.*

Ectocarpus confervoides f. pygmaeus (Aresch.) Kjellm.

Fronds forming a more or less extended layer, 1–12 mm. (mostly 1–3 mm.) high, unbranched, or slightly so, above, branches only slightly tapering at the apices; erect filaments 12–25μ diam., not constricted at the joints, cells 2–3 times as long as the diameter below, shorter above; chromatophores few, irregularly band-shaped; zoosporangia uncertain; gametangia terminal or lateral on the erect filaments, sessile or on short pedicels and often abundant on the creeping filaments, broadly conical or fusiform, abruptly narrowed at the apex, 60–100μ long, 20–30μ broad.

On various larger Melanophyceae. Alaska (Shumagin Islands) to central California (Pacific Grove).

Kjellman, Handb., I, 1890, p. 77; Saunders, Phyc. Mem., 1898, p. 154, pl. 15, figs. 5–9; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 525. *Ectocarpus terminalis* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1387. *Ectocarpus confervoides variabilis* Tilden, Amer. Alg. (Exsicc.), no. 358. *Ectocarpus pygmaeus* Areschoug, *in* Kjellman, Skand. Ectocarp., 1872, p. 85.

3. **Ectocarpus acutus** S. and G.

Fronds 5–9 cm. high, dark brown when dried, olive green when living, feathery; erect filaments more or less entangled and fasciculate below, free above, profusely branched, main filaments densely corticated; branches mostly alternate, strict; ultimate ramuli often secund, acute-subulate; cells slightly doliiform, 40–60μ diam., 0.4–2 times as long as broad (usually shorter than the breadth); chromatophores thick, irregularly branched bands, few in a cell, containing several pyrenoids; zoosporangia unknown; gametangia numerous and regularly placed, cylindrico-conical, 100–150μ (up to 230μ) long, 20–35μ broad.

Growing, for the most part at least, on larger Melanophyceae. Puget Sound to central California (Carmel).

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 404, pl. 48, figs. 36–39 and pl. 49, figs. 40, 41. *Ectocarpus penicillatus* Saunders, Phyc. Mem., 1898, p. 155, pl. 21, figs. 3, 4 (not of Kjellman). *Ectocarpus confervoides* f. *acuminatus* Collins, *in* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 237, Mar. Alg. Vancouver Is., 1913, p. 106; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), nos. 1033, 1127.

The type of this species is no. 2886 of Gardner, collected at Carmel, California, in May, 1915, and growing on *Desmarestia herbacea*. It seems to be the same as the plant figured (and described) by Saunders (*loc. cit.*) under *Ectocarpus penicillatus*. It is undoubtedly the same plant as that described by F. S. Collins under the name *E. confervoides* f. *acuminatus* which was founded on no. 235 of Gardner (Herb. Univ. Calif., no. 99022) collected at Whidbey Island, Washington, growing on a broad form of *Desmarestia*. Its affinities are closely with *Ectocarpus confervoides* f. *typicus*, but it has shorter cells, sharper ramuli, decidedly constricted filaments, with the gametangia more inclined toward cylindrical than is general in that form. The chromatophores are more distinctly band-shaped and more separated from one another than in *E. confervoides*.

A few small but profusely fruiting specimens of plants seemingly of this species have been found growing on *Myriogloia Andersonii* at Neah Bay, Washington (Gardner, no. 3817). These were attached to the host by means of penetrating rhizoidal filaments, particularly by the descending corticating filaments. The specimens differ from the typical form in being smaller, in having shorter and blunter gametangia and in having on separate individuals seriate zoosporangia (?) some of which are divided longitudinally into four loculi. Further study of more material will be necessary to determine the status of this form. For the present we are placing it with *E. acutus*. The zoosporangia are very numerous, and they resemble in form those figured by Sauvageau (1896*b*, p. 33) for *Ectocarpus virescens*. They, however, have a glistening appearance, as though they were abortive or in a pathological condition, while those represented by Sauvageau are producing zoospores. This condition in which we find ours is quite common among our Pacific Coast species of *Ectocarpus*. We have not yet seen a single specimen in which the so-called seriate zoosporangia show any indication of producing zoospores.

4. **Ectocarpus tomentosus** (Huds.) Lyngb.

Fronds tufted or caespitose, consisting of masses of erect, simple or branched, rope-like strands, yellowish brown to dark brown; prostrate filaments short, irregularly branched; erect filaments twisted together into rope-like masses, 1 mm. to 20 cm. high; main branches long, divergent; ultimate ramuli profuse, alternate, irregularly spaced, never opposite, mostly short and patent, subpiliferous, often hooked at the tips; cells of the main erect filaments 8–12μ broad, 1.5–2.5 times as long as broad, especially below, mostly quadrate above; chromatophores irregularly band-shaped, few in each cell; zoosporangia ovoid, terminal or lateral, 28–36μ long, 20–26μ broad; gametangia lateral, patent, often secund, straight or recurved, sessile or on short pedicels, 25–75μ long, 10–15μ broad.

Growing on members of the Fucaceae. Extending from Alaska (Harvester and Kadiak Islands) to southern California (Laguna).

Lyngbye, Hydrophyt. Dan., 1819, p. 132, pl. 44A 1–3; Greville, Crypt. Flor., vol. 6, 1828, pl. 316; Saunders, Phyc. Mem., 1898, p. 155, pl. 24, figs. 1, 2, Alg. Harriman Exp., 1901, p. 417; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 238. *Ectocarpus tomentosoides* Guernsey, Notes on Mar. Alg., 1912, p. 198. *Conferva tomentosa* Hudson, Fl. Angl., 1762, p. 480 (in part). (Ed. 2, 1778, p. 594.)

Our idea of *Ectocarpus tomentosus* dates back definitely only to Dillwyn. His interpretation differs somewhat from that of botanists earlier than his time, but is probably as reliable an interpretation of the species of Hudson as may be possible. Much hinges on the ideas as to the identity of the plant of Dillenius (1741, p. 19, pl. 3, fig. 19) figured and described under the name of *Conferva marina tomentosa, minus tenera et ferruginea* which is quoted by Hudson among the synonyms of his species. The figure of Dillenius is not reassuring and Dawson Turner (Trans. Linn. Soc., vol. 7, 1804, p. 105), as quoted by Dillwyn, states that the specimen in the Dillenian Herbarium "is only a bad specimen of *C. littoralis*." Dillwyn, however, is convinced from the description of Dillenius, as well as by "the original drawing in Sir Joseph Bank's Library" that he is correct in his interpretation.

Ectocarpus tomentosus varies much in height and in the matter of the greater or less branching of the rope-like masses into which the erect filaments and their branches are intertwined. Our Pacific Coast plants are all shorter than the average and more simple. We have found, in certain specimens, long seriate intercalary gametangia of the type of those of *Pylaiella* near the tips of some of the branches. The occurrence of such gametangia in several species of true *Ectocarpus* is worthy of note as well as extremely puzzling. They were particularly noticed also in specimens of *E. confervoides* f. *variabilis*.

The name *Conferva tomentosa* first appears in 1762 in the earliest edition of Hudson's Flora Anglica (p. 480). Hudson quotes two numbers of Dillenius's Historia Muscorum (1741), viz., no. 12 and no. 13 (*loc. cit.*, p. 19 and pl. 3, figs. 12 and 13). In the later editions of his work (1778, etc.) Hudson quotes only the second (no. 13) of these Dillenian descriptions as truly *C. tomentosa*, referring the first (no. 12) to his *Conferva albida*, now usually recognized to be *Cladophora albida* Kuetzing. The actual founding of *Conferva tomentosa* in the sense of Dillwyn, therefore, rests on the synonymy quoted in the edition of 1778 which is, so far as we are aware, the only Hudsonian reference thus far quoted for the species.

5. **Ectocarpus corticulatus** Saunders

Fronds 0.2–3 cm. high, tufted or feathery, from a small compact mass of creeping filaments; main filaments 90–120μ broad, usually densely corticated, irregularly and frequently branched; cells of main filament 65–90μ broad, usually shorter than long, doliiform; cells of branches and ramuli seldom as long as broad, terminal cells tapering, blunt; chromatophores band-shaped, few in each cell, often with pyrenoids; sporangia unknown; gametangia narrowly to broadly ovoid, 30–40μ long, 12–18μ broad, secund on the branches and ramuli, or even on the corticating filaments, short-stalked or sessile.

On larger Melanophyceae and on *Zostera*. Alaska (Popof Island) to southern California (San Pedro).

Saunders, Phyc. Mem., 1898, p. 152, pl. 20. *Ectocarpus confervoides corticulatus* Saunders, Alg. Harriman Exp., 1901, p. 418; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 238; Collins, Mar.

Alg. Vancouver Is., 1913, p. 106, not *Ectocarpus granulatus* f. *corticulatus* Collins, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1590.

There are two species of *Ectocarpus* of fair height with broader but short cells in the filaments occurring on our coast. One of these is *E. acutus* S. and G. and the other *E. corticulatus* Saunders. The differences between these two usually strongly corticated species are to be found in the differing terminal cells of the branches and ramuli and in the shapes and dimensions of the gametangia. After carefully considering the different points of view as represented in the synonymy, we have felt compelled to recognize the autonomy of this species as well as its close relationship with *Ectocarpus acutus.*

6. **Ectocarpus fructuosus** S. and G.

Fronds tufted, profusely and alternately branched, up to 2.5 cm. high, attached by a mass of relatively short, creeping filaments; erect filaments several times forked near the base, producing long branches beset throughout with numerous, short, blunt ramuli of 2–3 orders; cells of main erect filaments cylindrical to slightly doliiform, and in part constricted at the cross-walls, 18–25μ diam. below, 2–4 times as long, slightly wider and shorter above; zoosporangia unknown; gametangia numerous, broadly conical, sessile or on 1–3-celled pedicels, 50–70μ long, 25–35μ broad at the base.

Growing on the pneumatocyst of *Nereocystis Luetkeana.* Moss Beach, San Mateo County, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 410, pl. 45, figs. 1–4.

Ectocarpus fructuosus comes within the *E. confervoides* group, but seems amply distinct from any known forms to constitute a species. This species is based upon the character of the branches, viz., numerous long branches, producing throughout a great abundance of short, rather blunt ramuli and upon these very numerous, rather short and blunt, predominatingly sessile, gametangia. It seems to be a rare species.

7. **Ectocarpus mucronatus** Saunders

Fronds loosely intertwined, 1–6 cm. high, light olive green, attached by a few colorless creeping filaments; erect filaments profusely branched in the upper parts, piliferous; primary branches subdichotomous; ramuli alternate, mostly short and pointed; cells of main filaments cylindrical, 30–40μ diam., 1–3 times as long as the diameter below, 0.3–0.6 as long above; chromatophores numerous, small, discoid; zoosporangia unknown; gametangia numerous, broadly ovoid, short-acuminate, sessile, 50–100μ (up to 155μ) long, 20–30μ broad.

Growing on other algae and on *Zostera*. Vancouver Island (Bayard's Point) to southern California (San Pedro).

Saunders, Phyc. Mem., 1898, p. 152, pl. 19. *Ectocarpus granulosus* Tilden, Amer. Alg. (Exsicc.), no. 359*b* (not 359*a*).

Ectocarpus mucronatus seems to be a species of frequent occurrence in southern California. We have referred a very similar plant from the Puget Sound region (no. 359*b* of Tilden) here also. It is to be distinguished from other larger feathery species of this genus particularly by its broadly ovoid, abruptly and shortly mucronate gametangia.

8. **Ectocarpus Taoniae** S. and G.

Plate 51, fig. 15

Fronds diffuse, 0.5–1.5 mm. high, attached by profusely branched, superficial, creeping filaments; erect filaments simple, narrowed slightly at the base, gradually attenuated above, piliferous; cells of the creeping filaments cylindrical, 4–6μ diam., those of the erect filaments 8–10μ diam., quadrate below, 4–6 times as long as the diameter at the apices; chromatophores short, relatively thick, irregular bands; zoosporangia unknown; gametangia narrowly ellipsoidal, at times slightly curved, mostly sessile on the creeping and on the erect filaments, 20–28μ (up to 40μ) long, 15–20μ broad.

Growing on *Taonia Lennebackerae*. San Pedro, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 413, pl. 46, fig. 15.

This species forms rather diffuse and even layers, mostly along the margins of *Taonia*, over whose surface the creeping filaments spread and give rise to gametangia or to erect filaments not over 1.5 mm. high. In many ways it seems like a miniature *Ectocarpus Padinae* (Buffh.) Sauvageau (1896*c*–1897*a*, p. 30 *et seq.*). Our species, however, is only about one-half as tall, the cells of the erect filaments about one-half as broad, and the gametangia less than half as large as those of *E. Padinae*. We have found gametangia only of the "antheridium" type. *Ectocarpus Padinae* has its creeping filaments entirely endophytic while *E. Taoniae* has them entirely epiphytic.

9. **Ectocarpus terminalis** Kuetz.

Fronds 0.75–2 (or 4) mm. high, mostly forming a continuous velvety layer, brownish in color; creeping filaments irregular, branched, anastomosing and forming, at times, a partially pseudo-parenchymatous layer; erect filaments simple or sparingly branched, more or less attenuated above; cells of creeping filaments 8–24μ long, 10–18μ broad; cells of erect filaments cylindrical, 8–12μ broad, up to six times as long; chromatophores short, band-shaped, few in each cell; zoosporangia terminal, ellipsoidal, 26–52μ long, 20–30μ broad; gametangia ovoid or ovoid-oblong, often curved, terminal, or lateral and sessile or short-stalked, 48–120μ long, 16–32μ broad.

On larger Melanophyceae. Alaska (Unalaska) to southern California (Laguna).

Kuetzing, Phyc. Germ., 1845, p. 236, Tab. Phyc., vol. 5, 1855, pl. 74, fig. III; Kjellman, Skand. Ectocarp., 1872, p. 54, pl. 2, figs. 7*a*, 7*b*; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 237; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1034 (in part) (not no. 1387).

We have accepted Kjellman's interpretation of Kuetzing's *Ectocarpus terminalis* and refer here, although not without some hesitation, no. 1034 of the Phycotheca Boreali-Americana found growing on stipes of *Alaria fistulosa* in Unalaska Bay. There is intermingled in our specimens, however, a plant which seems to be a form of *Ectocarpus confervoides*. We have also referred here a plant found growing on *Fucus* at Fort Ross, California.

The creeping filaments in this species anastomose more or less and in some parts of the specimens form almost a parenchymatous basal layer, strongly resembling that of the species of the Myrionemataceae. Nearly every cell of the prostrate filaments gives off an erect filament, a condition characteristic among the Myrionemataceae, but not general among the Ectocarpaceae. The erect filaments are slender, with rather long cylindrical cells, and bear terminal zoosporangia and either terminal or lateral, sessile or short-stalked, gametangia. The chromatophores are clearly band-shaped though short. No. 1387 of the Phycotheca Boreali-Americana seems to be entirely made up of a form of *Ectocarpus confervoides*.

10. **Ectocarpus simulans** S. and G.

Fronds 1–2 mm. high, tufted; prostrate filaments irregular, tortuous, distinct; erect filaments simple, tapering slightly upward, not piliferous; cells cylindrical, not constricted at the dissepiments, 11–13μ diam. in the central part of the filament, 1–2.5 times as long as the diameter; chromatophores band-shaped, nearly covering the cell, few; zoosporangia unknown; gametangia lateral or occasionally terminal, sessile, narrowly ellipsoidal, blunt, mostly slightly curved, 55–65μ long, 15–20μ wide.

Growing on *Chaetomorpha aerea*. Cypress Point, Monterey County, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 412, pl. 45, figs. 9–11.

The present species resembles, in general, certain forms of *Ectocarpus pusillus* Griffiths (cf. Sauvageau, 1895), but the erect filaments are much more slender, usually never branched, and with much smaller gametangia. It forms tufts on *Chaetomorpha aerea*, whose filaments are encircled by the prostrate filaments of the *Ectocarpus* which form small cushions in their growth over one another. The gametangia are rather blunt and often more or less curved.

11. **Ectocarpus flagelliferus** S. and G.

Fronds densely tufted, 3–5 mm. high, attached by a few creeping filaments and by small, colorless, descending rhizoidal filaments from the lower cells; erect filaments simple below, sparingly and alternately branched above, tapering gradually upward and abruptly at the base, piliferous when young; cells of the main filaments slightly doliiform, 25–35μ diam., 0.25–1.5 times as long as the diameter; chromatophores small, irregular bands or plates, without pyrenoids; zoosporangia unknown; gametangia very variable in shape and size, fusiform to cylindrico-conical, mostly lateral on long pedicels, occasionally terminal on short, erect filaments, or long seriate-intercalary on the main filaments, the lateral 125–200μ long, 28–40μ broad, the terminal and intercalary up to 1.5 mm. long.

Growing on eel grass. Sitka, Alaska.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 408, pl. 47, figs. 25–27.

Ectocarpus flagelliferus, while resembling superficially some of the shortest plants of *Ectocarpus confervoides* f. *variabilis*, presents several peculiarities which are characteristic. The plants of this species are attached, so far as the adult specimens we have for study are concerned, by rhizoidal filaments which originate from several of the lower cells of the erect filaments and form complex basal masses which almost completely obscure the creeping filaments. Neither the rhizoidal filaments nor the creeping filaments, however, penetrate the host. The chromatophores are small and irregular in outline, seeming to be short bands rather than regular disks. They are generally so closely placed in the younger cells as to seem almost like a continuous band, but are separate in the older cells, with slender processes almost connecting them to one another. The cells are short and the erect filaments and their branches extend out into long hairs like whiplashes. The lateral gametangia are variable in shape, arranged much as in *Ectocarpus confervoides* f. *variabilis*, but are of different dimensions. Besides the characteristic *Ectocarpus*-type of gametangia which are lateral, there occur terminal seriate gametangia of the *Pylaiella*-type which reach an extreme length of 1.5 mm.

12. **Ectocarpus Mesogloiae** S. and G.

Fronds minute, 0.75–1.5 mm. high, attached by a mass of densely intertwined, branched, rhizoidal filaments penetrating among the cells of the host; erect filaments sparingly and alternately branched; main filaments and ramuli tapering gradually upward, very acute, not piliferous; cells cylindrical, slightly constricted at the dissepiments, 15–18μ diam. at the base, 1–2 times as long, 4–6μ at the apices of the filaments; chromatophores thin, irregular bands, nearly covering the cell; zoosporangia unknown; gametangia narrowly cylindrico-conical, 120–160μ (up to 210μ) long, 18–22μ broad, on short pedicels, rarely sessile.

Growing on *Myriogloia Andersonii* (Farlow) Kuck. Carmel Bay, Monterey County, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 411, pl. 45, figs. 5, 6.

The general characters of this diminutive species ally it with the *E. confervoides* group. We have deemed it best to consider it a distinct species on account of the small dimensions of all of its parts and its penetrating habits. It has not been seen on any other host except the one mentioned above.

13. **Ectocarpus commensalis** S. and G.

Fronds 200–400μ high, densely fasciculate, attached by intertwined, slightly branched rhizoids penetrating among the utricles and even well among the medullary filaments of the host; erect filaments alternately branched near the base, simple above, slightly attenuated upward, not piliferous; cells of the erect filaments cylindrical, not constricted, 12–18μ diameter at the base of the filaments, 1.5–2.5 times as long as the diameter; chromatophores band-shaped, few in each cell; zoosporangia unknown; gametangia blunt-fusiform to cylindrico-conical, short-pedicellate, mostly lateral near the base of the filaments, rarely terminal, 60–100μ long, 15–20μ wide.

Growing on *Codium Setchellii* Gardner, Carmel Bay, and on *Codium fragile* (Suring.) Hariot, Pacific Grove, Monterey County, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 407, pl. 48, figs. 32–35.

This minute species of *Ectocarpus* is one of several occurring on species of *Codium*, both on this coast and on that of southwestern Europe. The colorless rhizoidal filaments descend into the substance of the host even to the central (or basal) medullary tissues. The smaller diameter of the erect filaments and the more narrowly conical or fusiform gametangia readily distinguish this species from the others.

14. **Ectocarpus eramosus** S. and G.

Fronds diffused or in diminutive tufts, 1–3 mm. high, attached by irregularly branched rhizoidal filaments penetrating deeply among the utricles of the host; erect filaments eramose or rarely producing short, divergent branches usually terminated in gametangia, slightly attenuated toward the base and the apex, not piliferous; cells of mature filaments 28–40μ diam., 0.5–1.25 times as long as the diameter, cylindrical, very slightly constricted; chromatophores relatively thick, closely crowded, irregular bands without pyrenoids; zoosporangia unknown; gametangia very variable in shape and size, lateral and alternate along the entire filament or occasionally terminal and seriate on the main filaments, mostly on few-celled pedicels, lateral forms cylindrical to cylindrico-conical, 150–230μ long, 26–36μ diam., terminal, seriate forms, 700–900μ long, 15–20μ broad.

Growing on *Codium fragile* in the lower littoral belt. Near the entrance to Tomales Bay, Marin County, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 407, pl. 47, figs. 18–23.

This very small species has the general appearance of a form of *Ectocarpus confervoides*, but the cells are short and the filaments very slightly constricted at the partitions. It seems, in these respects, nearer to *E. acutus* and *E. corticulatus*, possibly bearing something of the same relation to these species that the dwarf forms of *E. confervoides* do to the typical form. *Ectocarpus eramosus*, however, is not readily to be referred as a dwarf form of either *E. acutus* or *E. corticulatus* and is consequently to be kept separate, at least for the present.

15. **Ectocarpus luteolus** Sauv.

Prostrate filaments moniliform, irregularly branched, covering, or even occupying, the injured cells on the surface of the host, even occasionally penetrating slightly inward, not anastomosing, but forming an irregular and confused layer of almost parenchymatous aspect emitting tortuous rhizoidal filaments from its lower cells; erect filaments very short, 100–300μ high, terminating in delicate hairs (or, at times, in seriate gametangia), simple or with a few branches from near the base; cells of the erect filaments short, swollen, and nearly globular below, cylindrical and longer above, about 8μ broad, 1.5 times as long as broad; chromatophores few in each cell, band-shaped; zoosporangia terminal on short basal branchlets, oblong-ellipsoidal, 26–30μ long, 16–18μ broad; gametangia narrowly cylindrical, consisting of single or double rows of loculi, 30–80μ (in ours about 30–45μ) long, 7–13μ (in ours 11–13μ) broad.

Forming small expansions on the surface of the lower portion of *Pelvetiopsis limitata* f. *typica* Gard. Central California (San Francisco).

Sauvageau, Sur. quelq. alg., 1892, p. 79 (p. 42 in repr.), pl. II, figs. 14–19; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1233. *Streblonema luteolum* De-Toni, Syll. Alg., vol. 3, 1895, p. 575.

Ectocarpus luteolus Sauv. is one of the species which seems intermediate between *Ectocarpus* and *Streblonema*. It does penetrate the host slightly and occasionally, but it seems to grow on the lower abraded portion of the host, filling the hollows between and even the cavities of the injured cells. Its prostrate filaments and the lower portions of the erect filaments have moniliform, almost globular, cells which, together with rhizoidal filaments issuing from the very basal ones, while perfectly separate, form a thin layer or cushion, with something of the appearance of that of *Elachistea*.

Our specimens seem to agree so closely with the figures and description of Sauvageau and to grow under such almost identical conditions, that we must necessarily refer them to this species. Thus far it has been detected only at Lands End, San Francisco, California, and only on one occasion. Our specimens show zoosporangia (not hitherto described) as well as gametangia.

16. **Ectocarpus granulosus** (Eng. Bot.) Ag.

Fronds tufted, rather coarse and rigid, 1–8 cm. (up to 16 cm.) high, profusely branched; primary branches opposite or whorled, mostly corticated below; secondary branches opposite or at times alternate, short, tapering upward, often recurved at the tip, ending in hairs; ultimate ramuli secund, short, acute, ending in short hairs; cells of the main filaments 80–100μ diam., quadrate or shorter than the diameter, constricted at the cross-walls; chromatophores small, regular disks; zoosporangia "sessile, globose"; gametangia sessile, broadly ovoid, asymmetrical, mostly secund on the terminal and subterminal ramuli, 60–100μ long, 30–60μ broad.

Growing on various other algae and on stones in the lower littoral belt. Washington (Puget Sound) to southern California (San Pedro).

Agardh, Sp. Alg., vol. 2, 1828, p. 45; Saunders, Phyc. Mem. 1898, p. 156, pl. 24, figs. 3–5; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 238; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1589. *Ectocarpus granulosus* f. *corticulatus* Collins, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1590. *Conferva granulosa* English Botany, 1814, pl. 2351.

Ectocarpus granulosus was discovered by W. Borrer in the vicinity of Brighthelmston (Brighton), East Sussex, England, and is now reported from many coasts of Europe and both eastern and western North America. There is considerable variation, especially as regards dimensions both of the primary branches and of the gametangia. In some of our specimens, the gametangia reach a length of 165μ, and a breadth of 65μ, but the majority are 90–110μ long and 50–60μ broad. We have not seen zoosporangia in any of our specimens. The very distinctly discoid chromatophores and the opposite arrangement of most of the main branches clearly distinguish this species from any other on our coast.

17. **Ectocarpus Parksii** S. and G.

Plate 49, fig. 15

Fronds 5–7 cm. high, densely caespitose, flaccid; main filaments of erect fronds, 34–40μ diam. in the lower part, tapering very gradually upward, profusely and alternately branched, very slightly corticated at the base; branches of succeeding orders reduced in diameter, long and tapering very gradually upward, not terminating in hairs; ultimate ramuli 10–15μ diam., terminal cell 5–7μ diam.; cells cylindrical to very slightly doliiform, 40–70μ long in the main filaments, quadrate to subquadrate above; chromatophores numerous, irregular plates densely crowded together and more or less connected in the ramuli, becoming more regularly disk-shaped and separate in the lower parts of the main filaments; gametangia relatively sparse, sessile, straight or slightly curved upward, mostly on the subterminal and terminal ramuli, secund, 4–10 in a group, occasionally solitary, blunt fusiform to subconical, 35–45μ long, 18–22μ broad.

Growing on *Gracilaria confervoides* (L.) Grev. in a small cove, San Francisco Bay, northeast of Tiburon, Marin County, California.

Setchell and Gardner, Phyc. Cont. VII, 1924, p. 1.

This species of *Ectocarpus* appears to be a very short lived spring form. Within a month after it was first observed, apparently just coming into fruit, it had largely disappeared. Its structure seems to relate it to several of our west coast species. Its long, slender, gradually tapering filaments, profusely branched, are similar to those of *E. siliculosus* (Dillw.) Lyngb. Its sessile gametangia are similar in form to those of *E. Taoniae* S. and G. The secund arrangement of the gametangia and the disk-shaped chromatophores are characters belonging to *E. granulosoides* S. and G. The delicate fronds, with profuse, alternate branching, the disk-shaped chromatophores, and the groups of small, sessile, blunt, secund gametangia make a combination of characters not found in any other species.

18. **Ectocarpus Mitchellae** Harv.

Fronds aggregated into dense feathery tufts, 2–8 cm. high, decompoundly branched, attached by long creeping filaments; yellowish green or olive green on drying; branching alternate, the branches divaricate, attenuated, often ending in short hairs, ultimate ramuli approximated; cells in the main branches 25–40μ diam., 1–3 times as long as the diameter below, shorter above; chromatophores numerous, small, discoid; zoosporangia unknown; gametangia ellipsoidal to narrowly oblong, obtuse, 50–100μ long, 18–35μ wide, sessile, mostly secund on the upper side of the branches.

Growing on limpets and on *Phyllospadix* in the lower littoral belt. Southern California.

Harvey, Ner. Bor.-Amer., part I, 1851, p. 142, pl. 12, G; Collins, Notes on New England Algae V, 1891, p. 337; Saunders, Phyc. Mem., 1898, p. 153, pl. 21, figs. 1, 2; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 671.

We have specimens from several collections from the coast of southern California which agree so well with plants from the southern New England coast referred to *E. Mitchellae* that we cannot satisfactorily separate them from it. We call attention to the views of Sauvageau (1896*b*, p. 39), Collins (1891, p. 337), Saunders (1898, p. 153) and Börgesen (1914, pp. 159–162) as to the possible relation, or even identity, of this species with *E. indicus* Sond., *E. virescens* Thuret, and *E. Duchassaingianus* Grunow, but we have no additional facts to present.

Our specimens show both mega- and meio-gametangia such as Sauvageau (1896*b*) describes and illustrates for *E. virescens* Thuret.

19. **Ectocarpus oviger** Harv.

Fronds somewhat densely matted together, 7–15 cm. (up to 22 cm.) high, main filaments densely corticated, dark brown, decompositely branched; branches mainly alternate, in part secund, strict; cells cylindrical throughout the frond, not constricted, 60–70μ diam. in the main filaments, 1.5–2.5 times as long as the diameter; chromatophores discoid, numerous; zoosporangia uncertain; gametangia broadly ovoid to subspherical, asymmetrical, sessile or subsessile, alternate or in part secund, promiscuously scattered throughout the branches, 35–45μ long, 30–35μ broad.

Growing on *Nereocystis Luetkeana.* Puget Sound region to central California.

Harvey, Coll. Alg. N.W. Amer., 1862, p. 167; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 238. *Ectocarpus granulosus* Tilden, Amer. Alg. (Exsicc.), no. 359*a* (not no. 359*b*); Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 2242.

The *Ectocarpus oviger* Harvey has been a puzzle for phycologists who, in general, have been inclined to refer it to *E. granulosus,* to which latter species Harvey himself compared it. An examination of the type specimen at Dublin and a careful study of Harvey's description, lead us to refer here no. 359*a* of Tilden's American Algae and no. 2242 of the Phycotheca Boreali-Americana and to keep *E. oviger,* at least as thus interpreted, distinct from *E. granulosus.* Harvey speaks of his plants as having the aspect of *Pylaiella littoralis,* and the plants we refer to his species resemble certain varieties or forms of that species more than they do any forms of *E. granulosus.* Harvey also remarks that the "fruit" of his species is like that of *E. granulosus,* and it is true that, in our specimens, which show only gametangia, these resemble the gametangia of *E. granulosus* more than those of any other species, but differ from them sufficiently in shape and dimensions to prevent merging the one species into the other. Our conclusion is that *Ectocarpus oviger,* while closely related to *E. granulosus,* is sufficiently different from it in habit, in the length of the main filaments, and in the shape and size of the gametangia, to be retained as an independent species.

We have indicated that we are uncertain as to the zoosporangia in this species, although it has been supposed that the "fruit" described by Harvey is zoosporangial. The bodies seen on the portion of the type specimen examined seemed to be empty zoosporangia. On the other hand, the gametangia at maturity and about to discharge their gametes show little or no trace of the internal partitions, so that further experience with this species is very desirable.

20. **Ectocarpus breviarticulatus** J. Ag.

Fronds tufted, 2–4 cm. high, arising from creeping filaments; erect filaments about 27μ broad (35–45μ, *fide* Kuetzing and De-Toni), either sparingly branched or more or less beset with short branchlets, both branches and branchlets attenuated toward the apex and hooked, intertwined into rope-like masses; cells usually 1.5–2 times as long as broad; chromatophores disk-shaped, several in each cell; zoosporangia unknown; gametangia from nearly spherical to broad ovoid, about 62μ long, 57μ broad.

On *Chnoospora pacifica.* West coast of Mexico (St. Augustin).

J. G. Agardh, Nya Alger från Mexico, 1847, p. 7, Sp. Alg., vol. 1, 1848, p. 16; Kuetzing, Spec. Alg., 1849, p. 453; Börgesen, Mar. Alg. Dan. West Indies, pt. 2, 1914, p. 173, fig. 136. *Ectocarpus hamatus* Crouan, *in* Maze et Schramm, Ess. Class. Alg. Guad. (ed. 2), 1870–77, p. 111 (*fide* Börgesen); Vickers, Phyc. Barbad., pt. 2, 1908, pl. 29.

Ectocarpus breviarticulatus J. Ag. is known to us as a member of our flora only from the literature and particularly from Börgesen's (*loc. cit.*) account of it. It seems closely related to *E. oviger,* from which it differs chiefly in size and branching, and slightly in dimensions of filaments and gametangia. Both Kuetzing and Börgesen state that they have examined cotypes and may be, therefore, considered to have spoken with authority. We have been enabled to study what certainly seems to be this species in material from American Samoa (cf. Setchell, Veg. Tut. Isl., p. 171, fig. 37).

21. **Ectocarpus chantransioides** S. and G.

Fronds arising from contorted creeping filaments, forming dense hemispherical cushions 4–8 mm. high; branching profuse, alternate below, mostly secund above; main filaments and branches not attenuated; cells 8–10μ diam., 2–3 times as long as the diameter below, quadrate above; chromatophore band-shaped; zoosporangia unknown; gametangia mostly sessile or on short pedicels, narrowly cylindrico-conical, 80–110μ long, 16–20μ broad at the base.

Growing on boulders in the lower littoral belt. Three miles northwest of Santa Monica, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 406, pl. 48, figs. 28–31.

The habit of *Ectocarpus chantransioides* distinguishes it at once from all other species of the genus with the exception of *E. hemisphericus* Saunders. The latter species is always found, so far as our knowledge is concerned, epiphytic on Fucaceae, while the former species is confined to rocks. *Ectocarpus chantransioides* has also more slender filaments than has *E. hemisphericus,* not at all tapering, and has distinct apical growth. The gametangia are differently shaped, being longer and more slender. It is therefore very distinct even from *E. hemisphericus.* It resembles the genus *Choristocarpus* of the family Choristocarpaceae, as diagnosed by Kjellman (1891, pp. 190, 191), in having apical growth. The growth in length of the erect filaments in the Choristocarpaceae is by the division of the terminal cell only, whereas in *E. chantransioides* the meristem extends over a number of cells at the outer or apical end of the filaments. These cells, some 10 to 15 in number, are much richer in cell contents, the terminal cell being the richest of all in the series. This is a very unusual condition for an *Ectocarpus*. The nearly uniform diameter throughout of the erect filaments and their method of branching resemble to a remarkable degree those characters found in *Chantransia*. The gametangia are typically those of *Ectocarpus* and, notwithstanding the other rather unusual characters, it seems to be most closely related to that genus, but a very distinct species.

22. **Ectocarpus granulosoides** S. and G.

Fronds 2–3 cm. high, profusely branched; main filaments subdichotomously branched, all branches suddenly attenuated at the base, corticated below, secondary filaments mostly alternate, in part secund, strict, long-attenuate, acute, not piliferous; ultimate ramuli mostly secund, acute; cells of the main filaments 70–80μ diam., 0.5–1 times as long as the diameter, those of the secondary filaments 30–40μ diam., 0.3–1 times as long and those of the ultimate ramuli 14–20μ diam., 0.3–1.5 times as long, all slightly constricted at the dissepiments; chromatophores numerous, discoid in the older cells, irregularly angular in the ramuli; cells of the corticating filaments 7–10μ diam., 3–4 times as long as the diameter; zoosporangia unknown; gametangia secund on the upper side of the ultimate and penultimate ramuli, sessile, subfusiform, asymmetrical, 40–60μ long, 12–20μ broad.

Growing on rocks (?). San Pedro, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 410, pl. 45, figs. 7, 8.

The very distinct species we have described under the name of *Ectocarpus granulosoides* has the habit of a small *E. granulosus* and gametangia of the same general type as found in that species, but considerably smaller. The branching, however, is never opposite, and the acute ramuli gradually attenuated upward recall those of *E. acutus*, from which our species is amply distinct in both chromatophore and characters of its gametangia. The branches, particularly the larger, are very suddenly and considerably attenuated at the base, giving the species a striking characteristic of its own, at least within the group of species with discoid chromatophores.

23. **Ectocarpus affinis** S. and G.

Plate 51, figs. 16, 17

Fronds diminutive, 500–700μ high, attached to the host by a few branched, colorless, entwining, rhizoidal filaments; erect filaments sparingly branched, gradually attenuated upward, piliferous; branches alternate or opposite; cells of the main filaments cylindrical, 24–30μ diam. at the base, 9–11μ at the apex, varying in length throughout the filament, 0.75–3 times as long as the diameter; chromatophores small, thin, angular plates in young cells, nearly regular disks in older cells; zoosporangia unknown; gametangia lateral, mostly sessile, occasionally on 1-celled pedicels, solitary, secund, or in whorls from a single cell, blunt-conical to spheroidal, 28–31μ long, 25–28μ broad, arranged along the entire filament to the terminal hairs.

Growing on *Callithamnion* sp. Sitka, Alaska.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 405, pl. 46, figs. 16, 17.

Two collections from Sitka, Alaska, but both made on the same day, show a small *Ectocarpus* growing on a species of *Callithamnion* which is so closely related to *E. ovatus* Kjellman (1877*a*, p. 35) that perhaps it may seem necessary, at some time, to refer it to that species. The plants are, however, less stout than those of Kjellman and with more nearly spherical gametangia. For these reasons and because of its geographic remoteness and the somewhat different climatic conditions, we feel that it is desirable to describe the Alaskan plant as a distinct, but closely related, species.

24. **Ectocarpus cylindricus** Saunders

Fronds diffuse, 1–2 mm. high; creeping filaments superficial; erect filaments very sparingly branched above, several arising from the same creeping filament, tapering slightly at the base and apex; cells of the creeping filaments 16–20μ diam.; cells of the erect filaments cylindrical, slightly constricted at the cross-walls, 2–3 times as long as broad below and at the apex, 0.5–1 times in the middle of the filament; gametangia mostly on the middle and upper parts of the filaments, usually alternate.

Growing on *Egregia Menziesii* and *Cystoseira osmundacea*. Central California (Pacific Grove).

Saunders, Phyc. Mem., 1898, p. 150, pl. 16; Setchell and Gardner, Phyc. Cont. VI, 1922, p. 415 (f. *typicus*).

The typical form, growing on the larger brown algae, differs somewhat from the variety found growing on *Codium* as is indicated below.

Ectocarpus cylindricus f. **codiophilus** S. and G.

Plate 51, fig. 14

Fronds densely caespitose, 3–5 mm. high; rhizoidal filaments densely intertwined, penetrating the host; erect filaments anastomosing and forked at the surface of the host, unbranched above, piliferous; gametangia, for the most part, near the base of the erect fronds.

Growing on *Codium fragile* (Suring.) Hariot and *Codium Setchellii* Gardner. Carmel Bay, Monterey County, and La Jolla, San Diego County, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 415, pl. 46, fig. 14 and pl. 49, figs. 42–45.

This form differs from the typical form in having penetrating rhizoidal filaments and in having the gametangia in a dense zone at or near the base of the erect filaments instead of being scattered.

Ectocarpus cylindricus f. **acmaeophilus** S. and G.

Fronds tufted, 7–10 mm. high; creeping filaments superficial; erect filaments unbranched, nearly the same diameter throughout; zoosporangia unknown; gametangia up to 270μ long, mostly opposite on the upper part of the erect filaments.

Growing on *Acmaea* sp. Carmel Bay, Monterey County, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 415, pl. 49, fig. 46.

This form seems to be rare, at least but few specimens have been detected up to the present time. It differs from the typical form in being practically unbranched, except the fructiferous branches. Where branches occur, they seem to arise as the result of an injury to the main filament. Also it differs in having the erect filaments more nearly cylindrical throughout. And finally it differs in having the gametangia more often opposite, and generally longer and proportionally narrower.

25. **Ectocarpus hemisphericus** Saunders

Fronds pulvinate, 2–4 mm. high, arising from a compact network of creeping filaments rhizoidal in character, much attenuated and crisped; primary branches pseudodichotomous, divaricate, gradually attenuated upward; secondary branches numerous, short, clustered, mostly long-piliferous; cells at the base of main filaments 22–26μ diam., 1–3 times as long as the diameter, smaller above, slightly constricted at the joints; chromatophores numerous, small, discoid; zoosporangia cylindrical, 30–35μ long, 20–25μ diam., on 1-celled stalks, at times on the same fronds with the gametangia (Saunders); gametangia fusiform to broadly ovoid, obtuse, 30–90μ long, 14–20μ diam., lateral on the upper parts of the fronds, short-pedicellate.

Growing mostly on *Pelvetia fastigiata*, but also on other species of algae. California (San Diego, Laguna and San Pedro).

Saunders, Phyc. Mem., 1898, p. 151, pl. 17; Guernsey, Notes on Mar. Alg., 1912, p. 198, fig. 108; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 528.

Ectocarpus hemisphericus f. **minor** Saunders

Very similar to the species, but forming less definite tufts and with the erect filaments simple or but slightly branched, 1–2 mm. high, 16–21μ diam., and with gametangia and zoosporangia mostly sessile.

Growing on and near the receptacles of *Hesperophycus Harveyanus*. San Pedro, California.

Saunders, Phyc. Mem., 1898, p. 151, pl. 18, figs. 1–3; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), nos. 529 and 1794.

Ectocarpus hemisphericus Saunders, in typical form, can readily be recognized by its habit and its host, but in some forms and particularly in f. *minor* is less distinct in habit, at least. Thus far, both the species and the form seem confined to the coast of southern California.

26. **Ectocarpus Saundersii** S. and G.

Fronds forming small tufts, 2–5 mm. high, attached by a mass of branched filaments creeping on the surface of the host; branching alternate; main branches long and divergent, ultimate ramuli sparse, short, acuminate; cells of the main filaments 25–40μ diam., quadrate below, shorter above, slightly constricted at the dissepiments; chromatophores numerous, discoid; zoosporangia on short stalks or intercalary, globose, about 30μ diam.; gametangia cylindrical to ovoid, obtuse or acuminate, lateral, borne on longer or shorter pedicels, 70–150μ long, 25–50μ broad.

Growing on *Fucus,* in the middle of the littoral belt. Pacific Grove, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 411. *Ectocarpus paradoxus* var. *pacificus* Saunders, Phyc. Mem., 1898, p. 152, pl. 18, figs. 4–7; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 530.

According to Saunders, his plant, the var. *pacificus,* differs from the type of *E. paradoxus* Mont., in lacking any manifestation of opposite branching as well as in having the gametangia longer and more pointed. In these respects and also because it is a shorter plant, it seems to us to be sufficiently distinct to be separated specifically from the type, and to be different from any other species known to us.

27. **Ectocarpus acuminatus** Saunders

Fronds diminutive, attached by a network of delicate rhizoidal filaments; erect filaments uniform in size throughout, 1–2 mm. long; cells cylindrical, not constricted, 12–14μ diam., quadrate below, 2–5 times as long above; chromatophores irregular or elliptical disks, more abundant in the central part of the filament than elsewhere; zoosporangia unknown; gametangia sessile on the creeping filaments or on the base of the erect filaments or terminal on short filaments arising directly from the creeping filaments, very long-acuminate, sometimes tipped with a short hair, often more or less curved, 90–300μ long, 20–30μ broad.

Growing within the conceptacles of *Cystoseira osmundacea* and *Halidrys dioica.* Central California (Pacific Grove) to southern California (San Pedro).

Saunders, Phyc. Mem., 1898, p. 149, pl. 14, figs. 1–5; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), nos. 524 and 2142.

The shape of the gametangia would seem to ally this very inconspicuous species most closely with *E. siliculosus,* but the chromatophores are described by Saunders as elliptical. We have only dried material for examination and cannot, therefore, add anything to the description by Saunders. It is a very curious and seemingly distinct species. Its habitat, within the conceptacles of members of the Fucaceae, seems to have reduced it almost to the state of parasitism, at least one-half of the plant being unable to function in food making.

28. **Ectocarpus ellipticus** Saunders

Fronds minute, about 1 mm. high, tufted, attached by numerous, colorless, branched rhizoidal filaments; erect filaments sparingly dichotomous at the base, unbranched or with few unicellular branches above, gradually attenuated upward, piliferous; cells 9–12μ diam. and 1–2 times as long as the diameter at the base of the filaments, 3 times as long above; "chromatophores thin branched bands, oval," numerous; zoosporangia sessile, ovate or ellipsoidal, 30–40μ long, 12–18μ broad; gametangia cylindrical to blunt-conical, 75–100μ (up to 180μ) long, 18–25μ diam., borne laterally at or near the base of the erect filaments, or occasionally arising directly from the creeping filaments, sessile or on short pedicels below; loculi one to few seriate.

Growing in the conceptacles and cryptostomata of *Fucus* sp. Pacific Grove, California.

Saunders, Phyc. Mem., 1898, p. 149, pl. 14, figs. 6–9; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 527.

Ectocarpus ellipticus is a curiously localized species growing upon the inner margins of the openings of the cryptostomata and conceptacles of *Fucus* at Pacific Grove, California. Transverse sections of the fronds of the *Fucus* show that this *Ectocarpus* simply forms a ring of growth just within the outer opening of the cryptostomata and conceptacles just outside the hair-forming tissues. The rhizoidal filaments of the *Ectocarpus* penetrate into the apparently looser tissues of the ostiole of the cavities it inhabits. The gametangia are all basal or borne near the bases of the erect filaments. It seems to be a very distinct species.

29. **Ectocarpus chitonicola** Saunders

Fronds small, 1–2 mm. high, tufted, creeping filaments numerous, irregular, branched; cells of the creeping filaments 11–15μ diam., 1–2 times as long as the diameter; erect filaments mostly simple, 14μ diam. at the base, somewhat narrower above, with cells 0.5–2 times as long as the diameter below, 2–3 times as long above, not constricted at the partitions; chromatophores small oval disks, numerous; zoosporangia unknown; gametangia subcylindrical to narrowly ovoid, obtuse at the apices, 90–175μ (up to 250μ) long, 25–35μ diam., borne laterally on the erect filaments, or occasionally on the creeping filaments, the lower gametangia on pedicels, the upper sessile.

Growing in minute tufts on the shells of Chitons and Limpets. Pacific Grove and Carmel Bay, California.

"*Ectocarpus chitonicolus*" Saunders, Phyc. Mem., 1898, p. 150, pl. 15, figs. 1–4.

The illustrations of Saunders (*loc. cit.*) show a diversity of forms of the gametangia, ranging from long ones with many small loculi, to short ones with few large loculi. The species either possesses great range of variation in this respect, or else there may possibly be two species concerned. Another explanation of the phenomenon may be the possibility that we have in this species the two forms of gametangia mentioned by Sauvageau (1896*b*, p. 17) found on *Ectocarpus virescens*. Saunders' figure 2 might well represent the "megasporangia" and figures 3 and 4 the "meiosporangia" of Sauvageau. The species needs further investigation to have the validity of these points established.

In the specimens we have examined, both that of Saunders and the single one of Gardner's collecting, the gametangia are long, and large-celled. The species is to be distinguished from any other of our low forms by its discoid chromatophores and its peculiar habitat.

30. **Ectocarpus socialis** S. and G.

Plate 51, figs. 12, 13

Fronds caespitose, 1–3 mm. high, attached by densely intertwined, penetrating rhizoidal filaments; erect filaments several times forked at the surface of the host, simple above or rarely alternately branched, long-attenuate upwards, piliferous; cells cylindrical to slightly doliiform, not constricted, 22–28μ diam., 1–2 times as long as the diameter below, 4–6 times above; chromatophores small, few in a cell, discoid; zoosporangia ellipsoidal, erect, lateral, alternate, mostly on 1–2-celled pedicels, occasionally sessile near the base of the erect fronds, 60–95μ long, 35–50μ broad; gametangia fusiform, sparse on the upper parts of the erect filaments; sessile or on 1–2-celled pedicels, alternate, 70–85μ long, 25–30μ broad.

Growing on *Codium fragile* (Suring.) Hariot, in company with *Ectocarpus globifer* Kuetz. and with various species of Myxophyceae and Rhodophyceae. Redondo, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 412, pl. 46, figs. 12, 13.

Ectocarpus socialis seems to be a relative of the *E. cylindricus* group. The chief distinctions between the two species lie in the shape, size and position of the gametangia.

31. **Ectocarpus flocculiformis** S. and G.

Fronds densely caespitose, 0.75–1.5 mm. high, attached by intertwined, penetrating, rhizoidal filaments; erect filaments more or less forked at the base, simple above or the largest plants with few, short, alternate, acute ramuli, tapering slightly at the base, long-attenuate upwards, not piliferous; cells cylindrical to slight doliiform, 20–25μ diam., 1–2.5 times as long; chromatophores numerous, angular-discoid in the younger cells, rounded in the older cells; zoosporangia ellipsoidal, 56–66μ long, 35–40μ broad, on short pedicels near the base of the erect filaments; gametangia ovoid to ellipsoidal, numerous, sessile or short-pedicellate, lateral near the base of the erect filaments, 95–110μ (up to 150μ) long, 30–45μ broad.

Growing on *Codium fragile,* the rhizoidal filaments penetrating deeply into the host, among and beyond the utricles. La Jolla, California.

Setchell and Gardner, Phyc. Cont. VI, 1922, p. 409, pl. 47, fig. 24.

The nearest relative of *E. flocculiformis* apparently is *E. cylindricus* f. *codiophilus.* One marked difference between it and any of the forms of *E. cylindricus* is in the shape and size of the gametangia. This difference, along with others of less importance perhaps, though apparently constant, seems to be sufficient to warrant keeping it separate.

32. **Ectocarpus globifer** Kuetz.

Fronds 2–5 mm. high, pulvinate, sparingly branched, attached by a few branched, rhizoidal filaments penetrating among the cells of the host; branches opposite or alternate, divaricate, constricted at the base, attenuated above, at times piliferous; eells cylindrical, slightly constricted at the dissepiments, 45–50μ diam. in the main filaments, 0.5–1.5 times as long as the diameter in the middle, up to 4 times the diameter above and below; chromatophores numerous, small, irregular discoid; zoosporangia lateral, spherical or subspherical, mostly on 1-celled pedicels, 30–40μ diam.; gametangia lateral, broadly ovoid to spherical, mostly on 1-celled pedicels, 70–100μ long, 50–70μ broad.

Growing on *Codium fragile.* Southern California (San Pedro and La Jolla).

Kuetzing, Phyc. Gen., 1843, p. 289, Tab. Phyc., 1855, vol. 5, p. 16, pl. 49, fig. 2; Bornet, Note sur quelq. Ect., 1891, vol. 38, p. 358 (repr. p. 6), figs. 6, 7; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 732.

This species has been distributed from southern California under no. 732 of the Phycotheca Boreali-Americana. The specimens distributed were collected at La Jolla by Mrs. Snyder. Gardner has collected it twice at Redondo. Both undoubted zoosporangia and gametangia have been found. All of the specimens from our coast, so far as is known, grow upon *Codium fragile*, into whose spongy substance they penetrate by long colorless rhizoidal filaments. The specimens agree so well with the figures and descriptions of Kuetzing and Bornet that there seems to be little doubt that our plants are of the same species as those from Europe.

33. **Ectocarpus gonodioides** S. and G.

Fronds minute, forming small tufts 500–550μ high, attached by long, more or less hyaline rhizoidal filaments penetrating the host; filaments sparsely branched at the surface of the host, tapering rather abruptly at the base, long attenuated upward to a blunt apex, 18–24μ diam. at the base, 10–14μ at the apex; cells 1–2 times as long as broad; zoosporangia unknown; gametangia narrowly fusiform on 1–2-celled pedicels, near the base of the erect filaments, up to 125μ long, 20–28μ diam. in the widest part.

Growing on *Codium cuneatum*. Smith Island, Gulf of California.

Setchell and Gardner, The Mar. Alg. Gulf of Calif., 1924, pp. 721, 722, pl. 17, fig. 44.

The small tufts which this species of *Ectocarpus* produces remind one of the genus *Gonodia* (*Myriactis*), but the penetrating part, which extends relatively deep into the host, is composed of slender, almost colorless, slightly branched, closely intertwined filaments, which, however, do not coalesce or form a false parenchyma as in the case of some species of *Gonodia*. The plants, though sparse, are in excellent fruiting condition. The chromatophores are too much disorganized for characterization.

34. **Ectocarpus Bryantii** S. and G.

Fronds intertwined, forming a more or less continuous stratum, 1–2.5 mm. high, attached by relatively short, penetrating, rhizoidal filaments; erect filaments forked more or less at the surface of the host, with very few short ramuli above, nearly cylindrical, tapering slightly above, uncorticated; terminal cell blunt, 28–32μ diam., cells 1–2 times as long as broad; chromatophores small disks; zoosporangia unknown; gametangia narrowly to broadly fusiform, sessile or on 1-celled pedicels, 70–100μ (up to 140μ) long, 25–35μ broad, scattered promiscuously along the whole length of the erect fronds.

Growing on *Codium Brandegeei.* La Paz, Lower California.

Setchell and Gardner, Mar. Alg. Gulf of Calif., 1924, p. 720, pl. 17, fig. 45.

Ectocarpus Bryantii and *E. gonodioides* are evidently closely related to each other and both have near affinities in the *pusillus* group of Sauvageau (1895). They both differ from all of the forms proposed in the method of branching and in having no hairs terminating the erect filaments.

5. **Streblonema** Derb. and Sol.

Fronds composed of more or less branched, monosiphonous or in part polysiphonous filaments, wholly or largely endophytic; prostrate primary filaments wholly endophytic, creeping among the cells of the host, erect secondary filaments wholly or in large part endophytic, simple or branched, hairs present or absent; zoosporangia and gametangia both present, terminal or lateral on the erect or on the prostrate filaments, sessile or, more rarely, short-stalked.

Derbès and Solier, *in* Castagne, Supplem. Catal. Marseille, 1851, p. 100.

The type species is *S. sphaericum.*

Key to the Species

1. Fronds causing noticeable distortions of the host 2
1. Fronds not causing noticeable distortions 3
    2. Distortions in the form of pustules .... 13. **S. scabiosum** (p. 450)
    2. Distortions in the form of extended rugose areas .... 12. **S. rugosum** (p. 449)
3. Fronds producing noticeable patches or discolorations 4
3. Fronds inconspicuous 11
    4. Patches large or extended 5
    4. Patches small, usually orbicular (0.5 cm. or less diam.) 6
5. Patches orbicular .... 11. **S. evagatum** (p. 449)

5. Patches indefinite in outline and extent ....6. **S. penetrale** (p. 446)
   6. Patches definitely erumpent 7
   6. Patches discolored, filaments only slightly erumpent ....7. **S. transfixum** (p. 446)
7. Gametangia pluriseriate ....8. **S. irregulare** (p. 447)
7. Gametangia uniseriate 8
   8. Parasitic on *Zostera* ....4. **S. vorax** (p. 444)
   8. Parasitic on other algae 9
9. Spots aecidioid ....14. **S. aecidioides f. pacificum** (p. 450)
9. Spots not aecidioid 10
   10. Gametangia cylindrical ....15. **S. myrionematoides** (p. 452)
   10. Gametangia narrowly elliptical ....10. **S. pacificum** (p. 448)
11. Erect filaments not over 8μ in diameter 12
11. Erect filaments over 10μ in diameter 15
   12. Gametangia single ....5. **S. Porphyrae** (p. 445)
   12. Gametangia corymbose 13
13. Gametangia 25–40μ long 14
13. Gametangia over 60μ long ....9. **S. minutissimum** (p. 447)
   14. Erect filaments 4–5μ in diameter ....1. **S. corymbiferum** (p. 441)
   14. Erect filaments 5–8μ in diameter ....16. **S. investiens** (p. 452)
15. Gametangia 50–100μ long, 10–16μ broad ....2. **S. anomalum** (p 442)
15. Gametangia 90–130μ long, 28–36μ broad ....3. **S. Johnstonae** (p. 444)

1. **Streblonema corymbiferum** S. and G.

Plate 52, fig. 8

Fronds microscopic, composed of irregularly and alternately branched filaments penetrating among the cells of the host; fructiferous ramuli decidedly aggregated, forming corymb-like clusters near the surface of the host; cells mostly cylindrical, in part irregular, 4–5μ diam., 1.5–4 times as long; chromatophore band-shaped, not covering the cell; zoosporangia unknown; gametangia cylindrical to slightly fusiform, blunt, terminal on short pedicels, borne in clusters, or sessile on filaments creeping near the surface of the host, 25–35μ long, 4.5–5.5μ broad; loculi uniseriate, dividing walls frequently oblique.

Growing on *Cumagloia Andersonii* (Farlow) S. and G., in company with *Streblonema anomalum* and *S. Johnstonae*. San Pedro, California.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 391, pl. 43, fig. 8.

While studying material of *Cumagloia Andersonii* (Farlow) S. and G. collected by Mrs. H. D. Johnston at San Pedro, California, in 1899 and deposited in the Herbarium of the University of California under no. 94663, some specimens of Ectocarpaceae were incidentally observed. When we came to study our material of this family, these specimens were given a careful scrutiny with the result that three species new to science were detected on a single specimen of the host, viz., *Streblonema corymbiferum, S. anomalum*, and *S. Johnstonae,* all of which have been published (*loc. cit.*).

The habit of each and the size of all the parts are so characteristic that, notwithstanding their intimate association on the same host, they can readily be distinguished. *S. corymbiferum* is the most delicate of the three. The very frequent grouping of the gametangia into corymb-like clusters is one of the most prominent distinguishing characters of the species. Other species of this genus are as small or even smaller. In size of parts, somewhat in habit and in habitat, it resembles *S. minutissimum* Saunders found growing at Sitka, Alaska, on "*Liebmannia* sp." (Saunders, 1901, p. 416.)

2. **Streblonema anomalum** S. and G.

Plate 52, figs. 1–3

Fronds microscopic, more or less confluent; filaments of the prostrate portion penetrating among the cells of the host, moderately and irregularly branched, much contorted, up to 16μ diam.; erect filaments unbranched, mostly cylindrical, blunt in part, and piliferous in part, 200–250μ long, extending beyond the surface of the host; hair filaments sparse, arising on the creeping filaments; cells of the creeping filaments more or less divided 1–2 times lengthwise in the oldest parts, producing a polysiphonous filament 18–24μ diam.; other cells somewhat irregular in form, 8–11μ diam., at times slightly constricted at the cross-walls; cells of the erect filaments cylindrical, 8–9μ diam., quadrate; chromatophore a single thin parietal band, unbroken in the erect filaments, more or less broken in the creeping filaments; zoosporangia ellipsoidal, ovoid or nearly spherical, 40–60μ long, 28–35μ broad, sessile on the creeping filaments; gametangia cylindrico-conical, mostly blunt, 50–100μ long, 10–16μ broad, sessile or short-pedicellate on the creeping filaments, single or secund.

Growing in *Cumagloia Andersonii* (Farlow) S. and G. in company with *Streblonema corymbiferum* and *S. Johnstonae.* San Pedro, California.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 392, pl. 43, figs. 1–3. *Streblonema fasciculatum* Saunders, Phyc. Mem., 1898, p. 148, pl. 13 (not of Thuret, *in* Le Jolis, Alg. mar. Cherb., no. 100, Liste, 1863, p. 73).

Examination of a small piece of authentic material of *S. fasciculatum* Saunders collected at San Pedro, California, in August, 1896, revealed the presence of specimens of the same three species mentioned under *S. corymbiferum*, collected by Mrs. Johnston at the same place and in the same month. *S. anomalum* is undoubtedly the one to which Saunders refers as *S. fasciculatum* Thuret. It does not seem, however, to be Thuret's species, if we have a correct conception of what *S. fasciculatum* Thuret includes. His species was published in Le Jolis, Algues marines de Cherbourg, no. 100, and in Liste, 1863, p. 73. Thuret quotes as a synonym, *S. volubilis* Pringsheim (Beitr. Morph. Meeresalg., p. 13, pl. 3, fig. B, read in 1862). Pringsheim's figure of *volubilis* shows the gametangia fasciculately branched, and he states that this character is one of the chief characters of the genus *Streblonema*. This figure has been much quoted since. Pringsheim gives no measurements of the parts, neither does Thuret.

Reinke (Algenfl., 1889, p. 41) recognizes *Streblonema* as a subgenus of *Ectocarpus*. He recognizes Pringsheim's plant, quoting the foregoing figure, but since *volubilis* was already occupied by Crouan (1867, p. 161) and *fasciculatum* was occupied by Harvey (Phyc. Brit., pl. 273), he renamed the plant, calling it *Pringsheimii*. Hauck (1884, p. 323) seems to have been the first to give measurements of the various parts of the plant. He lists it under *Streblonema*, cites the above literature of Thuret, and quotes *S. volubilis* Pringsheim. Considering Pringsheim's plant, recognized by Reinke and Hauck, as being the same as Thuret's, and taking Pringsheim's figure and Hauck's measurements as being correct for Thuret's *S. fasciculatum*, then our plant is distinct and undescribed.

There is a little doubt in our minds at present whether the plant we have described as *Streblonema anomalum* is one or two species. We do not find the filaments bearing the zoosporangia in the type material examined to be like those figured by Saunders. His figures show the main filaments as being like those of all the known *Streblonemas*, monosiphonous, while those in both collections of material which we have examined are uniformly polysiphonous, that is, the cells of the main central parts of the thallus are divided once or twice lengthwise. This never takes place in the plants which bear gametangia and which are intimately associated with them.

The measurements, method of branching of the two sets of plants, and their chromatophore characters are practically the same. At least two interpretations of this polysiphonous phenomenon appeal to us. They may represent a polymorphic state, in which a non-sexual plant differs in form from a sexual plant of the same species, a unique condition in the genus *Streblonema*, or the polysiphonous condition of the main filaments, found only in the non-sexual plants, may represent a character belonging to a wholly different genus, and hence it is a new species of that genus. Until a more extensive study of fresh material can be made, we feel that it is best to take the former view, and place it in a new and polymorphic species of *Streblonema*. We have amended the family Ectocarpaceae to include species with this polysiphonous condition.

3. **Streblonema Johnstonae** S. and G.

Plate 52, fig. 4

Fronds microscopic; creeping filaments moderately branched, branches alternate or opposite, at times slightly secund; erect filaments mostly simple, tapering slightly upward and at the base, extending beyond the surface of the host, in part short-piliferous; cells of the main creeping filaments more or less irregular in shape, chiefly doliiform, 12–18μ diam., 1.5–5 times as long; cells of erect filaments up to 24μ diam. in the widest part, nearly cylindrical, constricted at the cross-walls; chromatophore a thin parietal band, nearly covering the cell; zoosporangia unknown; gametangia cone-shaped to unsymmetrically fusiform, 90–130μ long, 28–36μ broad, mostly short-pedicellate on the creeping filaments extending to the surface of the host.

Growing in *Cumagloia Andersonii* (Farlow) S. and G. in company with *Streblonema corymbiferum* and *S. anomalum*. San Pedro, California.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 394, pl. 43, fig. 4.

Of the three plants found ramifying among the filaments of the above mentioned host, *Streblonema Johnstonae* is the most robust in all of its parts. It can readily be distinguished from the other two species with which it is associated by the large size of the gametangia. No zoosporangia have been observed.

4. **Streblonema vorax** S. and G.

Fronds microscopic, prostrate filaments profusely branched, very tortuous, penetrating among the epidermal cells and spreading into the interior of the host, decomposing the walls and filling the large parenchyma cells and devouring their contents; cells 6–10μ long, 5–8μ diam.; erect filaments 400–600μ long, 6.5–8μ wide, attenuated above into a hair, fasciculately branched at or near the surface of the host, forming a compact mass of cells; zoosporangia broadly clavate, 60–100μ long, 15–30μ broad; gametangia numerous, lateral on short pedicels or sessile, narrowly cylindrical, blunt, 40–70μ (up to 100μ) long, 7–9μ diam.; loculi mostly uniseriate.

Growing on the outer ends of the leaves of eel-grass, in the lower littoral and upper sublittoral belts. Sitka, Alaska.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 389, pl. 44, figs. 1, 2.

Of all the species of *Streblonema* thus far discovered on our coast, *S. vorax* is the most destructive to the host. Although the penetrating filaments have abundance of chromatophores, the plants seem to be in a large degree parasitic. The cells of the host are closely compacted, and have thick walls, yet they are devoured in large quantities. We suggest the possibility of the secretion of enzymes with digestive power which act upon the cell-wall and its protoplasm, after which they are absorbed. This plant is found in company with several other small Melanophyceae, Chlorophyceae and Rhodophyceae, none of which penetrate the host.

5. **Streblonema Porphyrae** S. and G.

Fronds mostly endophytic; prostrate filaments very tortuous, penetrating the cell-walls of the host between the cells, freely branched; erect filaments pushing slightly beyond the surface of the host, occasionally branched; hair filaments unknown; cells of the creeping filaments 3–4μ diam., irregular in shape; zoosporangia unknown; gametangia terminal in erect filaments, extending slightly beyond the surface of the host, fusiform to irregular in shape, 25–35μ long, 5–8μ broad.

Growing in the parenchymatous base of *Porphyra naiadum* on eel-grass. Pacific Grove, California.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 387, pl. 44, fig. 6.

Streblonema Porphyrae is an exceedingly diminutive, though apparently distinct, species, confined, so far as we know at present, to the cushion-like bases of *Porphyra naiadum*. It ramifies deep into the tissue, apparently not entering the cells.

6. **Streblonema penetrale** S. and G.

Fronds forming a continuous pulvinate stratum of indefinite shape and size on the stipe of the host; penetrating portion composed of sparingly branched filaments extending relatively deep into the host and mostly perpendicular to its surface; erect filaments fasciculately branched at the surface of the host, 70–125μ long, tapering slightly upwards, not piliferous; cells of the penetrating filaments cylindrical to irregular, 6.5–8μ diam., 3–5 times as long; cells of the erect filaments cylindrical to slightly doliiform; 6.5–8μ diam., 1.5–2.5 times as long; chromatophores band-shaped; zoosporangia unknown; gametangia cylindrical to blunt-fusiform, more or less irregular, 30–40μ long, 8–11μ broad; loculi uniseriate.

Growing on the stipes of *Hesperophycus Harveyanus*. Pacific Grove, California.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 388, pl. 44, figs. 3, 4.

Streblonema penetrale, like *S. myrionematoides* below, is a difficult species to classify. In its method of development and general structure it approximates *S. myrionematoides* closely. The penetrating portion is much more highly developed than in that species, extending into the host among the cells to a depth of four or five times as great as the part which extends beyond the surface. The size of all the parts is, in general, greater than in *S. myrionematoides.* No horizontal filaments are present. The penetrating filaments are mostly perpendicular to the surface.

7. **Streblonema transfixum** S. and G.

Fronds forming patches 5–8 mm. diam.; creeping filaments penetrating deeply among the cells of the host, distorted, irregularly branched, 4–5μ diam., giving rise to scattered, short, erect, unbranched filaments protruding from the surface and mostly terminated by gametangia; cells of the erect filaments cylindrical, 7–9μ diam., 0.75–1.5 times as long; chromatophores band-shaped, nearly covering the cell wall; zoosporangia unknown; gametangia cylindrico-conical, blunt, 40–60μ long, 8–12μ broad; loculi 1–2 seriate.

Growing on *Desmarestia herbacea.* San Pedro, California.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 391.

Streblonema transfixum forms definite, discolored areas on the surface of the host, readily detectable. The species was described from dried material. The cells of the host were much collapsed and did not straighten out when soaked and boiled, hence the details of the species were not so thoroughly worked out as is desirable. The plants penetrate among the cells of the host and seemingly pass all the way through it. Just how much constitutes a single plant cannot at present be made out.

8. **Streblonema irregulare** Saunders

Fronds consisting of irregularly branching prostrate filaments, applied closely to the host plant, from which arise numerous simple or sparingly branched erect filaments 1–2 mm. high, 9–14μ diam., with cells as long or twice as long as broad; rhizoidal filaments arise from the lower surface of the prostrate filaments and penetrate the host, 10–14μ diam., longer or shorter than the diameter; zoosporangia unknown; gametangia narrowly ellipsoidal, terminal or lateral on the erect filaments, 55–70μ long, 14–18μ diam.

Growing on the cysts of *Nereocystis Luetkeana.* Sitka, Alaska.

Saunders, Alg. Harriman Exp., 1901, p. 417, pl. 45, fig. 2; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 239.

We have not had an opportunity to examine the type material of this species, nor have we seen any other material representing the species since its discovery and first publication.

9. **Streblonema minutissimum** Saunders

Fronds composed of short, sparsely branched, creeping filaments, 1–2μ diam., ramifying among the cortical filaments of the host, sometimes applied to them, and of erect filaments arising from the prostrate filaments in the host, and intermingling with its peripheral filaments; erect filaments once or twice dichotomously branched, bearing above a few short branches which become transformed into uniseriate gametangia, 20–30μ long, 3–5μ broad.

"Growing in the branches of *Liebmannia.*" Sitka, Alaska.

Saunders, Alg. Harriman Exp., 1901, p. 416, pl. 45, fig. 3; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 239.

Nothing further has been learned of this species of *Streblonema* nor of the host upon which it grew since its discovery at Sitka and publication by Saunders (*loc. cit.*). We have not seen any of the specimens, but, judging from the figure and description, it seems distinct from all other known forms.

10. **Streblonema pacificum** Saunders (Orthog. mut.)

Plate 41, fig. 53

Fronds occupying circular areas, 2–4 mm. diam.; composed of a network of profusely and irregularly branched horizontal creeping filaments, penetrating among the paraphyses and sporangia of the host, giving rise at right angles below to numerous acute branches, 3–4 cells long, and above to numerous fasciculately branched filaments extending to the surface of the host and bearing the gametangia; cells of the horizontal filaments 3.5–4μ diam., somewhat irregular; cells of the rhizoidal filaments 1–2.5μ diam.; cells of the erect filaments variable in shape and size, 4–6μ diam.; zoosporangia unknown; gametangia numerous, terminating the erect filaments and projecting beyond the surface of the host, blunt fusiform, 20–28μ long, 4–6μ broad; loculi uniseriate.

Growing on the sporophylls of *Alaria*. Alaska (Yakutat Bay) to California (San Francisco Bay).

"*Streblonema pacifica*" Saunders, Alg. Harriman Exp., 1901, p. 417, pl. 45, figs. 1*a*, 1*b*; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 239.

Superficially *Streblonema pacificum* Saunders appears like a small *Myrionema*, the plants forming circular masses in the same manner as that genus. The plants are exceedingly difficult to interpret in the stage in which they begin to be visible to the unaided eye, that is when the gametangia are forming. The sporangia of the host are at this time elongating and more or less disturbing the arrangement of the filaments. As far as can be ascertained from the study of mature and nearly mature plants, the circular masses are occupied by a number of individuals instead of a single individual as in the case of a *Myrionema*. This may not be the case, however. Against this conclusion the argument might be urged that the groups of plants are too nearly uniform in size and too nearly circular in outline to be composed of a necessarily variable number of plants intermingled, yet this is the way they appear at maturity. More study of the early stages in the life-history will have to be resorted to before the question can be settled.

Saunders (*loc. cit.*) figures hair filaments but does not mention them in his description. We have not been able to find any true hairs in the material from California, nor in the portion of the type which we examined. Neither have we been able to find any anastomosing of filaments such as he represents in figure 1*b* (*loc. cit.*). These latter conditions we may have overlooked in our study, as the plants are exceedingly difficult to trace. The hair character is one that varies considerably in any species.

11. **Streblonema evagatum** S. and G.

Fronds forming circular masses 1–2 cm. diam.; creeping filaments irregular, much branched, penetrating among the sporangia of the host at their bases; erect filaments fasciculately branched, usually within the host, tapering very slightly at the apex and at the base, 190–230μ high; cells of the creeping portion 3.5–4μ diam.; cells of the erect filaments 4μ diam. at the base, 2–3.5 times as long, 6.5–7.5μ diam. in the widest part, 1–2 times as long, cylindrical, slightly constricted at the cross-walls; chromatophores band-shaped, 1–2 in a cell; zoosporangia unknown; gametangia numerous, cylindrical, lateral, sessile or on short pedicels, 65–80μ long, 5.5–6.5μ diam.; loculi uniseriate.

Growing in the blades of *Laminaria Andersonii*, upper sublittoral belt. Cypress Point, Monterey County, California.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 390, pl. 42, figs. 1–5.

This species has a habit of growth very similar to that of *Streblonema pacificum*, but the plants cover much more extensive areas which are quite certainly not infested by a single plant as may be the case in that species. Their presence seems to affect the host materially, to a large extent destroying its sporangia and causing discoloration. It is possibly partially parasitic.

12. **Streblonema rugosum** S. and G.

Plate 52, figs. 5–7

Fronds microscopic, producing decidedly rugose areas of considerable extent on the surface of the host; creeping portion penetrating among the cells near the surface of the host, giving rise above to fasciculately branched, erect, fructiferous filaments and hair filaments; cells of creeping and erect filaments very irregular in shape and size; chromatophores band-shaped; zoosporangia unknown; gametangia blunt, fusiform, terminal on most of the erect filaments, 18–24μ long, 5–6.5μ broad; loculi uniseriate, 4–6 in a series.

Growing on the blade of *Alaria tenuifolia*. Friday Harbor, Washington.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 390, pl. 43, figs. 5–7.

This species, like *Streblonema myrionematoides* and *S. scabiosum*, has the larger part outside of the host. It penetrates to a considerable depth among the cells of the uninjured host, later apparently mechanically causing the death of a few surface cells and an abnormal growth of others, giving to the surface a rugose appearance. The plants seem to associate in small groups of indefinite shape and size, often confluent and although small, can readily be detected by the peculiar appearance they give to the host.

13. **Streblonema scabiosum** S. and G.

Fronds forming circular to elliptical pustules of indefinite size on the host; penetrating portion profusely branched, at first pushing between the cells causing their death, later taking possession of the lumen of the cell, causing complete disintegration; erect filaments extending beyond the surface of the host, unbranched or more or less fasciculately branched at the base, 50–80μ high; cells of the creeping filaments very irregular in shape and size; cells of the erect filaments cylindrical, 4.5–5.5μ diam., 1–2.5 times as long; chromatophores band-shaped; zoosporangia unknown; gametangia cylindrical, sessile or short-pedicellate, extending beyond the surface of the host, 40–60μ long, 4.5–6μ broad.

Growing on the stipe of *Nereocystis Luetkeana*. Cast ashore near the "Cliff House," San Francisco, California.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 389, pl. 44, fig. 5.

Streblonema scabiosum forms marked scrofulous-like areas on the lower part of the stipe of the host. It has a disastrous effect upon the host, destroying its cells as far as it penetrates, and seems constantly to spread by new infections around the margin of the affected area. The cause of the death of the cells of the host has not been investigated. In habit of growth and general form the species seems related to *S. myrionematoides* and to *S. penetrale*.

14. **Streblonema aecidioides f. pacificum** S. and G.

Fronds microscopic, showing on the surface of the host as small elevations, 75–150μ diam., the vegetative part forming a more or less parenchymatous layer just beneath the surface layer of cells of the host and giving rise below to a few rhizoidal filaments penetrating deeper into the host; all erect filaments fructiferous except a few short hair filaments arising in the center of the frond; cells of the hair filaments 4–5.5μ diam., quadrate below, 5–8 times as long above, without a sheath; zoosporangia(?) narrowly clavate, sessile, 22–28μ long, 8–12μ broad at the apex; gametangia numerous, closely crowded, cylindrical, sessile on the horizontal layer, 45–55μ long, 5–6.5μ broad; loculi uniseriate.

Growing within the lamina of *Hedophyllum sessile* (Aresch.) Setchell, near the outer end. Neah Bay, Washington.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 395, pl. 44, figs. 8, 9. *Phycocelis fecunda* Tilden, Amer. Alg. (Exsicc.), no. 356 from Victoria, B. C. (determined by De Alton Saunders).

Streblonema aecidioides f. *pacificum* seems very closely related to the *Ectocarpus aecidioides* of Rosenvinge (1893, p. 894), found growing in Greenland on *Laminaria longicruris* and *L. groenlandica*. It differs only in minor details as to the dimensions of the parts. Regarding the zoosporangia we have to speak with uncertainty. As figured by Rosenvinge, the Greenland plant has them well developed and producing zoospores. They are in distinct "aecidia" and apparently on distinct non-sexual plants. In our species they likewise appear to be on non-sexual plants. In ours there is no indication of the production of zoospores. The plants are possibly too young, or possibly they bear abortive organs so commonly met with in various other genera on our coast, the nature of which is still an open question. This form seems to enter the host from the surface and after penetrating to the second layer of cells spreads out horizontally between the surface layer and the second layer. Later, filaments arise from the under side of this layer and penetrate among the cells of the host, apparently never entering them. Finally from the upper surface each cell in the central region of the layer gives rise to a filament and the mass acting together lifts up the surface layer of cells of the host, forming a small blister which finally ruptures, as in the case of Rosenvinge's plants. The erect filaments are almost simultaneously transformed into gametangia, except a few in the center which develop into hairs.

Foslie (1894, p. 167, 23 in reprint) describes forms of the same species found growing on *Laminaria saccharina* at Kjelvik and at Lyngø near Tromsø, Norway. These he listed under *Ectocarpus* (*Streblonema*) *aecidioides* Rosenvinge. The measurements of the parts of his forms average, in general, a little larger than those of Rosenvinge. De-Toni (1895, p. 577) cites these Arctic plants under *Streblonema aecidioides* (Rosenv.) Foslie. Foslie gives 80μ as the extreme length of the gametangia.

15. **Streblonema myrionematoides** S. and G.

Fronds microscopic; prostrate portion very poorly or scantily developed, penetrating only slightly among the two or three outer layers of cells of the host; erect filaments more or less fasciculately branched at the surface of the host, 65–80μ long, mostly fructiferous, hairs few; cells of the penetrating filaments 4–5μ diam., irregular in shape; zoosporangia unknown; gametangia numerous, cylindrical, 50–65μ long, 4.5–6.5μ broad; loculi uniseriate.

Growing on the blade of *Laminaria Andersonii* Farlow. Moss Beach, San Mateo County, California.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 387, pl. 44, fig. 7.

It is an extremely perplexing problem to decide upon the generic position of forms such as the one described above. It has close affinities with the three genera, *Streblonema, Ectocarpus* and *Myrionema*. The erect fronds exterior to the host and more or less branched, with relatively scanty attaching portions, constitute the vegetative portion of an *Ectocarpus* of microscopic size. The gametangia are strictly those of a typical *Myrionema*, but there is lacking the disk-shaped basal layer of filaments spreading out on the surface of the host, characteristic of that genus. The extremely reduced character of the penetrating portion does not speak well for the genus *Streblonema*. On the whole, we feel that with our present criteria for these genera it best agrees with the characters of the genus *Streblonema*, where we have placed it. It penetrates the uninjured host, but only to a slight depth. The plants, however, are usually so congested that their growth soon crowds the surface layer of the host cells to such an extent that they die and disintegrate, there being no evidence that the associate penetrates them and absorbs their material. The palisade-like stratum of gametangia suggests very strongly the *Myrionema* character which is the reason for the specific name.

16. **Streblonema investiens** (Collins) S. and G.

Fronds occupying indefinite areas on the host; creeping filaments irregularly branched, often curving outward and bearing on the outside short, simple, or sparsely branched filaments; hairs sparse; cells of creeping filaments 5–8μ diam., 1–2 (up to 4) times as long, swollen or cylindrical; cells of the ramuli 6μ diam., 1–2 times as long; cells of the hairs 8μ diam.; chromatophores discoid, small, several in a cell; zoosporangia ovoid, sessile or on 1-celled pedicels on both the creeping filaments and the ramuli, 20μ long, 15μ broad; gametangia cylindrical, 25–40μ long, 8–10μ broad; loculi mostly uniseriate; gametangia and zoosporangia growing on the same plant.

Growing in the fronds of *Helminthocladia calvadosii* (Lamour.) Setchell. San Pedro, California.

Setchell and Gardner, Phyc. Cont. V, 1922, p. 396. *Strepsithalia investiens* Collins, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 738.

It seems that the chief technical distinction between the genera *Strepsithalia* Sauvageau and *Streblonema* Derb. and Sol. is the secretion by *Strepsithalia* of a rather copious gelatinous sheath investing the entire plant, particularly the exposed portions, the ramuli. Since we are not able to demonstrate the presence of such a sheath, even to the slightest degree, we have thought it best to place Collins' *Strepsithalia investiens* in the genus *Streblonema.*

FAMILY 3. MYRIONEMATACEAE FOSLIE (ORTHOG. MUT.)

Thallus two-fold, viz., (1) of a prostrate disk formed of radiating filaments more or less closely united and one or two cells in thickness, entirely superficial or penetrating the host by short rhizoidal filaments, and (2) of erect, simple or branched, monosiphonous, usually parallel filaments, either free or enclosed in a common jelly; growth peripheral in the basal portion and subapical or intercalary in the erect filaments; hairs present or absent; erect filaments entirely fertile, partially sterile or sterile and fertile intermixed; cells uninucleate, each with one or more parietal disk-shaped or band-shaped chromatophores; zoosporangia unilocular, terminal or lateral, sessile or pedicelled, never intercalary; gametangia plurilocular, terminal or lateral, with loculi uni- or pluriseriate; gametophyte and sporophyte identical in size and structure.

Myrionemaceae Foslie, Contr. Knowl. Mar. Algae Norway, I, 1890, p. 91.

The members of the Myrionemataceae, as we understand them, seem closely related to the Ectocarpaceae, on the one hand, and the Elachisteaceae on the other. There seems to be little reason for placing the genera in Chordariaceae as Kjellman (1893, p. 225) has done, nor even associating them closely with the Mesogloiaceae, as Oltmanns (1922, p. 29) has done, since it seems to us that *Strepsithalia*, in typical form, resembles *Streblonema* in its basal portion, but agrees better with the *Elachistea* and *Myriactis*-groups of the Elachisteaceae in its erect filaments slightly contracted at the base. The various Myrionemataceae are most closely allied to the species of *Ralfsia*, particularly with those referred to *Stragularia*. The prostrate basal portion of one or two layers of cells readily distinguishes the members of the Myrionemataceae from those of all other families except those of the simpler Ralfsiaceae.

Key to the Genera

1. Erect filaments free 2
1. Erect filaments enclosed in a jelly .... 9. **Microspongium** (p. 492)
    2. Basal portion monostromatic 3
    2. Basal portion distromatic .... 8. **Hecatonema** (p. 488)
3. Gametangia with loculi uniseriate .... 6. **Myrionema** (p. 454)
3. Gametangia with loculi pluriseriate .... 7. **Compsonema** (p. 473)

6. **Myrionema** Grev.

Fronds forming small cushions, circular to ellipsoidal, or even quite irregular in outline, composed of a monostromatic basal stratum and numerous pigment-bearing erect filaments with or without hairs interspersed; the erect filaments in part or wholly transformed into gametangia, except at the margins; basal stratum composed of closely crowded filaments radiating from a common center, with dichotomous branching by splitting of the terminal cells, rarely with a few, short, subulate branches penetrating the host; reproduction by unilocular zoosporangia and by plurilocular gametangia mostly with uniseriate loculi.

Greville, Scottish Crypt. Flora, vol. 5, 1827, pl. 300.

The type species of this genus is *M. strangulans* Grev. The type locality is the shore of Appin, Scotland. It was first brought to notice by Captain Carmichael, who found it growing on a small species of *Solenia* (*Enteromorpha*), which it usually completely encircles. Greville says of his genus: "It evidently belongs to the Nostochinae of Agardh." Although it is undoubtedly known today to belong to the Melanophyceae, there has been considerable diversity of opinion concerning the family to which it properly has its closest affinities. Harvey (1841, p. 124) placed it among the Chlorospermeae, under the tribe Chaetophoroideae, probably on account of its "gelatinous" nature as suggested by Greville. He states, however, that it is "a genus of doubtful affinity," and "it rather belongs to the series Melanospermeae." J. G. Agardh (1848, p. 47) placed it in his order Chordarieae under his tribe Mesogloiaceae. Kjellman (1890, p. 40) emended the genus and placed it in the family Chordariaceae, and in 1893 (p. 226) retained it in the same family. Foslie (1890, p. 91) and Rosenvinge (1893, p. 901) and still later, Börgesen (1902, p. 419) placed it in the "Myrionemaceae," the first two designating the group as a family, and the last as an order. De-Toni (1895, p. 178) retained it in Chordariaceae. Oltmanns (1904, p. 382) placed it in the group Myrionemeae of the family Ectocarpaceae. In 1922 he arranged it under the "Isogame Ectocarpales" in the family "Myrionemaceae," along with *Strepsithalia* and *Ralfsia*.

After a careful study of a large assortment of material belonging to the Ectocarpales, we have limited the genus to include forms possessing the characters mentioned in the foregoing generic diagnosis and placed the genus in the family Myrionemataceae, along with three other very closely related genera; viz., *Compsonema*, *Microspongium*, and *Hecatonema*. We have, however, included under *Myrionema* the species formerly assigned to *Ascocyclus* Magnus and *Phycocelis* Stroemfelt.

In working over the members of the genus *Myrionema* found on the Pacific Coast of North America, we have studied and separated over twenty species or forms. This segregation must be considered as provisional since no attempt at cultural criteria has been possible. We have separated the species into two lines, the one in which only zoosporangial forms are known, and the other in which only gametangial specimens are known, or those having gametangia and "ascocysts," the latter problematic structures. Possibly some of the structures we have called "ascocysts" may be young zoosporangia, but probably most or all of such structures, as we have seen them, are hypertrophied gametangia. The possible genetic connection between some of the one series of species and some of the other series cannot be demonstrated except by cultures.

Key to the Species

1. With zoosporangia only 2
1. With gametangia only or with both gametangia and "ascocysts" 3
    2. Plants forming definite circular thalli .... 21. **M. strangulans** (p. 471)
    2. Plants forming indefinite rugose thalli .... 22. **M. obscurum** (p. 472)
3. Gametangia sessile 4
3. Gametangia pedicellate 9
    4. All of the erect filaments transformed into gametangia 5
    4. Part of the erect filaments transformed into gametangia .... 10. **M. foecundum** f. **divergens** (p. 463)
5. Plants with subulate rhizoids .... 7. **M. foecundum** f. **subulatum** (p. 462)
5. Plants without subulate rhizoids 6
    6. Gametangia branched in part .... 8. **M. foecundum** f. **ramulosum** (p. 462)
    6. Gametangia unbranched 7

7. Gametangia up to 40μ long .... 6. **M. foecundum** f. **simplicissimum** (p. 461)
7. Gametangia over 40μ long 8
    8. Gametangia up to 65μ long and 6μ broad .... 1. **M. primarium** (p. 456)
    8. Gametangia 80μ long and 8μ broad .... 9. **M. foecundum** f. **majus** (p. 463)
9. All of the erect filaments fructiferous 10
9. Part of the erect filaments fructiferous 12
    10. Gametangia up to 130μ long .... 12. **M. balticum** f. **californicum** (p. 465)
    10. Gametangia up to 45μ long 11
11. Pedicels 1–3-celled .... 3. **M. corunnae** f. **uniforme** (p. 458)
11. Pedicels up to 8-celled .... 11. **M. minutissima** (p. 464)
    12. Sterile filaments longer than the gametangia 13
    12. Sterile filaments not longer than the gametangia 20
13. Gametangia all terminal 14
13. Gametangia in part lateral on sterile filaments .... 19. **M. setiferum** (p. 470)
    14. Sterile filaments partially setiferous 15
    14. Sterile filaments not setiferous 16
15. Erect filaments unbranched .... 18. **M. phyllophilum** (p. 469)
15. Erect filaments branched .... 20. **M. globosum** f. **affine** (p. 471)
    16. Gametangia decidedly acuminate ....
    .... 2. **M. primarium** f. **acuminatum** (p. 457)
    16. Gametangia cylindrical or nearly so 17
17. Cells of sterile filaments doliiform .... 17. **M. attenuatum** f. **doliiforme** (p. 468)
17. Cells of sterile filaments cylindrical 18
    18. Creeping filaments with short subulate rhizoids ....
    .... 15. **M. hecatonematoides** (p. 467)
    18. Creeping filaments without rhizoids 19
19. Gametangia up to 45μ long .... 16. **M. attenuatum** (p. 468)
19. Gametangia up to 150μ long .... 13. **M. balticum** f. **pedicellatum** (p. 466)
    20. Erect filaments up to 65μ high .... 5. **M. corunnae** f. **sterile** (p. 460)
    20. Erect filaments over 65μ high 21
21. Gametangia on 1–3-celled pedicels .... 14. **M. compsonematoides** (p. 467)
21. Gametangia on long pedicels, 7–10-celled .... 4. **M. corunnae** f. **angulatum** (p. 459)

1. **Myrionema primarium** S. and G.

Plate 55, fig. 12

Fronds forming circular cushions 0.5–1.25 mm. diam.; prostrate portion composed of regularly radiating, closely compacted filaments; erect filaments unbranched, densely crowded, arising from every cell of the creeping filaments; true hair filaments numerous, scattered promiscuously in the center of the frond; cells of erect filaments 4–4.5μ diam., quadrate below, terminal cell, 2–3 times as long when young; cells of true hairs 4–5μ diam., 4–6 times as long; zoosporangia unknown; gametangia sessile on the creeping filaments, arising by transformation of all of each erect filament, except at the margin, very compact, of nearly equal length in the center of the frond, shorter toward the margin, cylindrical, 55–65μ long, 5–6μ broad, blunt or tapering slightly at the apices, terminal cell acute-conical.

Growing on the outer end of the young blade of *Costaria costata* in the lower littoral and the upper sublittoral belts. Oregon (Coos Bay) to central California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 334, pl. 34, fig. 12.

We consider *Myrionema primarium* to be a typical representative of a group whose members are the most primitive of the genus when considered from the standpoint of differentiation. The prostrate basal layer is composed of long, regularly radiating filaments with apical growth. Radial divisions of apical cells occur just often enough to completely occupy all of the space between one another as the plant continues to increase in diameter and in circumference. The branching is always dichotomous, and is accompanied by widening of the apical cell, and the establishment of two growing regions on opposite corners, which are subsequently separated from the remainder of the cell by a wall, thus establishing two equal branches. Beginning in the center, each cell successively toward the periphery gives rise by horizontal divisions to erect filaments of nearly equal length, the only exception or modification being that some cells give rise to long filaments, the so-called true hairs, with the meristem at the base, and the outer cells long and colorless. All other erect filaments are transformed into gametangia. Only the cells of the basal filaments remain sterile, or probably a few short erect filaments at the periphery of the frond may never come to maturity. Thus starting with a single cell the maximum of reproductive cells arises in this group. Starting with such forms the course of evolution seems to have been in the direction of the sterilization of tissue.

2. **Myrionema primarium** f. **acuminatum** S. and G.

Fronds microscopic, growing among other small algae, erect filaments in part sterile, 80–100μ long, cells slightly doliiform; gametangia 4–5μ diam., acuminate, in part short-pedicellate.

Growing on *Macrocystis pyrifera*. Carmel Bay, Monterey County, California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 335, pl. 32, fig. 9.

There is but a slight difference between *M. primarium* and forma *acuminatum*. It is worthy of note that many gametangia in the center of the thallus are short-pedicellate, and that a few, about one in twenty-five, of the erect filaments continue to grow, attaining a length two to three times as long as the gametangia.

Myrionema corunnae Sauv.

Fronds forming small, circular cushions, 2–3 mm. diam., basal disk monostromatic, not attached by rhizoids from below; erect filaments longest in the middle of the thallus, gradually reduced in length toward the margin; hairs scattered, relatively short, 4–5.5μ diam. at the base, cells 25–40μ long at the apex, meristem at the base but all cells elongating at maturity; all erect filaments fructiferous; gametangia on 2–4-celled pedicels at the center of the frond, becoming sessile toward the margin, mostly simple but not infrequently bearing 3–5 branches, 25–120μ long, 4.5–7μ diam.; zoosporangia unknown.

Sauvageau, Sur quelq. Myrioném., 1897, p. 237 (repr. 1898, p. 77).

The type material of the species was found growing in minute, closely associated cushions on the outer ends of *Laminaria pallida* at La Corogne (Spain), in November, 1895. We have not yet discovered in our region any specimen which we can refer to typical *M. corunnae* as described and figured by Sauvageau. The material collected by one of us (Gardner) in December, 1909, growing on *Nereocystis Luetkeana* (Mert.) P. and R., was identified by F. S. Collins as belonging to that species and distributed in Phycotheca Boreali-Americana (Exsicc.) as no 1738. Careful study of this material reveals a mixture of several genera belonging to Myrionemataceae and Ectocarpaceae, none of which, so far as the specimens in our copies go, is *M. corunnae*. Experience in collecting and critical study of the numerous forms found growing upon the above mentioned host, have shown the necessity of exercising extreme care in selecting pure or uniform material. The presence of branched gametangia in typical *M. corunnae*, as diagnosed by Sauvageau, is a character not found in any of our Pacific coast forms.

The three following distinct forms have been segregated:

3. **Myrionema corunnae** f. **uniforme**

Fronds forming irregular cushions, 0.5–1.5 mm. diam.; creeping filaments forming a compact layer with peripheral growth; hairs absent; erect filaments unbranched, slightly attenuated at the apices, 80–100μ (up to 120μ) high; cells of erect filaments 4.5–5.5μ diam., 1–1.5 times as long; "ascocysts" sparse, clavate; gametangia forming a solid, compact, palisade stratum of approximately the same height in the center, gradually diminishing toward the periphery, mostly sessile, some on 1–3-celled pedicels, 80–100μ high, 6–6.5μ diam.; loculi uniseriate.

Growing on the blades of *Costaria costata, Laminaria Sinclairii* and *Alaria marginata.* Central California (Moss Beach, San Mateo County, and Fort Point in San Francisco).

Setchell and Gardner, Phyc. Cont. II, 1922, p. 339, pl. 33, figs. 4, 5.

Forma *uniforme* differs from the species as described and figured by Sauvageau (1898, pp. 77–82, repr., figs. 14 A–F) in having no hair filaments, in having no branched gametangia, in having "ascocysts," and in having slightly different dimensions.

There are some differences in the size of the plants we have found growing on different hosts in central California. The plants chosen as the type of the form grew on the blades of *Alaria marginata* at Fort Point, San Francisco. Very generally, this species of *Alaria* has delicate grooves obliquely radiating from the midrib to the margin. The presence of these grooves is often accentuated by the growth of this minute *Myrionema*, usually so numerous as to be confluent, so that the individuals cannot be detected except by microscopic examination.

4. **Myrionema corunnae** f. **angulatum** S. and G.

Fronds forming microscopic cushions, irregular in outline, among other small algae on the host; creeping filaments regularly radiating when undisturbed; erect filaments unbranched, densely crowded, 120–140μ long; true hairs absent; cells of creeping filaments 4–4.5μ diam., mostly quadrate; cells of erect filaments cylindrical, 4–4.5μ diam., 1.5–3 times as long; zoosporangia and "ascocysts" unknown; gametangia cylindrical, slightly attenuated at the apices, terminal on 6–10-celled pedicels, 35–45μ (up to 60μ) long, 4–6.5μ broad, many partitions of the loculi oblique.

Growing on the cysts of *Egregia Menziesii.* Cast ashore near the "Cliff House," San Francisco, California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 340, pl. 33, figs. 6, 7.

This form is to be distinguished from the species as described by Sauvageau (1898, pp. 77–82, repr.) by the absence of hairs, the presence of sterile erect filaments, the gametangia mostly on longer pedicels and by the very small size of the loculi, often produced by perpendicular and slanting walls. In part, the gametangia seem pluriseriate, caused by the division of some of the original cells into small, angular loculi.

5. **Myrionema corunnae f. sterile** S. and G.

Fronds forming circular cushions, 1.5–3 mm. diam.; erect filaments straight, unbranched, cylindrical, blunt, 55–65μ long; true hairs and "ascocysts" absent; gametangia cylindrical, blunt, on 3–5-celled pedicels, rarely sessile, 55–65μ long, 4.5–5.5μ broad; gametangia and sterile erect filaments diminishing in length very regularly and gradually from the center to the circumference of the fronds.

Growing on the pneumatocysts of *Nereocystis Luetkeana*. Cast ashore. Carmel Bay, Monterey County, California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 340, pl. 33, figs. 13–15. *Chilionema ocellatum* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1739.

This form is to be distinguished from the species as described by Sauvageau (1898, pp. 77–82, repr.) by the presence of numerous sterile erect filaments interspersed among the gametangia, about one-fourth to one-fifth as many as the gametangia, by the absence of hairs, and by the very gradual diminution in the length of the sterile filaments and the gametangia from the center to the circumference of the fronds. The sterile erect filaments are of the same length as the gametangia.

Myrionema foecundum (Stroemf.) Foslie (Orthog. mut.)

Myrionema (*Phycocelis*) *foecunda* (Stroemf.) Foslie, New or Crit. Norw. Algae, 1894, p. 17 (repr.). *Phycocelis foecunda* Stroemfelt, *in* Notarisia, 1888, p. 383, pl. 3, fig. 5.

Foslie (1894, p. 15, repr.) states, "I have been unable to find any real distinction between *Myrionema*, *Phycocelis* and *Ascocyclus*, and therefore I consider the two latter as subgenus of the former, *Ascocyclus*, however principally founded on the presence of paraphyses." We likewise are unable to discern any fundamental distinctions among these three genera. *Phycocelis* was proposed by Stroemfelt (1888, p. 383) with *P. foecunda* as the type. This species has a unistratose base, and all of the erect filaments, except the hairs and the marginal filaments, metamorphose into gametangia. These are characters of typical *Myrionema*, as we interpret the genus.

The genus *Ascocyclus* was founded by Magnus (1874, p. 73) based upon J. G. Agardh's *Myrionema orbiculare*, which, as figured by Crouan (1867, pl. 25, gen. 163), has a unistratose base, plurilocular gametangia and hairs. Having found in addition to these certain single celled sack-like hairs, he created the new genus based upon this character. Two sizes of these are well illustrated by Kylin (1907, p. 39, fig. 9), found growing on *Zostera* and *Cladophora*. These are probably the structures which Foslie (*loc. cit.*) refers to as "paraphyses." After having studied these structures as they occur in a variety of species of different genera belonging to the Ectocarpales, our experience leads us to conclude that they are not constant in any species, and that they are probably caused by some pathological condition, the nature of which we are not at present able to state. We are tàking the view, therefore, that neither of the two genera, *Phycocelis* Stroemfelt and *Ascocyclus* Magnus are valid genera, or even subgenera.

We have not seen either the type or any other authentic material of the *Phycocelis foecunda* Stroemfelt, neither have we any authentic measurements of the original material. De-Toni (1895, p. 582) gives 35μ to 70μ as the height and 7μ to 12μ as the width of the gametangia. We are listing five forms under the species none of which, so far as we are able to judge, corresponds to the typical material.

6. **Myrionema foecundum** f. **simplicissimum** S. and G.

Fronds forming circular cushions 0.5–1.5 mm. diam.; prostrate portion composed of regularly radiating, closely adhering filaments with apical growth and branching; erect filaments all fructiferous; true hairs unknown; cells of creeping filaments 3–4.5μ diam., quadrate toward the center, two times as long at the margin; zoosporangia unknown; "ascocysts" rare to numerous, clavate, 28–34μ high; gametangia arising by transformation of all of each erect filament, except near the margin of the frond, 30–40μ high, 7–9μ broad.

Growing on the sporophylls of *Nereocystis Luetkeana*. Alaska (Kadiak Island), to central California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 336, pl. 33, figs. 9, 10. *Myrionema strangulans* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 249; *Myrionema vulgare* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 924. *Phycocelis reptans* Tilden, Amer. Alg. (Exsicc.), no. 357 (in part).

The *Phycocelis reptans* of Tilden, mentioned above, proves not to be uniform, so far as the distribution in the copy at hand is concerned. The material growing on the sporophyll of *Nereocystis* seems clearly to be *M. foecundum* f. *simplicissimum* although young. The material on the other part of the host is a mixture. In height of gametangia forma *simplicissimum* approximates to forma *seriata* Reinke (1889, p. 46), but has no true hairs so far as we have been able to observe from the examination of many specimens from different localities. At times the individuals are very numerous on the host, so much so as to interfere with each others' growth. In one collection (Gardner, no. 4651) they are completely confluent over several square inches, and the outline of the individuals can be detected only by staining and by microscopic examination.

7. **Myrionema foecundum f. subulatum** S. and G.

Basal filaments attached by numerous awl-shaped rhizoids, 2–4 cells long, penetrating between the cells of the host; zoosporangia, "ascocysts" and true hairs unknown.

Growing on the sporophylls of *Nereocystis Luetkeana.* Near the "Cliff House," San Francisco, California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 337, pl. 33, figs. 1–3.

Forma *subulatum* is very similar to forma *simplicissimum.* The gametangia average slightly larger and are usually more blunt. There are no so-called "ascocysts" present. The chief distinction is the presence in this form of numerous awl-shaped rhizoids, found in no other form of the species, so far as we have been able to ascertain.

8. **Myrionema foecundum f. ramulosum** S. and G.

Fronds forming small circular cushions, 1–3 mm. diam.; erect filaments slightly branched above, 55–65μ long; cells of the erect filaments 5.5–6.5μ diam., quadrate, terminal cell frequently 2–3 times as long; zoosporangia, "ascocysts" and true hairs unknown; all of the erect filaments transformed into gametangia.

Growing on the pneumatocysts of *Nereocystis Luetkeana.* Friday Harbor, San Juan Island, Washington.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 337, pl. 33, fig. 8.

This form of *M. foecundum* differs from the other forms of the species in having secund "proliferations" near the outer ends of many of the gametangia.

9. Myrionema foecundum f. majus S. and G.

Fronds forming circular cushions, 1–2 mm. diam. with convex upper surface; prostrate portion composed of closely adhering, regularly radiating filaments; erect filaments densely crowded, unbranched; cells cylindrical, 5–7μ diam.; true hairs sparse, distributed promiscuously over the frond, meristem at the base, surrounded by a sheath, 400–500μ long, cells 6μ diam., 5–8 times as long as the diameter at the apices; "ascocysts" sessile on the prostrate filaments, cylindrical, slightly larger at the distal end, 45–55μ long, 8–12μ diam., scattered sparsely over the frond, occasionally in groups; zoosporangia unknown; gametangia sessile on the basal filaments, cylindrical, 60–80μ long, 6–8μ diam., arising by transformation of all of each erect filament, cross-walls horizontal or oblique.

Growing on *Laminaria ephemera* Setchell. Port Renfrew, Vancouver Island, Neah Bay, Puget Sound and central California (Carmel Bay).

Setchell and Gardner, Phyc. Cont. II, 1922, p. 338, pl. 32, fig. 7.

This small epiphyte seems to be restricted in its habitat to the above named host. The only known localities in which the host has been observed are those mentioned above. The material from each locality is richly infested by this epiphyte. The host, richly infested, was distributed by Miss Josephine Tilden in her American Algae (Exsicc.), no. 609, under *Renfrewia parvula* Griggs.

It seems very closely related to *Myrionema foecundum* f. *simplicissimum*. The differences are in the larger measurements of all of the parts, the presence of numerous, larger, so-called "ascocysts," occurring in groups, or scattered among the gametangia, in the presence of well-developed hairs, and in the more convex upper surface of the mass of erect filaments.

10. Myrionema foecundum f. divergens S. and G.

Plate 55, figs. 8, 9

Fronds forming circular cushions, 1.5–3.5 mm. diam.; basal portion composed of regularly radiating filaments closely compacted, firmly adhering to each other and to the host; sterile erect filaments sparse, unbranched, blunt, scattered promiscuously among the gametangia, 300–400μ long; true hairs absent; "ascocysts" numerous, scattered among and shorter than the gametangia, cylindrical to clavate; cells of the creeping filaments 5–6μ diam., 1.5–2 times as long; cells of the erect filaments 8–9μ diam., 1.5–3 times as long, cylindrical, not constricted; zoosporangia unknown; gametangia variable in shape, cylindrical, clindrico-conical or fusiform, 50–60μ long, 7.5–8.5μ broad; loculi 1–2-seriate.

Growing on the sporophylls of *Nereocystis Luetkeana*. Pacific Grove, California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 338, pl. 34, figs. 8, 9.

This form of *M. foecundum* manifests some slight differentiations not present in any other form of the species. Scattered promiscuously over the fronds are erect filaments two to three times as long as the gametangia. The "ascocysts" are abundant. Some irregularities are also shown in the creeping filaments. Typically the branching seems to take place by the splitting of the apical cell, but it seems that frequently one of the dichotomy fails to develop till later, producing the appearance of lateral branching. There is also an occasional oblique or longitudinal division of a cell of the creeping filaments perpendicular to the host.

11. **Myrionema minutissimum** S. and G.

Plate 55, figs. 1–3

Fronds forming inconspicuous cushions, 0.75–1.5 mm. diam.; prostrate portion composed of very closely compact regularly radiating filaments; erect filaments densely crowded, cylindrical, all fructiferous; true hairs unknown; cells of creeping filaments 4μ diam., quadrate in the center of the frond, slightly longer at the margin; cells of erect filaments the same in size as in the creeping filaments; zoosporangia and "ascocysts" unknown; gametangia on 4–8-celled pedicels, cylindrical, densely crowded, 34–40μ long, 4–4.5μ broad.

Growing on the cysts of *Egregia Menziesii*. Cast ashore near the "Cliff House," San Francisco, California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 336, pl. 34, figs. 1–3.

Myrionema minutissimum may be distinguished by the absence of sterile erect filaments and hairs, and by the small sized, very densely crowded pedicellate gametangia. Thus far no "ascocysts" nor zoosporangia have been observed. In its phylogenetic relationship it would seem to stand equally close to *M. corunnae* and *M. foecundum*, differing from each, however, in details of measurements. The erect filaments are of the same diameter at their bases as the length of the cells in the creeping filaments. Since the lower part of each remains sterile, it gives the mass of cells the appearance of being parenchymatous.

Myrionema balticum (Reinke) Foslie

Myrionema (*Phycocelis*) *balticum* (Reinke) Foslie, New or Crit. Norw. Alg., 1894, p. 17. *Ascocyclus balticus* Reinke, Algenfl. westl. Ostsee, 1889*a*, p. 45, Atlas, 1889, p. 19, pl. 16, figs. 1–4.

A discussion of the reasons for rejecting *Ascocyclus* may be found under *Myrionema foecundum*. The chief character which Magnus used in establishing his new genus *Ascocyclus*, viz., the "ascocysts," does not appear in the diagnosis given by Reinke for *A. balticus*. It seems to us clearly that Reinke's plant is a *Myrionema*, and we are grouping two distinct forms under the species which, to us, seem amply different from the typical form, as described and figured by Reinke.

12. Myrionema balticum f. californicum S. and G.

Fronds forming microscopic cushions, 0.5–0.75 mm. diam.; prostrate portion composed of relatively straight, regularly radiating filaments; erect filaments unbranched, attenuated slightly upwards and at the base, blunt, 75–125μ long; true hairs 0.5–1 mm. long; cells of prostrate filaments 6–7μ diam., 1–1.5 times as long; cells of erect filaments 7.5–10μ diam., mostly quadrate; cells of true hairs 4–5.5μ diam., 6–10 times as long above, 3–5 times as long at the base, quadrate a few cells above the base; chromatophores irregularly broken bands; zoosporangia unknown; gametangia on 1–3-celled pedicels, either from the creeping filaments, or lateral at the base of the erect filaments, cylindrical, 90–130μ long, 7–9μ broad.

Growing on the outer ends of the leaves of *Phyllospadix* sp. Point Carmel, Monterey County, California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 341.

We have no authentic measurements of *Ascocyclus balticus* Reinke. He does not mention the size of the gametangia either in the Atlas (1889, pl. 16, figs. 1–4), where he first describes and figures it, or in the Algenflora (1889*a*, p. 45) where he describes it again. Foslie (1894, p. 17, repr.) made the combination *Myrionema* (*Phycocelis*) *balticum*, but he gave no measurements for any of its parts. De-Toni (1895, p. 581) lists the plant as *Phycocelis* (*?*) *baltica* (Reinke) Foslie, but gives no additional information concerning the size of the gametangia. Kylin (1907, p. 35) lists a plant under *Myrionema balticum*

(Rke.) Fosl. which he found growing on *Delesseria sanguinea* at 15 m. depth. He states that the assimilation filaments are 100–125μ long and 4–6μ broad, but gives no measurements for the gametangia.

The plant which we have diagnosed is doubtless very closely related to Reinke's *Ascocyclus balticus*. It may be a distinct species, but we have listed it as a form of *balticus* until we can obtain more knowledge of its variation, and more authentic information concerning the type material of *balticus*. The particular distinguishing character is the very frequent occurrence of lateral gametangia arising very close to the base of the vegetative filaments.

13. **Myrionema balticum** f. **pedicellatum** S. and G.

Fronds forming microscopic cushions 150–400μ (up to 800μ) diam., very irregular in outline; erect filaments short-piliferous in part, 140–160μ long; true hairs unknown; zoosporangia (?) narrowly clavate, sessile on the creeping filaments, or terminal on the erect filaments; gametangia terminal on 10–15-celled pedicels, rarely sessile, up to 150μ long.

Growing on the outer ends of the leaves of *Phyllospadix* sp. Point Carmel, Monterey County, California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 341, pl. 33, figs. 11, 12.

This form differs from the species in the absence of hairs, in having a few very short-piliferous, vegetative filaments, and in having the gametangia on long pedicels.

In this form, as in many others, the correct interpretation of the zoosporangia mentioned above in the diagnosis is an open question. They are filled with dense cell contents and, although none has been observed to produce zoospores, they appear as though they might later. Whatever their nature may finally prove to be, they represent another character in which this form differs from the species. Reinke neither figures nor describes them in *Ascocyclus balticus*. They appear on the same individuals with the gametangia or on different individuals.

14. **Myrionema compsonematoides** S. and G.

Plate 55, fig. 10

Fronds forming microscopic cushions irregular in outline, 200–400μ diam., prostrate portion composed of distorted filaments; erect filaments cylindrical, unbranched, 70–80μ high; hairs unknown; cells of creeping filaments considerably irregular in shape and size, 4–6μ diam.; cells of erect filaments cylindrical, 5–7μ diam., quadrate; "ascocysts" sparse, terminal or at times lateral near the base of the erect filaments; gametangia fusiform to clavate, sessile or short-pedicellate, 50–65μ long, 7–10μ broad; loculi uniseriate below, biseriate above.

Growing on the blade of *Laminaria complanata.* Friday Harbor, Washington.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 343, pl. 34, fig. 10.

Myrionema compsonematoides seems to be a modification of *M. foecundum.* There is a slight sterilization of tissue in that a few of the erect filaments remain sterile and develop slightly beyond the gametangia, and in that a part of the gametangia are pedicellate. It seems to tend toward *Compsonema* in these respects, and in having biseriate gametangia in part.

15. **Myrionema hecatonematoides** S. and G.

Plate 55, fig. 11

Fronds forming thin light brown cushions, more or less circular in outline, up to 6 mm. diam.; prostrate portion composed of distorted, irregularly radiating filaments, mostly monostromatic, in part distromatic, producing a few penetrating peg-like rhizoids below; erect filaments unbranched, cylindrical, 240–260μ long; true hairs absent; cells of erect filaments 6.5–7.5μ diam., 2–3 times as long; zoosporangia unknown; gametangia sessile or on 1–2-celled pedicels on the creeping filaments, cylindrical to fusiform, 45–55μ long, 7–8.5μ broad; loculi mostly uniseriate, biseriate in widest part of the gametangia.

Growing on the pneumatocysts of *Nereocystis Luetkeana.* Pacific Grove, California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 343, pl. 34, fig. 11.

As indicated by the partially distromatic base, the slight tendency to biseriate loculi in the gametangia, and the sterilization of a part of the erect filaments, this species of *Myrionema* seems to be differentiating in the direction of the genus *Hecatonema.* We are retaining it in the genus *Myrionema* because of the preponderance in number of uniseriate loculi and monostromatic filaments in the prostrate portion.

16. **Myrionema attenuatum** S. and G.

Plate 55, figs. 6, 7

Fronds forming microscopic, more or less confluent strata on the surface of the host; prostrate portion composed of regularly radiating filaments; erect filaments unbranched, attenuated gradually upwards and at the base, 180–220μ long; true hairs absent; cells of creeping filaments, 4.5–5.5μ diam., nearly quadrate; cells of erect filaments 6–7μ diam., variable in length; zoosporangia unknown; gametangia sparse, cylindrical to slightly fusiform, on shorter or longer pedicels, 30–45μ long, 4.5–6μ broad.

Growing on the stipes of *Macrocystis pyrifera*, *Laminaria Farlowii*, and on the sterile base of *Gigartina radula* f. Carmel Bay, Monterey County, California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 344, pl. 34, figs. 6, 7.

It seems that sterilization has proceeded in this species of *Myrionema* until about two-thirds of the erect filaments no longer produce gametangia, and these filaments are several times longer than the gametangia. The cells are slightly doliiform in some collections.

17. **Myrionema attenuatum** f. **doliiforme** S. and G. (Orthog. mut.)

Plate 55, figs. 4, 5

Fronds forming small, irregular tufts among other epiphytic algae; erect filaments up to 275μ long; cells of erect filaments quadrate to 3 times as long as broad, decidedly doliiform; gametangia occasionally small and terminal on the long erect filaments, otherwise as the species.

Growing on the stipe of *Macrocystis pyrifera*. Carmel Bay, Monterey County, California.

Myrionema attenuatum f. *doliiformum* Setchell and Gardner, Phyc. Cont. II, 1922, p. 344, pl. 34, figs. 4, 5.

The chief distinction between this form and the species, *M. attenuatum*, is the decided doliiform character of the erect filaments. Small terminal gametangia appear very frequently on the long, erect filaments.

18. **Myrionema phyllophilum** S. and G.

Fronds forming cushions more or less circular in outline, 400–800μ diam.; creeping portion composed of straight filaments radiating from the center, closely crowded; erect filaments unbranched, cylindrical, constricted at the base, 110–130μ long, attenuated upwards, piliferous in part; true hairs scattered promiscuously among the erect filaments and gametangia; cells of creeping filaments cylindrical, 4–5μ diam., 2–4 times as long; cells of erect filaments 8–9μ diam., quadrate, to 2.5 times as long; cells of the hairs quadrate at the base, 5–6μ diam., up to 20 times as long in the upper part; zoosporangia (?) broadly clavate, sessile or terminal on longer or shorter pedicels, 50–70μ long, 14–18μ broad at the outer end; gametangia cylindrical, mostly on 1–2-celled pedicels, on the creeping filaments, or more rarely lateral on the base of the erect filaments, blunt, 90–130μ long, 9–11μ broad; loculi uniseriate.

Growing on the outer ends of the blades of eel-grass, in the lower littoral and upper sublittoral belts. Sitka, Alaska.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 344, pl. 32, figs. 1–5.

In this species about one-third of the erect filaments remain sterile, and extend beyond the gametangia. The cells in the creeping filaments are relatively long. The filaments are closely crowded, but distinct and readily separable. All the erect filaments are abruptly narrowed at the base. On account of the long creeping cells, the erect filaments are very much less crowded than is usually the case in most Myrionemas. The erect filaments do not arise successively toward the margin of the nearly mature plants, cells here and there developing an erect filament to the length of several cells before the intervening cells show signs of farther growth. The gametangia are typical of the genus, with uniseriate loculi and with mostly horizontal, cross cell walls. The zoosporangia (?) are fairly abundant, and are either with the gametangia on the same individual or on separate individuals. We question these structures as being functional since none of them has been observed to produce zoospores. They have the appearance of being abortive organs, either zoosporangia or gametangia, more likely the latter, and are probably like the organs observed by Magnus which induced him to establish the genus *Ascocyclus*.

19. **Myrionema setiferum** S. and G.

Fronds forming small, dense, irregular tufts or cushions, 0.5–0.75 mm. diam.; prostrate portion composed of regularly radiating, closely compacted filaments, 4–5μ diam., 1.5–3 times as long toward the margin; true hairs unknown; erect filaments numerous, unbranched, gradually attenuated toward the apex, long-piliferous, 700–800μ long; cells of erect filaments cylindrical, 4–5μ diam., 2–3 times as long; zoosporangia broadly clavate, 80–90μ long, 18–24μ broad; gametangia cylindrical, 150–200μ long, 7–8.5μ broad, sessile, or on short pedicels on the erect filaments or rarely on the creeping filaments; loculi uniseriate.

Growing on the outer ends of the leaves of eel-grass, in company with other small algae, in the lower littoral belt. Sitka, Alaska.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 345, pl. 32, fig. 8.

Myrionema setiferum is undoubtedly very closely related to *M. phyllophilum* on the one hand, and to *M. foecundum* f. *californicum* on the other. From the former, it differs in having longer and narrower erect filaments with longer cells and in having much longer and narrower gametangia which are more frequently borne laterally on the erect filaments, and often fasciculately branched from a short pedicel. From the latter, it differs in having functional zoosporangia, one of the few instances in which we have actually seen the undoubted zoospores, in having longer and setiferous erect filaments, and longer and slightly narrower gametangia.

Myrionema globosum (Reinke) Foslie

Myrionema (*Phycocelis*) *globosum* Foslie, New or Crit. Norw. Algae, 1894, p. 17. *Ascocyclus globosus* Reinke, Algenfl. westl. Ostsee, 1889*a*, p. 46, Atlas, 1889, p. 20, pl. 17. *Microspongium globosum* Reinke, Die brauenen Alg., 1888, p. 20.

Typical *M. globosum*, as we understand this plant, has not been reported from our territory, but we have described a forma *affine* which seems very closely related to it.

20. **Myrionema globosum f. affine** S. and G.

Fronds microscopic 200–300μ diam., irregular in outline, intermixed with other small algae; prostrate filaments much distorted, freely branched; erect filaments fasciculately branched, 100–140μ long, tapering upwards, piliferous in part; true hairs 300–400μ long; cells of prostrate filaments 4–6μ diam., variable in shape; cells of erect filaments cylindrical, 4–5μ diam.; zoosporangia unknown; gametangia cylindrical, 35–45μ long, 4–4.5μ broad, sessile and lateral on the erect filaments or rarely terminal; loculi uniseriate.

Growing on the leaves of eel-grass. Sitka, Alaska, to central California (Point Carmel, Monterey County).

Setchell and Gardner, Phyc. Cont. II, 1922, p. 342, pl. 33, fig. 16.

We have no measurements in detail for the parts of *Myrionema globosum*, this seemingly distinct species. Reinke (1889*a*, p. 46) states that the plants are one-half to one millimeter in diameter. Our plants seem much smaller, in general. It is difficult to make out the size on account of their being so intimately intermixed with other small algae. This is the case in both collections of plants which we have examined, one from Sitka, Alaska, and the other from Point Carmel, California.

21. **Myrionema strangulans** Grev. (*in sensu strictiore*)

Plate 35, fig. 12, and plate 40, fig. 51

Fronds forming very irregularly shaped cushions, 1–2 mm. diam., firmly adhering to the surface of the host, without rhizoids; prostrate portion composed of regularly radiating filaments with apical growth and branching, producing dichotomous filaments, strictly monostromatic; cells of prostrate filaments 4–4.5μ diam., 1–2 times as long, cylindrical or slightly doliiform; hairs, 1–1.5 mm. long, cells of hairs up to 100μ long at the apices, 5μ diam., quadrate and with short sheath at the base; erect filaments clavate, longest in the center of the frond, diminishing in length toward the periphery, 55–65μ (up to 110μ) long, 4μ diam. at the bases, 8μ at the apices; basal cells cylindrical, terminal cells subspherical; chromatophores spherical, several in a cell; unilocular zoosporangia numerous, interspersed among the erect filaments, sessile or on 1-celled pedicels on the creeping filaments, ellipsoidal to obovoid, 38–46μ (up to 60μ) long, 18–24μ broad; gametangia unknown.

Growing on the base of *Ulva* sp. in the lower littoral belt. Sitka, Alaska, to central California (Carmel Bay).

Greville, Scot. Crypt. Flora, vol. 5, 1827, pl. 300; Harvey, Phyc. Brit., vol. 3, 1851, pl. 280; Saunders, Alg. Harriman Exp., 1901, p. 423, pl. 46, figs. 1, 2; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 249; Tilden, Amer. Alg. (Exsicc.), no. 350. Not Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1795 (a mixture of several Myrionemataceae).

Myrionema strangulans Greville has been variously interpreted and the name has frequently been placed as a synonym under *M. vulgare* Thuret. In the attempt to determine the exact nature of *M. strangulans*, specimens from Greville's herbarium, from the western isles of Scotland (but not from Appin, the technical type locality) have been obtained (through the kindness of Professor Isaac Bayley Balfour) and carefully studied. From these the description given above has been drawn up. We find specimens on *Ulva* which agree with these Greville specimens in every detail, except that the zoosporangia in our plants average slightly larger.

22. **Myrionema obscurum** S. and G.

Fronds microscopic, distributed more or less irregularly on the surface of the host; creeping filaments much branched, very compact and contorted, forming a pseudoparenchymatous layer; erect filaments sparse, unbranched, 40–70μ high; true hairs unknown; cells of creeping filaments extremely irregular in shape and size, 4.5–10μ diam.; cells of erect filaments cylindrical, 6.5–7.5μ diam., quadrate or nearly so; zoosporangia very numerous, sessile on the creeping filaments, ovoid to broadly clavate, 45–65μ long, 18–30μ broad; gametangia unknown.

Growing on the blade of *Costaria costata*. Moss Beach, San Mateo County, California.

Setchell and Gardner, Phyc. Cont. II, 1922, p. 346, pl. 32, fig. 6.

Myrionema obscurum seems decidedly distinct from all other species of the genus. It seems to be a near relative of *M. strangulans* Grev. The basal layer is very compact, and adheres very firmly to the host, following closely the irregularities on its surface. We are unable to make out whether or not the epiphyte causes the death of the cells of the host, which seems to be quite frequent in all of the plants we have observed. The creeping filaments push among the dead cells of the host at times. The zoosporangia are numerous and all sessile.

7. **Compsonema** Kuck.

Fronds forming small cushions more or less circular in outline, composed of a prostrate creeping, primary portion, giving rise to numerous erect unbranched or branched filaments, with or without hairs; prostrate portion monostromatic, composed of filaments quite regularly radiating from a common center and usually with subterminal branching, closely crowded; reproduction by unilocular zoosporangia and plurilocular gametangia with mostly pluriseriate loculi.

Kuckuck, Beiträge zur Kennt. Meeresalg., 1899, pp. 56–58 (90–92 in repr.), pl. VI (12), figs. 6–9.

The type species of *Compsonema* is *C. gracile* and the type locality is Rovigno, on the east coast of the Adriatic Sea, where it was found growing on stones in water 1–2 meters deep.

The genus *Compsonema* was established by Kuckuck. We have accepted the genus to include forms which, like *Myrionema*, start from a single cell that, by divisions, soon originates a series of closely crowded, radiating filaments, forming a monostromatic basal layer more or less circular in outline; and which, unlike *Myrionema*, produce on erect filaments numerous gametangia that develop pluriseriate loculi. The genus is very closely related to the genus *Myrionema* on one side and to *Hecatonema* on the other.

Key to the Species

1. Erect sterile filaments branched 2
1. Erect sterile filaments simple 5
    2. Creeping filaments with few subulate rhizoids..7. **C. fasciculatum** (p. 478)
    2. Creeping filaments without rhizoids 3
3. Sterile branches short, high up, secund 4
3. Sterile branches long, low down, not secund..........13. **C. intricatum** (p. 482)
    4. Erect filaments piliferous in part..........17. **C. ramulosum** (p. 484)
    4. Erect filaments not piliferous..........12. **C. sporangiiferum** (p. 481)
5. Gametangia all terminal 6
5. Gametangia terminal and lateral or intercalary..........14
    6. Gametangia all sessile 7
    6. Gametangia pedicellate or in part sessile 8
7. All erect filaments completely transformed into gametangia....2. **C. sessile** (p. 474)
7. Gametangia intermixed with sterile filaments..........6. **C. tenue** (p. 478)
    8. Prostrate filaments producing penetrating rhizoids 9
    8. Prostrate filaments not producing rhizoids..........10
9. Rhizoids abundant, straight, penetrating deeply into the host .... 11. **C. streblonematoides** (p. 481)
9. Rhizoids contorted, not penetrating deeply..........5. **C. pusillum** (p. 477)
    10. Gametangia very abundant, of uniform height....4. **C. fructuosum** (p. 476)
    10. Gametangia with pedicels very variable in height..........11

11. Gametangia cylindrical or very slightly tapering....................12
11. Gametangia decidedly fusiform....................13
 12. Gametangia mostly on 1–2-celled pedicels..1. **C. myrionematoides** (p. 474)
 12. Pedicels of gametangia very variable in height..3. **C. nummuloides** (p. 475)
13. Gametangia 24–30μ long, 6–8μ broad....................18. **C. immixtum** (p. 487)
13. Gametangia 45–65μ long, 15–18μ broad....................9. **C. coniferum** (p. 479)
13. Gametangia 50–75μ long, 8–11μ broad....................8. **C. dubium** (p. 479)
13. Gametangia 60–130μ long, 18–28μ broad....................10. **C. serpens** (p. 480)
 14. Erect filaments in part piliferous.....16. **C. speciosum** f. **piliferum** (p. 485)
 14. Erect filaments not piliferous....................15
15. Terminal gametangia up to 400μ long....................14. **C. secundum** (p. 483)
15. Terminal gametangia up to 110μ long........15. **C. secundum** f. **terminale** (p. 484)

1. **Compsonema myrionematoides** S. and G.

Fronds forming small, circular to irregular cushions, 1–2.5 mm. diam., prostrate portion strictly monostromatic, composed of closely crowded, contorted, radiating filaments; erect filaments unbranched, cylindrical, 110–130μ long; true hairs absent; cells of creeping filaments cylindrical to irregular in form; cells of erect filaments cylindrical, 7.5–8.5μ diam., 1–2 times as long, terminal often several times as long; chromatophore a slightly broken band in each cell; zoosporangia (?) broadly clavate, sessile or on short pedicels on the creeping filaments, 35–50μ long, 20–28μ broad; gametangia numerous, cylindrical to fusiform, sessile or on short pedicels on the creeping filaments, 50–70μ (up to 100μ) long, 9–12μ broad.

Growing on the stipe of *Nereocystis Luetkeana*. Pacific Grove, California.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 361, pl. 36. fig. 1.

There is but little choice as to the generic position of this small alga. It forms small brown tufts or cushions of loose filaments. Very frequently the gametangia are wider in the middle than at the ends and have decidedly biseriate loculi. Because of the more or less loose tufted character of the erect filaments and the partially biseriate gametangia we have placed it with the genus *Compsonema*.

2. **Compsonema sessile** S. and G.

Fronds forming inconspicuous cushions up to 1.5 mm. diam., circular to irregular in outline; creeping filaments contorted, closely crowded, adhering firmly to the host, without rhizoids; erect filaments sparse, 20–24μ high; true hairs absent; cells of creeping filaments irregular in shape and size, 9–12μ diam.; chromatophores band-shaped, one in each cell; zoosporangia unknown; gametangia numerous, sessile on the creeping filaments, cone-shaped to fusiform, 16–22μ long, 11–14μ broad, many walls of the loculi oblique.

Growing on the lamina of *Hedophyllum sessile* near the outer end. Neah Bay, Washington.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 358, pl. 39, fig. 6.

Compsonema sessile represents the extreme of the genus in the direction of simplicity. There are no hair filaments, and it is doubtful whether any of the erect filaments remain sterile. At times even the cells of the basal layer seem to become a part of the gametangia, at least more than one cell in the basal layer may be at the base of a single gametangium. There would seem to be only a single modification of *Myrionema* of the simplest type to produce this species, viz., the change in the type of gametangium from uniseriate to pluriseriate. If we hold to the principal distinction between *Compsonema* and *Myrionema*, it will be necessary to ally this species with the former. It was found growing in company with *Streblonema aecidioides* f. *pacificum* S. and G., which gave to the host a roughened appearance, otherwise it probably would not be noticeable without microscopic examination.

3. **Compsonema nummuloides** S. and G.

Fronds forming thin circular cushions, 7–12 mm. diam.; prostrate portion composed of radiating, much crisped, closely crowded filaments following closely the irregularities of the host; erect filaments unbranched, numerous, 300–400μ long, tapering slightly at both ends; true hairs absent; cells of creeping filaments very irregular in shape and size; cells of erect filaments cylindrical, 6–7μ diam. at the base, 3–8 times as long, 9–11μ diam. in the widest part, quadrate apical cell 6–7μ diam., 3–8 times as long; zoosporangia unknown; gametangia mostly sessile or on short pedicels, some terminal on the erect filaments, 70–90μ (up to 140μ) long, 11–15μ broad; loculi mostly 2-seriate.

Growing on the pneumatocysts of *Nereocystis Luetkeana*. Moss Beach, San Mateo County, California.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 359, pl. 35, figs. 5, 6.

Compsonema nummuloides forms thin, light brown cushions on the pneumatocysts of the host. The whole cushion is a single plant, circular in outline and attaining a diameter of twelve or more millimeters, although the majority of the plants are much smaller. Like a typical *Myrionema* the plant starts from a single cell and by divisions forms a series of filaments radiating in all directions with apical growth and dichotomous branching, by the splitting of the apical cell, thus forming a continuous monostromatic layer of cells. Beginning in the center, practically every cell in each radiating filament of the basal layer gives rise successively to an erect filament, about two-thirds of which are fructiferous, the others remaining sterile. A very large majority of the gametangia are sessile or on short pedicels, thus occupying a zone near the creeping filaments, a myrionematoid character, but the remainder of the filaments continue to grow and attain a length of 300μ to 400μ. Some of these filaments are terminated by relatively short gametangia. This is one of several species with this general method of development which has been found growing only on the above mentioned host, differing from each other and from the type of the genus, *C. gracile* Kuckuck, in the size of the plant as a whole, in details of dimensions of their parts, in the presence or absence of zoosporangia and hairs, in the position of the gametangia, and in the relative amount of sterile filaments. It seems to form a fairly compact group but with overlappings, however, in the genera *Streblonema, Myrionema,* and *Hecatonema.*

4. **Compsonema fructuosum** S. and G.

Fronds forming circular or somewhat irregular cushions, 4–5 mm. diam.; prostrate portion composed of tortuous creeping filaments following closely the irregularities of the surface of the host; erect filaments unbranched, densely crowded, 190–230μ long, cells cylindrical, 8–9μ diam., 2–4 times as long below, 1–2 times above; chromatophores band-shaped; hairs absent; zoosporangia sparse, broadly clavate, terminal on short pedicels from the creeping filaments, 55–65μ (up to 100μ) long, 22–28μ broad; gametangia terminal on erect filaments, cylindrical to slightly fusiform, blunt, 80–120μ long, 12–16μ broad; loculi 2–4-seriate.

Growing on the pneumatocysts of *Nereocystis Luetkeana.* Tomales Bay, Marin County, California.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 355, pl. 36, fig. 2.

Compsonema fructuosum departs from the type of the genus, *C. gracile* Kuckuck (1899, p. 90, pl. VI (12), figs. 6–9), in having a different host, no hairs, fewer and shorter sterile filaments, more gametangia, and in having differences in details of measurements. In the abundance and position of the fruit and in the definite circular thallus with compact monostromatic basal layer of filaments, it approaches very closely to a typical *Myrionema*, but the multiseriate gametangia represent a stage in development which we have not admitted into that genus. The gametangia occupy a definite zone on the outer ends of the erect filaments. Practically all of the erect filaments bear gametangia.

At times the basal layer seems to be distromatic, or even polystromatic, but careful investigation shows that this appearance is occasioned by the overlapping creeping filaments which follow the very irregular surface of the host, due to the death of its surface layer of cells, probably before the epiphyte took possession. The zoösporangia are very sparse, but specimens have been seen which show undoubted zoospores.

5. **Compsonema pusillum** S. and G.

Plate 54, fig. 3

Fronds forming thin, light brown cushions, irregular in outline, 3–4 mm. diam.; prostrate portion composed of very tortuous, branched filaments following closely the irregularities of the host, producing a few filaments from the under side penetrating among the cells of the host; erect filaments simple, cylindrical, 270–300μ long; cells of creeping filaments very irregular in shape and size; cells of erect filaments cylindrical, 6–7μ diam., 3–5 times as long; chromatophore a slightly broken band; true hairs absent; zoösporangia spherical to ovoid, sessile or on short pedicels on the creeping filaments, 18–25μ (up to 40μ) long, 16–22μ broad; gametangia cylindrico-conical to blunt fusiform, sessile or on short pedicels on the creeping filaments, 40–60μ long, 10–12μ broad; loculi 1–2-seriate.

Growing on the pneumatocysts of *Nereocystis Luetkeana*. Carmel Bay, Monterey County, California.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 356, pl. 37, fig. 3.

Compsonema pusillum seems to overlap each of several genera. Its zoösporangia, gametangia, and penetrating filaments ally it with *Streblonema*. Sauvageau (1897) has figured a *Myrionema* with rhizoids. The gametangia are very small and have about as many uniseriate as biseriate loculi. It might be considered a very minute creeping *Ectocarpus*. We have placed it with the genus *Compsonema* on account of the scarcity of fruit in proportion to the sterile tissue, and on account of the monostromatic base, believing that the penetrating filaments are more or less accidental on account of the injured condition of the surface layer of cells of the host.

6. **Compsonema tenue** S. and G.

Plate 54, fig. 6

Fronds microscopic, forming a more or less continuous stratum on the host among other small algae; creeping filaments numerous, branched, following closely the irregularities of the surface of the host; erect filaments sparse, unbranched, tapering slightly at both ends, 80–100μ high; hair filaments sparse; cells of creeping filaments irregular in shape and size; cells of erect filaments cylindrical, not constricted, 7–8μ diam., 1.5–2.5 times as long; cells of hair filaments cylindrical, 5.5–6.5μ diam., quadrate or less below, 7–10 times as long above; zoosporangia (?) clavate, 24–28μ long, 8–10μ broad, sparse; gametangia fusiform to irregularly conical, sessile on the creeping filaments, numerous, 22–28μ long, 7–11μ broad; loculi mostly 2-seriate.

Growing on the fruiting fronds of *Cystophyllum geminatum*. Sitka, Alaska.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 359, pl. 37, fig. 6.

Compsonema tenue, although scarcely typical of the genus, seems to possess affinities as closely allied to *Compsonema* as to any other genus, and hence we have placed it here for the present.

7. **Compsonema fasciculatum** S. and G.

Fronds forming microscopic tufts more or less confluent; creeping filaments tortuous, adhering to the host without rhizoids; erect filaments branched near the base, 90–130μ long, tapering at the apex and at the base, not piliferous, constricted at the cross-walls; true hairs absent; cells of erect filaments 10–14μ diam. in the widest part, 1–2.5 times as long; zoosporangia unknown; gametangia somewhat irregular in form, conical to fusiform, 35–45μ long, 12–18μ broad, mostly lateral on short pedicels.

Growing on *Gigartina radula* f. Pacific Grove, California.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 360, pl. 38, figs. 7–9.

This species is allied here rather than with *Ectocarpus* because of its extremely small size and its creeping fasciculate habit.

8. **Compsonema dubium** S. and G.

Fronds diminutive, forming small tufts among other microscopic algae on the host; prostrate portion composed of much contorted, branched, creeping filaments; erect filaments unbranched, almost cylindrical throughout, 275–350μ long, not piliferous; true hairs absent; cells of creeping filaments very irregular in form and size; cells of erect filaments cylindrical, 7–9μ diam., slightly less at the base and the apex of the filament, 2–3 times as long; zoosporangia (?) ellipsoidal, terminal on short pedicels, 16–22μ long, 12–15μ broad; gametangia cylindrical to slightly fusiform, terminal on longer or shorter pedicels from the creeping filaments, rarely terminal on the long erect filaments, 50–75μ long, 8–11μ broad; loculi mostly 2-seriate.

Growing on the sterile base of *Gigartina radula* f. Cypress Point, Monterey County, California.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 365, pl. 38, fig. 6.

Compsonema dubium, like *C. coniferum* and *C. serpens*, has close affinities with small members of the genus *Ectocarpus*. Its relatively long and narrow gametangia distinguish it from the two species here mentioned with which it is frequently associated.

9. **Compsonema coniferum** S. and G.

Fronds microscopic, more or less confluent, forming a velvety stratum on the host among other minute algae; prostrate portion profusely branched, much contorted; erect filaments numerous, simple, slightly attenuated at both ends, not piliferous, 150–200μ high; true hairs absent; cells of creeping filaments irregular in shape and size, 6–7.5μ diam., 9–12μ long; cells of erect filaments cylindrical to slightly doliiform, 8–10μ diam. in widest part, 1–1.5 times as long; chromatophores band-shaped; zoosporangia unknown; gametangia sessile or on short pedicels on the creeping filaments, narrowly conical, 45–65μ long, 15–18μ broad.

Growing on the sterile base of *Gigartina radula* f. Cypress Point, Monterey County, California.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 365, pl. 38, fig. 3.

Compsonema coniferum seems to be a very close relative of *C. fasciculatum*, found growing on the same host. The fronds are more extensive, unbranched, and have larger gametangia. We consider this species of *Compsonema* a very near approach to an *Ectocarpus* of extremely small size. We are inclined toward the genus *Compsonema* as a more appropriate genus for this species than *Ectocarpus* on account of its extensive creeping habit and prolific production from the creeping filaments of nearly sessile gametangia and many sterile erect filaments. It is to be found quite commonly associated on the same host with several other species of Myrionemataceae.

10. **Compsonema serpens** S. and G.

Fronds forming a more or less continuous expanded stratum on the surface of the host; creeping portion composed of much contorted, irregularly branched filaments; erect filaments unbranched, or rarely with a few subulate branches above, tapering slightly at the base, gradually attenuated in the upper part, not piliferous, 375–425μ long; true hairs absent; cells of creeping filaments cylindrical to irregular, 10–13μ diam., 0.5–3 times as long; cells of erect filaments cylindrical, not constricted at the dissepiments, 5.5–8.5μ diam. at the base, 10–17μ diam. in the widest part, 1.25–2.5 times as long; chromatophores band-shaped, densely crowded in the young cells, more numerous and separated in the old cells; zoosporangia unknown; gametangia cylindrico-conical, terminal on shorter or longer pedicels from the creeping filaments, rarely terminal on the long filaments, 60–130μ long, 18–28μ broad.

Growing on the sterile base of *Gigartina radula* f., in company with several other small algae. Cypress Point, Monterey County, California.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 363, pl. 39, fig. 7.

This diminutive member of the Melanophyceae is on the border line between *Compsonema* and *Ectocarpus*. Our comprehension of these two genera, so far as the vegetative portion is concerned, is that a typical *Compsonema*, starting from a single cell, develops an extensive, creeping, attaching mass of filaments, radiating in all directions from the origin, which later produces very numerous erect filaments, some of which remain sterile and others become fructiferous; and that a typical *Ectocarpus*, starting likewise from a single cell, develops a rather insignificant series of attaching filaments, more or less rhizoidal in nature, and a relatively extensive system of erect filaments finally producing the fruit. Starting with this conception concerning the two genera, we are assuming that differentiation has proceeded from *Compsonema* in the direction of the reduction of the creeping portion, to a more extensive development of the erect portion, finally resulting in an *Ectocarpus*.

The species under consideration has a relatively extensive system of creeping filaments but very much less so than that of a typical *Compsonema.* The creeping filaments do not form a solid disk, but those from different plants are so intertwined that it is impossible to determine the limits of a distinct individual. In this character it resembles an *Ectocarpus.* The gametangia are like those of a typical *Ectocarpus,* but since they are mostly short-pedicellate and spring directly from the creeping filaments, as is the case in a typical *Compsonema,* and because of the relatively extensive system of creeping filaments, we have placed it in the latter genus.

11. **Compsonema streblonematoides** S. and G.

Fronds forming thin, circular cushions, 3–5 mm. diam.; prostrate portion composed of filaments following closely the irregularities of the host, giving rise below to numerous rhizoidal filaments penetrating to a depth of 300–350μ among the cells of the host, and above to sterile filaments and gametangia; erect filaments 140–160μ long; cells of erect filaments cylindrical, 8.5–10μ diam., 1.5–3 times as long; zoosporangia unknown; gametangia mostly cylindrical, short-pedicellate, 55–70μ long, 11–14μ broad; loculi mostly 2-seriate.

Growing on the pneumatocysts of *Nereocystis Luetkeana.* Mouth of Tomales Bay, Marin County, California.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 353, pl. 35, fig. 4.

Compsonema streblonematoides, like a *Streblonema,* has a large part of the vegetative portion of the frond within the host-plant, the penetrating filaments extending into the host two or three times as far as the length of the external vegetative filaments. The whole frond, however, is the result of the growth of a single cell and forms a compact monostromatic basal disk. In the character of the gametangia it is close to a *Myrionema,* but in a very large majority of cases the loculi are biseriate.

12. **Compsonema sporangiiferum** S. and G.

Fronds forming circular cushions, 1–4 mm. in diameter; prostrate portion composed of compact, irregular, more or less contorted filaments following the irregularities of the surface closely, monostromatic or in part distromatic; erect filaments 300–700μ long, unbranched or bearing above a few short, mostly secund, fructiferous ramuli; cells of the erect filaments 6–8μ diam. at the base, and 2–3 times as long, 11–13μ diam. at the apex, and 1–1.5 times as long, many cells in the upper part of the filaments dividing 1–2 times longitudinally; chromatophores band-shaped, few in a cell; zoosporangia very abundant, very variable in shape and size, narrowly ellipsoidal, clavate to broadly ovoid, 40–130μ long, 20–35μ wide, sessile or on short pedicels from the prostrate filaments, or lateral or terminal on the erect filaments; gametangia rare, cylindrical, sessile or mostly short-pedicellate on the creeping filaments, rarely terminal and tuberculate on the erect filaments, 80–130μ long, 11–15μ broad.

Growing on the pneumatocyst of *Nereocystis Luetkeana.* Neah Bay, Washington.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 357, pl. 36, figs. 3–8.

The unusual condition in *Compsonema* prevails in *C. sporangiiferum*. The gametangia seem to be of rare occurrence. Examination of specimens of different sizes from different parts of the host revealed the presence of a large number of zoosporangia in all stages of development, many being empty. The gametangia are prevailingly near the base, although occasionally a complex one appears terminal on an erect filament. A very common character is the division of the cells in the upper parts of the filaments into 2–4 parts by longitudinal walls, producing a slight clavate condition in such filaments. We do not know, at present, the morphological significance of this condition. The zoosporangia and gametangia, so far as observed, develop on distinct individuals.

13. **Compsonema intricatum** S. and G.

Fronds 1.5–2.5 mm. high, more or less confluent, forming a continuous velvety stratum of indefinite expansion; creeping filaments numerous, profusely branched, crooked; erect filaments numerous, unbranched or with a few short branches near the base, straight, gradually attenuated at the apices, piliferous in part; true hairs absent; cells of creeping filaments irregular in shape and size; cells of erect filaments cylindrical, 8–9μ diam., 1–2.5 times as long, slightly narrower at the base of the filaments; chromatophores band-shaped; zoosporangia ovoid to ellipsoidal, terminal on short filaments from the creeping filaments or lateral and sessile or pedicellate on the erect filaments near the base, 25–33μ long, 18–22μ broad; gametangia terminal on short erect filaments from the creeping filaments, lateral and sessile or pedicellate near the base of the erect filaments or intercalary in the main erect filaments, 80–120μ (up to 175μ) long, 10–14μ broad; terminal and intercalary ones up to 600μ long; loculi mostly 2-seriate.

Growing on *Fucus furcatus* f. Carmel Bay, Monterey County, California.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 354, pl. 35, figs. 1–3.

Compsonema intricatum has diverged very far from a typical *Compsonema*. The size of a single individual at maturity cannot be ascertained, since the creeping filaments, and to some extent the erect filaments, are thoroughly and inextricably intertwined, forming continuous velvety strata on the surface of the host for several inches in expanse. The gametangia have, to a considerable degree, moved to the lateral position, the majority, however, remain terminal on long pedicels from the basal filaments. The lateral position is characteristic of *Ectocarpus*. The intercalary gametangia are typical of the genus *Pylaiella*. The creeping filaments are very numerous, although they do not radiate regularly side by side, thus forming a regular circular disk typical of the genus *Myrionema*. The zoosporangia (?) are numerous and develop with the gametangia on the same individual. It is exceedingly doubtful whether or not these structures are functional. At the stage in which the material was found, they were practically all of the same size, and some of the accompanying gametangia were empty. There is no indication of the formation of zoospores. They are filled with what seem to be densely crowded, angular chromatophores. The apical end is slightly beaked, and the outer wall dissolved, except a thin inner membrane. Their position on the same plants with gametangia, the peculiar open beak, and the fact that they all seem to be of the same age lead us to suspect that they are some sort of abnormalities, or pathological conditions of the gametangia, which will require much more investigation to interpret. We have retained this in the genus *Compsonema* on account of the prevailing simplicity of the erect filaments and the abundance of creeping filaments, practically every cell of which gives rise to an erect filament.

14. **Compsonema secundum** S. and G.

Plate 54, figs. 1, 2

Fronds very small, usually more or less confluent; prostrate portion monostromatic, composed of much crisped, branched filaments; cells of creeping filaments irregular in shape, 7–8μ diam., variable in length; erect filaments up to 1.25 mm. long, unbranched, or rarely with a few short fructiferous ramuli; cells of erect filaments cylindrical, 5.5–6.5μ diam. at the base, 4.5–6 times as long, 9.5–10.5μ diam., in widest part, terminal cells up to 9 times as long; chromatophores band-shaped; zoosporangia broadly clavate, sessile or on short pedicels from the creeping filaments, 60–90μ long, 22–28μ broad; gametangia very variable, rarely on short pedicels on the creeping filaments, at times formed by transforming the upper portion of a long erect filament, at other times by developing lateral secund projections from part or all of the groups of loculi in the long, terminal gametangia, up to 400μ long, 11–15μ broad, blunt, clavate on the ends of the long filaments.

Growing on the pneumatocyst of *Nereocystis Luetkeana.* West coast of Washington (Moclips) to central California (Carmel Bay).

Setchell and Gardner, Phyc. Cont. III, 1922, p. 361, pl. 37, figs. 1, 2.

Like *Compsonema ramulosum, C. secundum* has gametangia occupying a variety of positions and assuming a diversity of forms. The form of gametangium which marks the species is the long terminal form which develops numerous, short, blunt-conical, seriate, secund, sessile gametangia, thus forming a complex composed of these gametangia and the metamorphosed cells in the upper part of the filament. The end of the filament becomes reflexed, at times almost scorpioid. The specimens from Moclips, Washington, were taken in May and the gametangia were practically all empty. The other parts of the plants manifested signs of old age conditions. They seem to belong to this species, but the filaments have a considerably greater diameter. Typical zoosporangia with well-formed zoospores have been observed in this collection.

15. **Compsonema secundum** f. **terminale** S. and G.

Plate 54, figs. 4, 5

Fronds forming a continuous velvety stratum of indefinite expanse, attached by very much distorted, branched, creeping filaments with numerous, penetrating, subulate rhizoids from the under surface; erect filaments 700–800μ (up to 1 mm.) long, unbranched, or producing a few short secund fructiferous ramuli, straight, slightly tapering toward the base, cylindrical above; cells of the creeping and rhizoidal portions irregular, variable in size; cells of the erect filaments cylindrical, not constricted, 6–8μ diam. at the base of the filaments, 2–3.5 times as long, 9–12μ diam. above, 0.5–2 times as long; chromatophores irregular bands, few in a cell; zoosporangia (?) broadly clavate, sessile or on short pedicels from the creeping filaments, 50–60μ long, 18–22μ broad, or terminal and seriate with lateral secund prolongations; gametangia sessile near the outer ends of the erect filaments, or on short pedicels from the creeping filaments, 90–110μ long, 15–18μ broad, nearly cylindrical, or terminal on the erect filaments, clavate, often with lateral, tuberculate, secund prolongations, variable in size.

Growing on the pneumatocysts of *Nereocystis Luetkeana.* Central California (San Francisco and Pacific Grove).

Setchell and Gardner, Phyc. Cont. III, 1922, p. 366, pl. 37, figs. 4, 5.

This form of *Compsonema* is to be distinguished by the great predominance of relatively short terminal gametangia, and many relatively large, lateral, secund, sessile gametangia which are curved upwards. There are a few sessile or short pedicellate examples at the base and a few lateral forms on short ramuli. Specimens taken in December had the larger number of gametangia empty.

16. **Compsonema speciosum** f. **piliferum** S. and G.

Fronds forming cushions, more or less circular in outline, 5–8 mm. diam.; creeping filaments very irregularly and profusely branched, following closely the irregularities on the surface of the host, at times short branches penetrating among the injured cells of the host; erect filaments numerous, unbranched or bearing short, secund, fructiferous branches or an occasional piliferous branch, 500–800μ long, tapering at the base, piliferous above; cells of creeping filaments very irregular in shape and size; cells of erect filaments cylindrical, 6–7.5μ diam. at the base, 9–12μ diam. in the widest part, 1–3 times as long; cells of hairs 5–6.5μ diam., up to 15 times as long; chromatophores band-shaped, few in a cell; zoosporangia obovoid, 55–65μ long, 28–32μ broad, rare; gametangia sessile or on shorter or longer pedicels from the creeping filaments or lateral, secund, sessile or pedicellate on the erect filaments or, more rarely, intercalary; terminal gametangia 60–100μ long, 14–18μ broad, secund gametangia variable, much smaller.

Growing on the pneumatocysts of *Nereocystis Luetkeana.* Moclips, Washington.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 356, pl. 38, figs. 1, 2.

Compsonema speciosum f. *piliferum* seems undoubtedly to be very closely related to *Compsonema speciosum* (Börg.) S. and G. comb. nov., (*Myrionema speciosum* Börgesen, 1902, pp. 421–424, which is the *Hecatonema speciosum* (Börgesen) Cotton, 1912, p. 121 and the

Hecatonema diffusum Kylin cf. Cotton, *loc. cit.*), at least the two sets of plants agree very closely in general habit and structure as described by Börgesen. Judging alone from the description and figures the chief differences are that our plant has short penetrating rhizoids, many terminal and no lateral hairs, and larger gametangia. We are unable to say that the plant would produce rhizoids on an uninjured host. The surface cells of the host are destroyed under the epiphyte, and it is an open question whether the penetrating rhizoids are or are not the cause of their death. Börgesen does not give the dimensions of the whole plant, but he states that the plants form short dense mats on the conceptacles of *Himanthalia lorea*, which would indicate that they were quite small. Our plants form circular cushions or mats 5–8 mm. in diameter. Typical zoosporangia were found at the base of the erect filaments. The lateral secund gametangia, standing nearly perpendicular to the filaments, the cells of which become the basal part of the gametangia, is a character not found in *Compsonema gracile* Kuckuck.

17. **Compsonema ramulosum** S. and G.

Fronds forming circular cushions 5–7 mm. diam.; prostrate portion monostromatic, composed of more or less contorted and irregularly branched radiating filaments; erect filaments piliferous in part, unbranched or bearing above short, mostly fructiferous and secund branches and occasional hairs, tapering slightly at the base; cells of creeping filaments 6–7μ diam., quadrate or slightly longer than the diameter; cells of erect filaments 6–7.5μ diam. at the base, slightly broader above, 1–3.5 times as long; cells of the branches and hairs 4–6μ diam.; chromatophores band-shaped, more or less broken and angular; zoosporangia (?) broadly clavate, terminal on longer or shorter pedicels, lateral and secund or whorled near the ends of the erect filaments; gametangia exceedingly variable in shape, size and position, sessile or pedicellate on the creeping filaments or lateral on the erect filaments or intercalary or terminal either on short lateral ramuli or on the main filaments, clavate, cylindrical to cylindrico-conical, up to 140μ long, 16μ broad, loculi mostly 2-seriate.

Growing on the pneumatocysts of *Nereocystis Luetkeana*. Carmel Bay, Monterey County, California.

Setchell and Gardner, Phyc. Cont. III, 1922, p. 362, pl. 39, figs. 1–5.

There exists in this species extreme variation in the form, size, and position of the gametangia. Some are sessile on the creeping filaments, though they are more frequently to be found on the pedicels up to fifteen cells long. At times sessile forms are to be found on the erect filaments about two-thirds of the way up to the apex, but more generally they are terminal on small lateral ramuli on the erect filaments arising from the middle to near the apices. Rarely there are small lateral forms on the ramuli. Finally, they may rarely be terminal or intercalary and seriate on the erect filaments although the erect filaments are usually piliferous. The terminal forms on pedicels, and particularly those on the main erect filaments, are often quite blunt, even clavate. Others on the prostrate filaments are narrow and sharply attenuated, at times terminated by a sterile pointed filament, in effect intercalary. Many of the gametangia, terminal on the ramuli, are composed of a single series of loculi. Most of the others are two or more seriate. The hair filaments do not seem to be abundant. They arise laterally on the main filaments, usually above the center. The meristem in these hairs is at the base which is surrounded by a sheath similar to that described by Sauvageau (1898, p. 47) for *Myrionema*. The ramuli are decidedly curved upwards. The species is similar to *Myrionema speciosum* from the Faeröes, described by Börgesen (1902, p. 421). Our plant is more slender in all of its parts, has much longer gametangia, and possesses, in addition to the sessile, secund gametangia figured by Börgesen, occasional intercalary ones and many terminal ones on the numerous clustered ramuli. These ramuli are in turn occasionally branched, usually arise in groups, sometimes whorled, two or three arising from the same cell, in other instances they are secund.

The species often grows in association with other members of the Myrionemataceae and the Ectocarpaceae. As a rule, the main erect filaments do not enter into the formation of gametangia, but give rise either to sessile gametangia or to the ramuli. No zoospores have been observed in the so-called zoosporangia. We suspect that these may represent pathological conditions.

18. **Compsonema immixtum** S. and G.

Thallus inconspicuous, the basal filaments creeping among the gametangia of the host; erect filaments very numerous, all bearing gametangia; hairs and zoosporangia unknown; gametangia narrowly ellipsoidal, 24–30μ long.

Growing on *Colpomenia sinuosa* f. *deformans*. Isla Partida, Gulf of California.

Setchell and Gardner, Mar. Alg. Gulf. of Calif., 1924, p. 724, pl. 17, fig. 49.

This organism is on the border between *Myrionema* and *Compsonema* as we interpret these two genera (Setchell and Gardner, Phyc. Cont. II–VI, 1922). Under the present condition of the host it is impossible to learn much of the basal portion. It appears that the basal layer was largely developed before the gametangia of the host started to develop. Later the latter pushed out among the basal filaments and leaving them behind developed along with the gametangia of the epiphyte. The gametangia project beyond the general surface of the host nearly their entire length. On account of the pluriseriate nature of the gametangia, we have placed it in the genus *Compsonema* rather than in *Myrionema.*

8. **Hecatonema** Sauv.

Fronds starting from a single cell, soon developing a series of closely crowded filaments radiating in all directions, forming a compact disk; the branching of radiating filaments often subterminal; the cells of the radiating filaments wholly or in part dividing once horizontally, thus creating a distromatic layer, the lower cells of which may or may not produce short, penetrating, subulate rhizoids; the upper layer of cells producing erect assimilating filaments, wholly or in part producing gametangia, and hyaline hairs; gametangia pluriseriate.

Sauvageau, Sur quelq. Myrioném., 1897, p. 248 (p. 88, Repr.).

The type species of the genus is *H. maculans,* collected at Cherbourg, France, growing on *Rhodymenia palmata* Grev. The specific name was taken from *Phycocelis maculans* Collins (Bull. Tor. Bot. Club., vol. 23, 1896, p. 459), the plants of which were distributed in Collins, Holden and Setchell's Phycotheca Boreali-Americana (Exsicc.), no. 274.

Key to the Species

1. All of the erect filaments transformed into gametangia ....1. **H. Lawsonii** (p. 489)
1. Part of the erect filaments transformed into gametangia 2
    2. Erect sterile filaments clavate ....3. **H. clavatum** (p. 491)
    2. Erect sterile filaments cylindrical ....2. **H. variabile** (p. 490)

1. **Hecatonema Lawsonii** S. and G.

Plate 53, figs. 5–7

Fronds forming microscopic cushions, 250–500μ diam., irregular in outline; prostrate portion composed of very much contorted, profusely branched filaments with subterminal forking; erect filaments forming a compact, palisade-like stratum interspersed with numerous hair filaments, 0.75–1.5 mm. long; cells of creeping filaments dividing radially as well as tangentially, forming a pseudoparenchymatous tissue in the center of the thallus, irregular in shape, 4–5μ diam.; cells of the hair filaments quadrate at the base and surrounded by a sheath, up to 25 times as long as the diameter above; zoosporangia unknown; gametangia cylindrical to slightly fusiform, 25–30μ long, 5–6.5μ broad; many loculi formed by longitudinal and by oblique walls.

Growing on the sporophylls of *Nereocystis Luetkeana*. Uyak Bay, Alaska.

Setchell and Gardner, Phyc. Cont. IV, 1922, p. 379, pl. 40, figs. 5–7. *Myrionema vulgare* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 924 (not of Thuret). *Myrionema strangulans* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 249 (not of Greville).

This plant superficially resembles very closely *Myrionema foecundum* f. *simplicissimum* S. and G. Microscopic examination, however, reveals several important differences. The creeping filaments are unique. The branches are very numerous, come off at wide angles and seem, for the most part at least, to be subterminal, or if the terminal cell splits, one of the dichotomy very frequently fails to develop till much later. Many of the cells in the center, and even toward the periphery, divide radially and perpendicular to the surface of the host, forming a pseudoparenchymatous layer. Thus the species, strictly speaking, cannot be said to be distromatic, since the distromatic condition of a frond is really brought about by *radial* divisions of the cells of the filaments, but parallel to the surface of the host. The character of the gametangia and of the creeping filaments will not permit of its being placed with *Myrionema vulgare* Thuret as further described and figured by Sauvageau (1897, p. 186, *et seq.*). On account of the radial divisions of the creeping filaments and the prevailing biseriate condition of most of the gametangia, we have placed this species with the genus *Hecatonema*.

2. **Hecatonema variabile** S. and G.

Fronds forming circular cushions, 4–7 mm. diam.; prostrate portion composed of regularly radiating filaments with subterminal branching, attached by numerous short rhizoids, 1–3 cells long; erect filaments not densely crowded, not arising successively from the center toward the periphery, unbranched, 400–500μ long; hairs unknown; cells of creeping filaments irregular in form, 7–9μ diam., 1–3 times as long as at the margin; cells of erect filaments 4.5–5μ diam. at the base and 2–5 times as long, 8–10μ diam. and 1–3 times as long toward the distal end; zoosporangia (?) broadly clavate, sessile or on short pedicels on the prostrate filaments, rarely lateral or terminal on the erect filaments, 50–65μ long, 20–24μ broad; gametangia cylindrical, tapering slightly at the apices, sessile or on short pedicels on the prostrate filaments or rarely terminal on the erect filaments, 70–120μ long, 9–12μ broad; loculi 1–2-seriate.

Growing on the pneumatocysts of *Nereocystis Luetkeana*. Carmel Bay, Monterey County, California.

Setchell and Gardner, Phyc. Cont. IV, 1922, p. 377, pl. 41, figs. 1–12.

From the standpoint of the structure of the gametangia, the type of this species of *Hecatonema* could scarcely be separated from a *Myrionema* such as *M. phyllophilum* S. and G. They, in part, possess uniseriate loculi, but have many perpendicular and slanting walls, making a partial biseriate condition. The basal layer, particularly in the center of the thallus, is distinctly distromatic, developing numerous peg-like rhizoids, which serve to anchor it more firmly to the host, and, for the most part at least, the branching of the filaments is subterminal, whereas that of a true *Myrionema* is terminal and brought about by the splitting of the apical cell.

The size of the plants as a whole varies considerably. The material of the type varies in this respect from 4 mm. to 7 mm. in diameter. In some collections of specimens which we have included under the species, the specimens are as small as 2 mm. in diameter, in others they are up to 10 mm. in diameter. The length of the erect filaments varies from 150μ to 500μ. Mature gametangia vary from 55μ to 120μ long. The relative number of gametangia terminal on the erect filaments, as well as their size and complexity, is exceedingly variable in different collections. Two or three cells only may metamorphose in some filaments, in others eight or ten. Occasionally small lateral outgrowths from the metamorphosed cells may occur. The number of erect filaments in proportion to the number of gametangia is a character which seems to be very unstable. In some collections they exceed the number of gametangia almost two to one, in others they do not occur more than in proportion of one to five. They are very irregular in origin along the radiating creeping filaments. Some near the margin of the frond may be nearing maturity before others near the center of the frond have started.

3. **Hecatonema clavatum** S. and G.

Plate 53, figs. 1–4

Fronds forming circular cushions 2–3 mm. diam., with relatively wide margin free from erect filaments; prostrate portion attached by numerous, short, subulate rhizoids, and composed of regularly radiating, closely crowded filaments; erect filaments mostly clavate, unbranched, 190–210μ long; cells of creeping filaments 5–6μ diam., 1.5–2 times as long; cells of erect filaments cylindrical below and 5.5–6.5μ diam., 2–2.5 times as long, slightly constricted at the dissepiments above and 8–11μ diam., 1.5 times as long; zoosporangia (?) sessile or subsessile on creeping filaments, clavate, 60–80μ long, 10–14μ broad; gametangia cylindrical to slightly fusiform, sessile or on short pedicels on the creeping filaments, 55–85μ (up to 111μ) long, 8–12μ broad; loculi mostly 2-seriate.

Growing on the pneumatocysts of *Nereocystis Luetkeana*. Mouth of Tomales Bay, Marin County, California.

Setchell and Gardner, Phyc. Cont. IV, 1922, p. 378, pl. 40, figs. 1–4.

The structures designated zoosporangia (?) in the foregoing diagnosis of this species were found interspersed among the gametangia. No indication of the formation of zoospores has been observed, which leads to the suspicion that they may be abortive gametangia. The terminal cell of the erect filaments is often longer than the cells below it, and in these filaments in which the cells are divided lengthwise, producing the clavate condition, the terminal cell degenerates in a similar manner as do the hairs in other species. The longitudinal division of cells in the upper parts of the filaments is undoubtedly connected with the formation of the short, lateral, often secund, gametangia characteristic of nearly related species in *Hecatonema* and in *Compsonema*, for in a few instances such gametangia were observed in old specimens in which the gametes had, to a large degree, escaped from the characteristic gametangia.

9. **Microspongium** Reinke

Fronds forming small, cushion-like, rounded, gelatinous masses of various shapes and sizes, composed of a distromatic basal layer the upper cells of which give rise to erect, compact, cylindrical filaments branched or unbranched, among which are intermixed a few hyaline hairs; reproduction by zoospores formed in single (or in seriate?) zoosporangia and by gametes formed in plurilocular gametangia.

Reinke, Die braunen Algen der Kieler Bucht, 1888, pp. 16 and 20, Atlas, 1889, p. 11, pls. 7, 8, Algenfl. westl. Ostsee, 1889*a*, p. 46. *Hapalospongidion* Saunders, New and little known brown Alg., 1899, p. 37.

The type species is *Microspongium gelatinosum* Reinke. In our judgment there are no fundamental differences between *Microspongium* Reinke (1888, p. 20) and *Hapalospongidion* Saunders (1899, p. 37), consequently we are adopting the earlier generic name. Both genera form diminutive gelatinous cushions and have a distromatic basal disk which gives rise to erect ''hairs'' and filaments bearing chromatophores. Unilocular zoosporangia and plurilocular gametangia are present in both, although there are specific differences. In the first place, the erect filaments in *Hapalospongidion gelatinosum* are simple. In the second place, the suspected zoosporangia are seriate and intercalary, probably always so since we doubt Saunder's statement of their being terminal (in complete filaments). In the third place, the gametangia are pluriseriate and always intercalary, although there may be, at times, only one sterile, enlarged cell with dense contents at the very apex of the gametangial filament. The arrangement and character of both zoosporangia (if normal?) and of the gametangia resemble those of *Pylaiella*, but we find similar structures occasional among the Myrionemataceae, but generally on plants showing the terminal types of gametangia. It is for these reasons that it seems best to merge *Hapalospongidion* in *Microspongium*.

Microspongium Saundersii S. and G.

Erect filaments 250–750μ long, embedded in a gelatinous matrix; cells in the lower part of the filament doliiform, 8–10μ long, 4–5μ broad, in the center of the filament cylindrical, 24–36μ long, 5–6μ broad, in the distal end, 4–5μ long, 7–10μ broad; hairs scattered, one or more millimeters long; chromatophores discoid; zoosporangia (?)

terminal and seriate, ellipsoidal; gametangia terminal, with loculi 1–2-seriate, 10–14μ broad.

Growing on rocks, forming small, irregular, gelatinous or sponge-like cushions, separate at first, but later many coalescing into a common mass. Pacific Grove, California.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 12. *Hapalospongidion gelatinosum* Saunders, New and little known brown alg., 1899, p. 37, pl. 1; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 534.

Microspongium Saundersii differs from *M. gelatinosum* Reinke in having the erect filaments unbranched, the zoosporangia (?) seriate instead of single, the gametangia with loculi 1–2-seriate and intercalary instead of lateral and uniseriate, and in details of measurements.

FAMILY 4. RALFSIACEAE KJELLMAN

Thallus crustaceous, flat, discoid and rounded or crenate at the margins, or deeply lobed and dissected, consisting of a flattened monostromatic, discoid, basal layer with marginal growth, soon becoming few to many layered by horizontal partitions, with hairs, single, or in small groups, in depressions of the upper surface, with or without rhizoids from the lower surface; unilocular zoosporangia, either borne at the base of more or less free multicellular paraphyses, collected into more or less distinct patches or ''sori'' or terminal and forming naked ''sori''; gametangia uniseriate or pluriseriate, terminal or borne on lateral branchlets near the tips of the more or less coalescent vertical rows of the thallus.

Kjellman, Handbok Skand. Hafsalg., I, 1890, p. 29 (lim. mut.); *Stragulariaceae* Stroemfelt, Om Algenveg. vid Islands Kuster, 1886, p. 49. *Lithodermataceae* Kjellman, *loc. cit.*, 1890, p. 17.

The Ralfsiaceae, in the somewhat extended sense in which we consider the application of the name, i.e., as including the Lithodermataceae of Kjellman, is closely related to the Myrionemataceae (where Reinke places *Ralfsia* and its segregates) and the Elachisteaceae, without being conveniently placed under either. The frond seems clearly a further development of that of the simpler *Myrionema*-species, retaining the flattened circular habit as a fundamental type. The coalescence of the vertical filaments, the greater or less separation of fertile areas from sterile, the position of the sporangia and gametangia as to whether terminal or lateral, find close resemblances among the Myrionemataceae or may readily be considered as progressive developments from them. It does not seem desirable to separate the *Lithoderma* series of genera and species from the *Ralfsia* series since both may be considered as derived from the Myrionemataceae, the sporangia being transformed vertical filaments in the *Ralfsia* series and only the transformed terminal cells in the *Lithoderma* series, while the gametangia may be either terminal or on short lateral branches in the *Lithoderma* series, but terminal in the *Ralfsia* series, so far as known.

Key to the Genera

1. Zoosporangia included, borne at the bases of the paraphyses................................ 2
1. Zoosporangia superficial, terminal on the erect filaments..12. **Lithoderma** (p. 500)
    2. Thallus entire, or with rounded simple lobes..................10. **Ralfsia** (p. 494)
    2. Thallus deeply and narrowly lobed....................11. **Hapterophycus** (p. 499)

10. Ralfsia Berk.

Thallus forming flat expansions of indefinite size and more or less circular outline, at least at first, only slightly and broadly lobed at the margin, never dissected into deep and narrow lobes; either attached firmly to the substratum or later separating largely from it, composed at first of a single basal layer of few to many cells in thickness, but later developing closely packed vertical filaments more or less tightly cohering and covered by a common cuticula, those in fertile areas, "sori," later becoming free and rupturing the cuticula; hairs in minute tufts, scattered, projecting beyond the upper surface of the thallus, generally at least in funnel-shaped depressions; zoosporangia lateral, at the bases of the free filaments, "paraphyses"; gametangia terminal or subterminal, on the erect filaments or lateral from near their tips.

Berkeley, *in* Engl. Bot., Suppl., vol. 3, 1843, pl. 2866; *Stragularia* Stroemfelt, Om Algenveg. vid Islands Kuster, 1886, p. 49. *Mesospora* Weber van Bosse, Not. sur quelq. gen. nouv., 1910, p. 27.

We have taken the genus *Ralfsia* in the original sense and as including the genera *Stragularia* Stroemfelt and *Mesospora* Weber van Bosse, relying on the habit chiefly to characterize the genus and assigning the variations in thickness, position of the gametangia, and aggregation of the zoosporangia to distinguish the species, or at most, the sections of the genus. We have been influenced to this point of view by our experience with the variability in these respects among the species of the Ectocarpaceae and the Myrionemataceae. The type of the genus is *Ralfsia fungiformis* (Gunn.) S. and G. (*Fucus fungiformis* Gunn.).

Most specimens collected show only the unilocular zoosporangia, but although gametangia have been seen in the majority of the species, we have not detected them, as yet, with certainty in any of our west coast specimens.

KEY TO THE SPECIES

1. Thallus loosely attached, free at the margin .... 5. **R. fungiformis** (p. 499)
1. Thallus firmly attached, not free at the margin 2
    2. Thallus up to 2 mm. thick, 12 cm. diam. 3
    2. Thallus less than 0.5 mm. thick, 5 cm. diam. 4
3. Paraphyses up to 130μ long .... 3. **R. verrucosa** (p. 497)
3. Paraphyses up to 360μ long .... 4. **R. hesperia** (p. 498)
4. Zoosporangia 80–95μ long .... 2. **R. californica** (p. 497)
4. Zoosporangia 60–70μ long .... 1. **R. clavata** (p. 495)

1. **Ralfsia clavata** (Carm.) Crouan

Fronds flattened, crustaceous, circular in outline at first, later becoming more or less lobed, firmly applied to the substratum by the whole lower surface with occasional rhizoids, 2–20 mm. diam., about 150μ thick; zoosporangia narrowly ovoid to pyriform, distributed over the whole upper surface of the frond except near the margin, 40–60μ long, 13–18μ broad, borne at the bases of the paraphyses; gametangia short, terminal on the erect filaments, pluriseriate, paraphyses 80–100μ long, 12–15μ broad, slightly clavate; hairs unknown.

Growing on rocks, wood, etc., in the upper sublittoral belt, and in tide pools in the littoral belt. Unalaska Bay, Alaska.

Crouan, Alg. mar. du Finistère, Fasc. 1, 1853, no. 56 (excl. specim.); Reinke, Atlas Meeresalg., 1889, pl. 6, figs. 14–20, Algenflora, 1889*a*, p. 48; Kuckuck, Bemerk. zur mar. Algenveg., 1894, p. 244, fig. 14; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 253. *Myrionema clavatum* Harvey, Man. Brit. Alg., 1841, p. 124. *Linkia clavata* Carmichael, MS., *in* W. J. Hooker, British Flora, vol. 2, 1833, p. 391.

The measurements given above for the zoosporangia are taken from Kuckuck (*loc. cit.*) and from De-Toni (1895, p. 313). The material from Unalaska cited above is scarcely mature but seems to come within the range of measurements as given in the diagnosis above. We are unable to harmonize the measurements given by Farlow (1881, p. 88) for this species, with the material which we have examined from the Atlantic coasts of America and Europe. His measurements for the zoosporangia are 150–180μ long, and 60–70μ broad. These measurements are larger than those given for any other species except for *R. hesperia* S. and G.

Kuckuck (Bemerkungen, 1894, p. 244 *et seq.*) figures and describes "plurilocular sporangia" (gametangia) in *R. clavata* and in *R. Bornetii*. These were found on the same individual and often in the same sorus with zoosporangia. The material showing these organs was collected in the winter. The study of the genus made from fresh material and from herbarium material at our disposal, unfortunately has been made on summer collections only. Study of the winter material may reveal the presence of this method of reproduction in the species on our coast. Börgesen, however (1902, p. 432), reported having discovered "plurilocular sporangia" on *R. verrucosa* collected in May and July.

The *Linkia clavata* of Carmichael was proposed for specimens from Appin on Loch Linnpe in the west of Scotland. Harvey adopted the specific name of Carmichael, but removed the species to the genus *Myrionema*, without, however, having seen a specimen. The Crouan brothers referred the species to *Ralfsia*, quoting Harvey and thus establishing the present binomial. The specimen referred by the Crouans to their *Ralfsia clavata* seems to be *R. verrucosa* (cf. Reinke, 1889*a*, p. 48, as well as Crouan, Florule du Finistère, 1867, pl. 26, fig. 168). Farlow (Mar. Alg. N.E., 1881, p. 88) used the correct binomial and states that "American specimens resemble perfectly the No. 56 of Crouan's Algues marines du Finistère," but, as noted above, he gives dimensions for the sporangia which are twice as long and several times broader than those which we have assumed to belong to the type of the species. No. 418 of the Phycotheca Boreali-Americana, collected at Spectacle Island, Maine, seems perfectly in agreement with European material from Reinbold and Kylin and the mature sporangia in all average about 60μ high and 18μ in diameter. Our Alaskan specimens agree with these in every detail. We have seen no New England specimens with sporangia more nearly approximating the dimensions given by Farlow than the European and Alaskan specimens, although an occasional sporangium may be as long as 90μ, but such is a very rare occurrence.

2. **Ralfsia californica** S. and G.

Plate 36, fig. 22

Thallus flattened, crustaceous, circular to irregular in outline, adhering firmly without rhizoids to the substratum by the whole lower surface, 280–350μ thick, 2–4 cm. diam., dark brown in color; basal parenchymatous layer composed of 8–12 layers of cells in vertical rows; zoosporangia numerous, clavate, borne laterally at the base of the paraphyses, distributed uniformly over the central and larger part of the frond, 80–95μ (up to 140μ) long, 16–22μ (up to 32μ) thick; gametangia unknown; paraphyses cylindrical to slightly clavate, 180–220μ long, 9–11μ broad at the outer end; hairs unknown.

Usually found growing on smooth, flattened pebbles and on rock ledges in the upper sublittoral belt, and in tide pools in the littoral belt. Central California.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 2.

Ralfsia californica is very similar and is probably closely related to *R. clavata* (Carm.) Crouan and has passed under that name locally for some time. Careful comparison, however, with material of that species from the Atlantic coasts of America and Europe shows several differences in detail, sufficient to entitle it to specific rank. The specimens are, in general, much larger in diameter and are thicker. The paraphyses are generally longer and narrower. The zoosporangia are longer and relatively narrow. The cells of the basal portion are slightly smaller.

3. **Ralfsia verrucosa** (Aresch.) J. Ag.

Frond coriaceous, adhering firmly throughout to the substratum, juvenile state circular in outline, becoming more or less distorted, especially on coming in contact with each other and with other crustaceous algae, 3–12 cm. diam., 1–2 mm. thick, with concentric zones and radiating lines; color olive brown; erect vegetative filaments curved towards the zone of active growth; paraphyses up to 130μ high, composed of 6–9 cells, the lower 2–3 times as long as broad; zoosporangia ovoid to pyriform, 65–80μ long, 15–25μ broad; gametangia short, terminal; both reproductive organs on the same individual, disposed in sori.

Growing on rocks, shells, etc., in the middle and lower littoral belts. Reported from various localities from the Bay of Unalaska, Alaska, to Monterey Bay, California.

J. Agardh, Sp. Alg., vol. 1, 1848, p. 62; Reinke, Atlas Meeresalg., 1889, pls. 5, 6, Algenflora, 1889*a*, p. 48; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 253; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. LV (?). *Cruoria verrucosa* Areschoug, *in* Linnaea, 1843, p. 264, pl. 9, figs. 5, 6.

The measurements given for this species by different authors are quite variable. The dimensions of the zoosporangia given in our diagnosis above are taken from Kuckuck (1894, p. 244) and our specimens agree; these were taken as representing the average typical size. Farlow (1881, p. 87) gives the measurements of the zoosporangia as 38μ long and 19μ wide. De-Toni (1895, p. 312) gives 65–80–100μ long, and 15–30μ wide. The material quoted from Unalaska is all sterile. Careful comparison with mature material from the eastern and European coasts may show that our California specimens are of a distinct species.

The material distributed from southern California under *R. verrucosa* in Collins, Holden and Setchell, Phycotheca Boreali-Americana, no. LV, is very young and the rows of cells are mostly perpendicular to the substratum instead of being curved as is the case with the typical *R. verrucosa*. It seems quite possible that this plant belongs to some other species, or possibly to another genus.

4. **Ralfsia hesperia** S. and G.

Thallus flattened, coriaceous, circular in outline, adhering firmly to the substratum by the whole lower surface, at times developing rhizoids, 3–4 cm. diam., 1–1.5 mm. thick, with concentric zonation; color light yellowish brown, dark on drying; paraphyses 290–360μ long, very slightly clavate, 9–12 cells long, 8–11μ broad at the apices, densely crowded with chromatophores above, but few below; cells of paraphyses 7–9 times as long as broad below, 2–3 times above; sori extensive, often confluent; zoosporangia broadly clavate, 120–140μ (up to 180μ) long, 28–34μ broad; gametangia unknown.

Growing on rocks in the upper littoral belt. Central California.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 2.

Ralfsia hesperia is very closely related to *R. verrucosa* in morphological characters. The plants are, as a rule, smaller in diameter and larger in thickness, are more spongy, lighter colored and have very decidedly larger zoosporangia and longer paraphyses than that species. The exact southern limits of either of these species has not been determined.

5. **Ralfsia fungiformis** (Gunn.) S. and G.

Thallus licheniform, coriaceous, dark brown in color, black on drying, loosely attached in the center by numerous multicellular rhizoids, free around the margin, with free overlapping lobes seemingly from the top of the thallus as well as the margin, circular to irregular in outline, with concentric zones and radiating striae, 2–6 cm. diam., 250–300μ thick; cells forming rows curving upward and downward from a central layer in the lobes; zoosporangia, gametangia and hairs unknown.

Growing on rocks in the lower littoral belt. Port Clarence to Sitka, Alaska.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 11. *Fucus fungiformis* Gunnerus, Fl. Norv., 1772, p. 107; Œder *in* Flora Dan., 1770, pl. 420. *Ralfsia deusta* J. Agardh, Sp. Alg., 1848, p. 63; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 253; Saunders, Alg. Harriman Exp., 1901, p. 424. *Zonaria deusta* Agardh, Syn. Alg., 1817, p. 40. *Padina deusta* Postels and Ruprecht, Illus. Alg., 1840, p. 20.

The method of reproduction in this species has, apparently, never been observed. It is a plant of the colder waters and has not been collected and studied as much as the other species of the genus. All of the material collected on our coast has been taken in midsummer. In habit and structure, our Alaskan specimens agree with those from northern New England (Phyc. Bor.-Amer., no. 419 and Phyc. Univ., no. 418).

11. **Hapterophycus** S. and G.

Thallus decumbent, dorsiventral, deeply separated into linear lobes radiating from the center, fleshy, short, several times dichotomously branched, concave on the ventral side, convex above, with crenate margins, rounded sinuses and wide, blunt ends; growth apical; central part of the frond consisting of large horizontal hyaline, more or less cylindrical cells, from which rows of hyaline cells curve upward and downward terminating in the small surface cells which are filled with chromatophores above, hyaline below; cryptostomata with fascicles of included hairs scattered promiscuously over the upper surface; reproduction by zoosporangia, arising from the same basal cell as the multicellular paraphyses; gametangia unknown.

Setchell and Gardner, *in* Setchell, Alg. Novae I, 1912, p. 233, pl. 25, figs. 1–4.

Hapterophycus canaliculatus S. and G.

Plate 41, fig. 54, and plate 77

Fronds up to 5 cm. wide; color yellowish brown; sporangia 65–75μ long, 18–25μ wide; paraphyses cylindrical, composed of 4–7 cells, 6–7μ wide, 12–16μ long.

Growing on rocks in small tide pools, or on the horizontal surface of flat rocks subjected to wave action, in the upper littoral belt, or even above high-tide limit. San Pedro, California.

Setchell and Gardner, *in* Setchell, *loc. cit.*

Hapterophycus, up to the present, is a monotypic genus, *canaliculatus* being the only known species. It has been found only in the vicinity of San Pedro, California, but doubtless may extend much farther south.

In its histological structure, it resembles *Ralfsia deusta*, especially in the free lobes of that species. Since the publication of the original description, it has been discovered that on the upper surface there are numerous, small, inconspicuous cryptostomata containing fascicles of hairs which do not extrude beyond the surface of the frond.

12. **Lithoderma** Aresch.

Thallus consisting of a thin parenchymatous disk, circular or irregular in outline, of indefinite expansion, attached to the substratum by the entire under surface without rhizoids; hairs absent; growth in diameter marginal, and in thickness by horizontal cell division, the cells arranged more or less regularly in vertical rows; reproduction by zoosporangia and by gametangia borne in sori on different individuals, the zoosporangia on the outer ends of the vertical rows of cells, the gametangia either terminal on the vertical rows of cells or lateral on special filaments.

Areschoug, Observ. Phyc., part 3, 1875, p. 22.

The type selected by Areschoug to represent his newly proposed genus is *Lithoderma fatiscens*, which is the *Ralfsia extensa* of Crouan

(Flor. du. Fin., p. 166). It is credited only to the extreme northern part of our region. All of the specimens previously reported within our territory are sterile and there is the greatest doubt as to their identity, both generic and specific. Two species have been assigned to our coast, but it is doubtful whether they are correctly referred. We can only list these two species with description and comment.

KEY TO THE SPECIES

Thallus nearly circular in outline, up to 3 dm. diam..................1. **L. fatiscens** (p. 501)
Thallus irregularly elongated or almost linear in outline...........2. **L. lignicola** (p. 501)

1. **Lithoderma fatiscens** Aresch.

Thallus broadly expanded, nearly circular in outline, up to 3 dm. diam., scarcely 1 mm. thick, smooth, shining when wet; the basal layers of cells minute, and somewhat polyhedral, vertical filaments 12–18μ diam., 8–12 cells long; gametangia small, cylindrical or oval, formed by transformation of terminal cells or borne on short, almost colorless branches from the terminal cells; zoosporangia terminal, sessile on the vertical rows of cells, ellipsoid or ovoid.

Growing on stones in the lower littoral and upper sublittoral belts. Port Clarence, Alaska, and Iliuliuk, Unalaska.

Areschoug, Observ. Phyc. part 3, 1875, p. 22; Kjellman, Om Bering. Alg., 1889, p. 49; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 253.

The plants of Kjellman from Port Clarence are sterile and those of Setchell and Lawson from Iliuliuk are not to be found for reëxamination.

2. **Lithoderma lignicola** Kjellm.

Thallus forming thin, uneven, elongated, almost linear, somewhat confluent crusts, 250μ or more thick; the basal layer composed of united, radiating branched rows of thick-walled cells, nearly parallel, not flabellate; the basal layer giving rise to vertical rows of cells, 20 or more, branching occasionally, loosely united above; cells 10–15μ long, 8–10μ diam.; character of reproductive organs unknown.

Growing on piles in the littoral belt. St. Michael, Alaska?.

Kjellman, Alg., Arc. Sea, 1883, p. 256, pl. 26, figs. 8–11; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 253.

This species was discovered by Kjellman "in the Norwegian Polar Sea." Specimens were taken at Talvik in the middle of September, as described by Kjellman (*loc. cit.*). The specimens were all sterile. We have seen no data as to the reproductive characters of the species since. A single collection of sterile material taken by one of us (Setchell) at St. Michael, Alaska, in July, 1899, was referred by us (*loc. cit.*) to this species. A reëxamination of the material and comparison with material of the type collection, demonstrate that the Alaskan plants are different, but without assisting in definitely placing them.

FAMILY 5. ELACHISTEACEAE KJELLMAN

Thallus pulvinate or penicillate, more or less lubricous, composed of loosely to compactly intertwined, more or less monosiphonous filaments at times agglutinating or anastomosing and forming a pseudoparenchymatous base, often penetrating the host below and always giving rise above to numerous free assimilating filaments, either zoosporangia or gametangia or both and at times colorless hairs; gametangia uniseriate or interruptedly pauciseriate, occasionally lateral, single or grouped; "paraphyses" present or absent.

Kjellman, Handbok Skand, Hafsalgfl., I, 1890, p. 41; Folsie, Contr. knowl. mar. alg. Norway, I, 1890, p. 92. *Elachisteae* Reinke, Algenfl. westl. Ostsee 1889*a*, p. 49.

The family of the Elachisteaceae, as separated and indicated by recent writers, includes a number of pulvinate species, all small, but some even minute, largely epiphytes, or possibly growing at times on rocks. They are to be distinguished by their basal portions. In *Elachistea*, the basal portion is solid due to the agglomeration, or anastomosing of the filaments in this portion of the thallus. In *Halothrix*, *Giraudia*, *Symphoricoccus*, *Leptonema*, etc., the basal portions of the filaments are not united to any considerable extent or at all, but are intertwined and woven together to form a spongy mass. We are inclined to refer to this family *Cylindrocarpus microscopicus* Crouan (cf. Kuckuck, 1899, pp. 49–55, figs. 1–5) as being a link between the Ectocarpaceae and the Elachisteaceae but, because of its pulvinate habit and densely interwoven filaments, approaching the Elachisteaceae more nearly than typical Ectocarpaceae. Several species of *Ectocarpus* and especially *E. hemisphericus* Saund. seem to foreshadow the Elachisteaceae, but are not sufficiently compacted or agglutinated at the base to properly be included in this family. The method of origin of the tufts of the members of this family does not seem to have been traced, but prostrate filaments, either free or more or less united into a disk or irregular membrane probably precede the development of the compacted or agglutinated erect filaments, thus assisting in linking the Elachisteaceae with the Ectocarpaceae and the more pulvinate Myrionemataceae.

Key to the Genera

Basal cells of the thallus more or less firmly agglutinated; paraphyses present ....13. **Elachistea** (p. 503)
Basal cells of the thallus loosely interwoven; paraphyses wanting ....14. **Gonodia** (p. 505)

13. **Elachistea** Duby

Frond tufted or expanded, composed of a colorless basal pseudoparenchymatous mass of cells, which may or may not penetrate the host, and arising from these, closely compacted "paraphyses," long free assimilating filaments and numerous long hairs, present only in certain species; reproduction by zoosporangia and by gametangia, both borne among the "paraphyses."

Duby, Bot. Gall., 1830, p. 972.

We have adopted the original spelling of Duby who founded the genus on the *Conferva scutulata* Engl. Bot., pl. 2311. The type species of the genus, *E. scutulata*, was collected in 1811 by Mr. Borrer at Brighthelmston on the coast of Sussex, England. There seem to be two species within our territory, both occurring to the north of the California coast. *Opospermum* of Rafinesque (Précis decouv. et trav. somiol., 1814) seems, from the description, to be unidentifiable, at least by no means certainly to apply to any member of *Elachistea*.

Key to the Species

1. Paraphyses decidedly curved, strongly moniliform, with upper cells as long or longer than broad .... 1. **E. fucicola** (p. 503)
1. Paraphyses straight or slightly curved, barely constricted at the dissepiments, with upper cells shorter than broad ....2. **E. lubrica** (p. 504)

1. **Elachistea fucicola** (Velley) Aresch.

Plate 38, figs. 33–35

Thallus fasciculate, 4–7 mm. high, the basal portion composed of a small, usually hemispherical, dense, lubricous mass of closely intertwined branched filaments, giving rise to numerous free paraphyses, sporangia and assimilating filaments; paraphyses clavate, uncinate, moniliform, 170–200μ long, 18–24μ diam. above, 7–10μ diam. below;

assimilating filaments briefly tapering near the base, and long and gradual tapering above, variable in size, 20–70μ, mostly 40–50μ, diam. not ending in a hair; cells 0.5–2 times as long, cell wall thick; chromatophores in actively growing cells a network extending throughout the cell, later becoming granular; zoosporangia narrowly cuneate, rounded above, 90–110μ long, 22–26μ diam., 200 or more spores escaping at the apex in a utricle; gametangia unknown.

Growing on different species of *Fucus* in the lower littoral belt. Sitka, Alaska, to central Oregon (Coos Bay).

Areschoug, *in* Linnaea, vol. 16, 1842, p. 235, pl. 8, figs. 6, 7. *Conferva fucicola* Velley, Mar. Pl., 1795, no. 4.

This species was first reported as being in our region by Ruprecht in 1851 (p. 389) from Sitka. No subsequent report of its having been collected had come to us until one of us (Gardner) collected it in 1917 at the same station.

There seems to be some question as to the exact limits of *Elachistea fucicola*, but it has appeared most reasonable to us to adopt, as typical, the plant figured by Kuetzing in the Tabulae Phycologicae (vol. 7, pl. 95). We find plants within our territory corresponding in general to Kuetzing's figure and epiphytic on species of *Fucus*. The free filaments are long attenuate at both the tip and the base. They vary decidedly in diameter and in length and breadth of cells even in the same individual, and the paraphyses are decidedly curved and decidedly moniliform, with the uppermost cells usually as long as, or longer than, broad. Our plants agree fairly well, also, with no. 417 of the Phykotheka Universalis collected at Warnemünde on the north coast of Germany by Heiden. Our figure (plate 38, figs. 33–35) gives the essential characteristics of structure. *Elachistea fucicola* is usually, at least, more olivaceous than *E. lubrica* and all parts of the plants are firmer and collapse less on drying than do those of *E. lubrica*. Thus far we have detected *E. fucicola* only on species of *Fucus*.

2. **Elachistea lubrica** Rupr.

Thallus usually forming distinctly separate tufts, 3 mm.–2 cm. (9–11 mm. Rupr.) high, lubricous; mass of paraphyses relatively small and loosely intertwined; hairs absent; erect free filaments abruptly attenuated at the base, and gradually attenuated above the center, 18–22μ diam. at the base, 38–48μ in the widest part, tapering to 9μ or less at the apex; cells of erect filaments cylindrical to slightly doliiform, 2–3 times as long as the diameter at the base, 0.3–0.8 times as long a short distance above the base, 1–1.5 times as long in the widest part, up to 6 times as long at the apex; chromatophore a fine nodular network in the young cells, separating more or less into spheroidal masses in the older cells; zoosporangia subovate to broadly clavate, 75–100μ (up to 135μ) long, 30–40μ broad at the outer end; gametangia unknown; paraphyses clavate, about 225μ long, slightly curved at times but not sensibly constricted at the dissepiments.

Growing on other species of algae, especially those of *Rhodymenia*. From Prince William Sound to Wrangell, Alaska.

Ruprecht, Tange Ochots. Meer., 1851, p. 196 (388 Orig.); Setchell and Gardner, Alg. N.W. Amer., 1903, p. 248; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 828.

The type of *Elachistea lubrica* Rupr. came from the Ochotsk Sea, but Ruprecht states that specimens from Russian Lapland are in close agreement. The most typical specimens seem to grow upon species of *Halosaccion* and *Rhodymenia*. Specimens from Yakutat Bay collected by Saunders (Phyc. Bor.-Amer., no. 828) and by Albin Johnson as well as at Orca by Setchell, seem to agree well with specimens distributed from Spitzbergen by Kjellman and from Mehavn in Finmarken (Phyk. Univ., no. 366) collected by Foslie. The free filaments taper both above and below as in *E. fucicola*, but the paraphyses are less curved, only slightly, if at all, constricted at the dissepiments, and the upper cells are inclined to be broader than high.

14. **Gonodia** Nieuwland

Fronds minute, tufted, composed of a mass of colorless, densely intertwined filaments, mostly penetrating the host, giving rise to a dense mass of erect assimilating filaments and "hairs," at least at times; "paraphyses" wanting; reproduction by zoosporangia and gametangia.

Nieuwland, Critical Notes IX, 1917, p. 30; Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 722; *Myriactis* Kuetzing, Phyc. gen., 1843, p. 330.

The distinctions between *Gonodia* and *Elachistea* are not always readily discernible in all of the species. In the younger stages of some of the species of *Elachistea*, and at times in the older stages, the basal portion, especially if it penetrates the host, is of about the same degree of compactness as it is in the mature stages of the species of *Gonodia*.

Typically, however, in the mature stages of the two genera, *Elachistea* has a firm, closely intertwined, agglutinated mass of filaments for the basal portion, and *Gonodia* remains free and loosely intertwined. We are using this character as a basis of separating the two genera.

Key to the Species

1. Basal cells of the erect free filaments symmetrical........1. **G. Johnstonii** (p. 506)
1. Basal cells of the erect free filaments asymmetrical....2. **G. Marchantae** (p. 506)

1. **Gonodia Johnstonii** S. and G.

Plants forming dense minute tufts in the conceptacles and on other parts of the host, 160–200μ high, attached by rather deeply penetrating, sparsely branched, rhizoidal filaments; erect fronds forked at the surface of the host, vegetative filaments unbranched above, decidedly clavate and blunt, at times tapering upwards above the center; cells in widest part 10–14μ diam., 1–1.5 times as long as broad, slightly constricted at the dissepiments; zoosporangia broadly clavate, 65–75μ long, 18–22μ broad; gametangia cylindrical, 60–75μ long, 6–9μ broad, densely fasciculate; both sets of reproductive organs borne on the same plant at the surface of the host.

Growing on *Sargassum insulare*. San Marcos Island, Gulf of California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 722, pl. 17, figs. 46, 47.

2. **Gonodia Marchantae** S. and G.

Fronds forming dense tufts with a dense mass of colorless filaments at the base penetrating the host, the free portion about 200μ long; filaments unbranched above the host, the lower portion composed of 2–3 long, narrow cells, abruptly changing into 2–3 asymmetrical swollen cells, then gradually attenuated upwards to blunt apices; widest cells 18–22μ, the length of the cells in the upper part equaling the breadth; pseudoparenchymatous cells doliiform to subspherical; zoosporangia broadly clavate, 55–65μ long, 22–26μ broad; gametangia cylindrical, densely fasciculate 55–65μ long, 6–7μ broad; both sets of reproductive organs borne on the same plant at the base of the free filaments.

Growing on the fronds of *Sargassum horridum*. La Paz, Lower California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 723, pl. 17, fig. 48.

G. Marchantae differs from *G. Johnstonii* in the character of the basal penetrating portion, the former having few narrow filaments and the latter having a dense, copious base. Two or three cells in the lower part of the free filaments are usually asymmetrical in *G. Marchantae* and not in *G. Johnstonii.* Neither species has hairs nor any indication of having had them, a prominent character as figured by Thuret and Bornet in Etudes Phycologiques, pl. 7, figs. 2–6, for *Elachista pulvinata* and mentioned by Yendo as "paraphysibus paucioribus" in *Myriactis Sargassi* (Novae Alg. Japon., 1920, p. 3). *G. Marchantae* is close to *G. pulvinata* in the character of the basal penetrating portion. *G. Johnstonii* in general resembles *G. moniliformis* but is much smaller throughout.

FAMILY 6. LEATHESIACEAE FAM. NOV.

Thallus thick, carnose, expanded on the substratum and solid or irregularly globular and hollow, arising from a flattened, monostromatic (?) persistent or evanescent disk; inner cells large, colorless, loosely parenchymatous of di- to trichotomous filaments, outer colored, in anticlinal rows, generally decreasing in size from within outwards, held together, at least loosely, by the surrounding jelly; zoosporangia and gametangia with loculi uniseriate or nearly so, both immersed among the external anticlinal rows present and borne on the same or similar plants; epiphytic or saxicolous.

Corynophlaeceae Oltmanns, Morph. und Biol. der Alg., 1922, p. 23.

As will be made apparent later, it seems most desirable to restrict the family Chordariaceae to the genus *Chordaria*, as typified by *C. flagelliformis*, an erect branched plant with distinct elongated axis and lateral branches of limited growth, with subapical terminal meristem, not trichothallic in the same degree as in the Ægiraceae and with only the unilocular zoosporangia thus far known, suggesting the strong probability of a microscopic gametophyte. The Ægiraceae are more or less elongated, simple or branched plants, with strongly trichothallic apical meristems, and both zoosporangia and gametangia borne on macroscopic plants. The Corynophlaeaceae of Oltmanns (1922, p. 23) includes the genera *Cylindrocarpus*, *Microcoryne*, *Strepsithalia*, *Corynophlaea*, *Myriactis*, and, presumably, *Leathesia*, although Oltmanns might be suspected of merging (*loc cit.*, p. 26) *Leathesia* (Gray, 1821) in *Corynophlaea* (Kuetzing, 1843). We have referred *Myriactis* (*Gonodia*) to the Elachisteaceae because of its close resemblance to *Elachistea*. *Cylindrocarpus microscopicus*

Crouan seems to us to be more properly included in the Ectocarpaceae, as a further development of such forms as *Ectocarpus hemisphericus* and *E. chantransioides* and on the way toward simpler Ægiraceae, such as we conceive may be represented by *Microcoryne* (cf. Oltmanns, *loc. cit.*, pp. 25, 26). *Strepsithalia* is unknown to us, but on account of its gelatinous character may possibly be considered to be a slightly developed, or even degenerate relative of *Corynophlaea*. *Corynophlaea*, if it be distinguished from *Leathesia*, is more generally solid, with longer assimilating filaments which are also less swollen at the tip; Kylin (1907, p. 83) is of the opinion that the three genera, *Microcoryne*, *Corynophlaea*, and *Leathesia* are to be retained as representing a series in complexity, leading up to the most highly developed species of *Leathesia*. As indicated above, *Microcoryne*, on account of its elongated form and greater or less differentiation of layers seems to approach *Ægira* and the resemblance in structure to *Ægira* has been generally noticed and commented upon. Between *Leathesia* and *Corynophlaea* there seems to be no satisfactory distinction either as between solid and hollow, or between longer and shorter cortical filaments. We have therefore merged the two genera under *Leathesia* and designated the family as Leathesiaceae. We can see no resemblances sufficiently close to unite *Petrospongium* with *Cylindrocarpus* (considering *C. microscopicus* Crouan as the type). We have therefore kept them distinct for reasons to be given later.

The Leathesiaceae are carnose algae of flattened or globular form, solid or hollow, arising from a primitive basal disk, with the inner cells large and colorless, more or less agglutinated, the cortical cells in short filaments with chromatophores, without exserted structures of any kind except colorless hairs, with peripheral growth, and having gametangia and zoosporangia on the same or on similar plants.

Key to the Genera

1. Zoosporangia more or less difform, usually attached laterally.................................15. **Petrospongium** (p. 508)
2. Zoosporangia pyriform to ellipsoidal, attached at the base..16. **Leathesia** (p. 510)

15. **Petrospongium** Naeg.

Thallus small, thin, flat, usually encrusting rocks, with or without rhizoids, gelatinous, composed of 3 more or less distinct tissues, viz.: (1) a basal layer, monostromatic (?), giving off rhizoids, whence arise (2) loosely compacted, di- or trichotomous filaments, decumbent below, curving to erect above, consisting of elongated, cylindrical or swollen, colorless cells with scanty chromatophores, and (3) a cortical layer of short, branched, closely compacted, erect filaments composed of short, colored cells forming a more or less smooth or wrinkled surface; zoosporangia, embedded within the thallus, more or less cylindrical, becoming difform, usually attached laterally; gametangia unknown.

Naegeli, *in* Kuetzing, Tab. Phyc., vol. 8, 1858, p. 2, pl. 3, fig. II.

Comparison of *Petrospongium Berkeleyi* (Grev.) Naeg. with *Cylindrocarpus microscopicus* Crouan reveals such a difference in habit, structure, etc., that it seems impossible to place the two species in the same genus. We are also of the opinion that they belong in separate families. The figures of *Cylindrocarpus microscopicus*, especially those of Kuckuck (1899, p. 88, pl. 6, figs. 1–5) show a plant of definite habit, growing in tufts (mucose, fide Crouan) rather tending to elongate although only slightly so, without its individual branched filaments being agglutinated into the definite thallus with inner and outer distinct tissues as in the Leathesiaceae, but united into a spongy (fide Kuckuck) mass by intertwining rhizoidal corticating filaments. We are inclined to place *Cylindrocarpus microscopicus* in the Ectocarpaceae, as an extremely differentiated type of such forms as *Ectocarpus hemisphericus* and *E. chantransioides* and looking toward the Ægiraceae and perhaps, also, the Leathesiaceae, but not properly of them or, to the same degree, differentiated into definite inner transparent and outer colored layers. *Petrospongium Berkeleyi* (Grev.) Naeg. and *P. rugosum* (Okamura) S. and G., especially the latter, have their tissues differentiated and of agglutinated, level-topped filaments and are, in our opinion, perfectly typical members of the Leathesiaceae.

Petrospongium rugosum (Okamura) S. and G.

Plate 39, figs. 42, 43

Thallus adhering more or less loosely to the substratum, circular to irregular in outline, flat or thrown up into folds, more or less spongy and lubricous, 2.5–5 cm. (up to 10 cm., cf. Okamura) diam., 1.5–2.5 mm. thick, of a dark, glossy, chestnut brown color; cells of the cortical layer 8–11μ diam., 1–2 times as long as the diameter; zoosporangia narrowly ellipsoidal, at times decidedly difform, attached laterally a little below the middle and near the base of the cortical filaments, 75–90μ long, 16–22μ broad.

Growing on rocks in the upper littoral belt exposed to surf. Central and Southern California.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 12. *Cylindrocarpus rugosa* Okamura, Alg. Japon. Exsicc., no. 88, 1903, Icon, Jap. Alg., vol. 1, 1907, p. 20, pl. 5, figs. 1–6. *Petrospongium Berkeleyi* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 232, 1896 (not of Naegeli).

This curious, dark colored, rather firm, yet carnose plant is common on rocks exposed to surf along the central Californian coast and has been found on that of southern California as well. Its peripheral filaments differ in size (about twice the diameter) and in branching from those of the European species and agree closely with those of the Japanese species.

16. **Leathesia** Gray

Fronds irregularly globose, solid in the juvenile stage, soon becoming hollow in some species and remaining solid in others, decidedly carnose, interior consisting of radiating, dichotomously or trichotomously branched filaments composed of large, irregular, colorless cells toward the base or center as the case may be, merging into smaller cells toward the periphery; cortex composed of a short series of small, color bearing cells set in a firm mucous matrix; zoosporangia and uniseriate gametangia known, both arising at the base of the cortical filaments; hairs single or in fascicles.

Gray, Nat. Ar. Brit. Pl., vol. 1, 1821, p. 301.

The genus *Leathesia*, as understood and interpreted by us, should include the *Corynophlaea* and *Corynephora* of Kuetzing (1843, p. 331). The chief distinction between *Corynophlaea* and *Leathesia* as diagnosed, seems to be that in *Corynophlaea* the adult thallus is attached by a single layer of cells from which arise all the other cells, forming a flattened, hemispherical or spherical, solid structure depending upon the nature of the substratum, while in *Leathesia* the adult thallus is more or less spherical and usually hollow. Structurally and in mode of development there seems to be no fundamental difference. The basal part is practically the same in both genera in the early stages of development (cf. Oltmanns, 1922, p. 26, but cf. also Okamura, 1907, p. 81, pl. 18, figs. 9–14). The cells of the basal portion are more or less modified to serve as attaching cells in both genera. It is difficult to determine in the diminutive species of both genera whether or not all of the specimens are solid or hollow. Kuetzing indeed transferred the type species of his genus *Corynophlaea*, *C. baltica*, to his genus *Corynephora* in Tabulae Phycologicae (1858, pl. II), which is hollow and differs in no fundamental characters from *Leathesia*. In the larger species of *Leathesia* the whole under portion sooner or later disintegrates, leaving only the marginal cells for attaching the plant. Until more can be learned of the life-history of and extent of variation in these genera, it seems to us best to combine them and place them all under the oldest name, *Leathesia*.

Key to the Species

1. Fronds diminutive, up to 1.25 mm. diam. .... 1. **L. nana** (p. 511)
1. Fronds variable in size, up to 8 cm. diam. 2
    2. Paraphyses terminating in a spherical or subspherical cell .... 3. **L. amplissima** (p. 513)
    2. Paraphyses clavate, gradually and uniformly enlarging upward .... 2. **L. difformis** (p. 511)

1. **Leathesia nana** S. and G.

Plate 43, fig. 67

Thallus solid, spherical, 500–800μ (up to 1.3 mm.) diam.; color dark brown; cells in the center subspherical, 40–55μ diam.; paraphyses 30–40μ long, composed of 3–4 cells, terminal cell enlarged, subspherical, 10–11μ diam.; hairs 300–400μ long, 4–5μ diam., scattered, not in fascicles; gametangia with 4–5μ loculi, uniseriate, 3.5–4.5μ diam.; zoosporangia unknown.

Growing on the leaves of *Phyllospadix* near the outer ends. Monterey, California.

Setchell and Gardner, Phyc. Cont. VII, 1924, p. 3.

The host upon which this species of *Leathesia* was found has a wide distribution along the west coast of the United States and careful observation may show that this little known epiphyte is coexistent with its host. In structure it is not far unlike the *Corynephora marina* of Kuetzing (1843, p. 331 and 1858, pl. 3, fig. I) but is of smaller dimensions and has much smaller interior cells.

2. **Leathesia difformis** (L.) Aresch.

Plate 40, fig. 52 and plate 43, figs. 65, 66

Fronds gregarious, very variable in size, up to 6 cm. diam., spherical and solid when young, becoming hollow and more or less lobed at maturity, hairs in small scattered groups; cortical filaments clavate, 5–6 cells long, with enlarged, subspherical to spherical terminal cells; color olive brown; gametangia cylindrical, 34–45μ long, 4–6μ

broad, with 6–8 uniseriate loculi; zoosporangia pyriform or ovoid, 35–60μ long, 16–22μ broad.

Growing on other algae and on rocks in the littoral belt. Ranging from Bering Sea, Alaska, to southern California.

Areschoug, Phyc. Scand. I, 1846, p. 154 (Repr.); Saunders, Alg. Harriman Exp., 1901, p. 423; Setchell and Gardner, Alg. N.W. Amer., 1903, pp. 249, 250; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 829; Tilden, Amer. Alg. (Exsicc.), no. 243 (?). *Tremella difformis* Linnaeus Fl. Suec. (ed. two), 1755, p. 429.

Regarding the dimensions of *Leathesia difformis* as a whole or especially of its parts the literature is practically silent. Areschoug (*loc. cit.*) states "Thallus nunc semine Cannabidis vix major, nunc 2–5 uncias diametro aequans," but gives no definite statements regarding the size of the various parts. Farlow (1881, p. 82) gives as the diameter of the frond "from half an inch to two inches." De-Toni (1895, p. 422) states sporangia "35 x 17." It seems to us quite probable that this name has been used freely to include a number of species somewhat similar in general appearance, but in reality distinct. We feel that much more work should be done on our Pacific coast material before the limits of the species can definitely be determined.

Gardner no. 3462 was collected at Tomales Bay, California, in August and shows mature zoosporangia and gametangia on the same individual. The gametangia have 6–8 loculi. Gardner no. 4501 was collected at Pacific Grove, California, in December, and has only gametangia. These have 9–13 loculi. It may be that we are dealing with two entities, but for the present we are grouping them under *L. difformis.* Plants from both of these numbers are figured on plate 43.

The dimensions given in our diagnosis above are more or less a composite but represent a fair average of the size of the structures found in the plants which we have included in the species. We have examined material of this species in our herbarium from Kylin, collected at Strangahnfund and at Varberg, Sweden, which may be considered to be topotypes of *L. difformis.* The material from both of these localities is bearing fruit and apparently mature. The following measurements of their parts will indicate the relation in this respect to our Pacific coast material. Paraphyses, composed of 3–4 cells, 38–44μ long in plants with gametangia, up to 75μ long in plants with zoosporangia, terminal cells 14–18μ in diameter. Gametangia composed of 4–6 uniseriate loculi, 20–25μ long, 5–6μ in diameter. Zoosporangia are 30–50μ long, 15–22μ in diameter.

3. **Leathesia amplissima** S. and G.

Plate 43, fig. 64

Thallus hollow, subglobose to irregular, attached by a broad area, the central part of which disintegrates on nearing maturity, 3–8 cm. diam.; color yellowish brown; interior colorless cells relatively large, compact and angular from compression, becoming radially arranged and smaller toward the surface; hairs single, scattered over the whole free surface, 11–13μ diam.; paraphyses clavate, enlarging gradually from the base to the apex, 55–65μ long, 4–7μ diam. at the base, 7–12μ at the apex, 4–5 cells long; chromatophores densely crowded; zoosporangia ovoid to ellipsoidal, 38–46μ long, 22–28μ broad; gametangia unknown.

Growing on rocks and over other small algae, in tide pools in the lower littoral and upper sublittoral belts. Central California (Pacific Grove and Monterey).

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 3.

Leathesia amplissima is not readily distinguishable in gross morphological characters from *L. difformis* as we understand that species at present. The histological structure, however, is essentially different as may be seen from our descriptions and figures.

FAMILY 7. PUNCTARIACEAE KJELLM.

Fronds from filiform and almost monosiphonous to saccate, ligulate or broadly expanded and membranaceous, attached by a relatively small parenchymatous disk or by rhizoidal filaments, all but the monosiphonous species differentiated into an inner and an outer tissue, the inner mostly of colorless cells and the outer of color bearing cells; reproduction both asexual, by zoosporangia projecting slightly or not at all beyond the surface, and sexual, by gametangia projecting wholly or in part beyond the surface; both zoosporangia and gametangia transformed single surface cells, either scattered or collected into definite sori; hairs (and paraphyses?) present in some.

Kjellman, *in* Gleerup, Enum. Pl. Scand., 1880, p. 9 (fide Foslie, Contr. Knowl. Mar. Alg. Norway, I, 1890, p. 98); Oltmanns, Morph. und Biol. der Alg., 1922, p. 49 et seq. *Punctarieae* Thuret, *in* Le Jolis, Liste alg. mar. Cherb., 1863, p. 14 (in part); Farlow, Mar. Alg. New Eng., 1881, p. 63.

As usually limited, the Punctariaceae include the genera *Omphalophyllum* Rosenv., *Phaeosaccion* Farlow, *Punctaria* Grev., *Desmo-*

trichum Kuetz., *Pogotrichum* Reinke, *Litosiphon* Harv. and *Corycus* Kjellm. We know of but one of these in our territory, viz., *Punctaria*. Structurally the simplest forms of the Punctariaceae, as generally understood, are almost monosiphonous. The more complex forms usually included in the family are either filamentous and solid, saccate or membranaceous. They agree in general in that the zoosporangia and gametangia arise as transformed single surface cells, projecting beyond the surface but slightly, if at all, but if projecting not accompanied by pluricellular paraphyses. They form fairly definite and circumscribed sori.

The Punctariaceae have for their type genus *Punctaria* Grev. whose type species is *P. latifolia* Grev. Their relation is closely with Striariaceae, on the one hand, and the Scytosiphonaceae on the other. This relationship is so close that it is largely a matter of convenience to separate them. From the Striariaceae they may be separated by the tendency of their fronds even in the simplest *Desmotrichum* species, to develop a membrane rather than a cylindrical frond. In case this distinction is made, *Pogotrichum* and *Litosiphon*, under such understanding, should be referred rather to the Striariaceae and to the neighborhood of *Stictyosiphon*. While the species of *Desmotrichum* and *Punctaria* are both supposed to have hairs, yet some of our Pacific coast species of *Punctaria* have no trace of hairs in adult plants. There is an absence of hairs also in the known species of *Phaeosaccion* and of *Omphalophyllum*, two genera usually referred to the Punctariaceae. The two genera just mentioned also lack specialized sporangial cells in groups and it may be found desirable to separate them and give them a family designation of their own. Neither of these genera have been detected as yet in our territory, so that we have no opportunities for careful study. *Corycus* of Kjellman is hollow and, so far as descriptions inform us, devoid of hairs in the adult stages. It is flattened, even if it is hollow, and seems to belong in the Punctariaceae on that account as well as agreeing with both Striariaceae and Punctariaceae in having circumscribed sori which do not project beyond the surface.

The Punctariaceae differ from the Scytosiphonaceae in having the sori circumscribed and, commonly, of regular shape. The Scytosiphonaceae have extensive, indefinite and confluent sori and, thus far, have been detected only with gametangia.

17. **Punctaria** Grev.

Fronds simple or more or less branched, monosiphonous, usually complanate, membranaceous, linear to broadly expanded, attached by a small discoid base, composed of several layers of cuboidal cells similar in size or those of the surface layer much smaller; reproduction by zoosporangia immersed in the tissue or slightly projecting or bulging beyond the surface, and by gametangia usually partly or wholly immersed in the tissue; both gametangia and zoosporangia representing transformed surface cells, single or in small groups, scattered promiscuously on both sides of the frond; hairs present in some species; paraphyses wanting.

Greville, Alg. Brit., 1830, p. 52 and Syn., p. xlii. *Diplostromium* Kuetzing, Phyc. Gen., 1843, p. 298. *Phycolapathum* Kuetzing, Phyc. Gen., 1843, p. 299 (pro parte maxima). *Desmotrichum* Kuetzing, Phyc. Germ., 1845, p. 244. *Homoeostroma* J. Agardh, Anal. alg., Cont. III, 1896, p. 7. *Nematophlaea* J. Agardh, *loc. cit.,* 1896, p. 12. *Rhadinocladia* Schuh, *Rhodora,* vol. 2, 1900, p. 3, pl. 18.

There can be little question as to the idea underlying Greville's proposal of the genus *Punctaria,* if we accept his *P. latifolia* as the type. The specimen examined by Greville in its living state was collected at Sidmouth on the south coast of England by Mrs. Griffiths. It seems sufficiently certain that Wyatt's Algae Damnonienses, no. 9, is practically a topotype, having been collected along the same coast and not far removed from the actual type locality. Wyatt's specimen answers in every detail to Greville's description and we base our idea of the genus *Punctaria* and of the type species, *Punctaria latifolia* Grev., on it. It is probably the same as the plant figured by Harvey in Phycologia Britannica (plate 8). The Wyatt specimen is a *Punctaria* also in the sense of J. G. Agardh (1896, p. 4, pl. 1, fig. 1), although a distinct species from any included by him. The *Punctaria* of Greville, besides including *P. latifolia* Grev. and *P. plantaginea* (Roth) Grev., was also extended to include *P. tenuissimum* (Ag.) Grev. This last species was removed later by Kuetzing to his *Diplostromium* (1843, p. 298) and this genus, in turn, in spite of the reference to it as first or "type" species of *Ulva plantaginifolia* Lyngb., is identical, partly in foundation and partly in content, with Kuetzing's later genus *Desmotrichum* (1845, p. 244). Kuetzing's genus *Diplostromium* has, then, the characters of Greville's genus *Punctaria.*

The *Punctaria tenuissima* Grev. is probably identical with *P. undulata* J. Ag., now generally referred to *Desmotrichum*.

It is much more difficult to determine the exact status of *Punctaria plantaginea* (Roth) Grev. The original is the plant figured in Dillenius (1741, pl. 9, fig. 4) which, as well as the description, was founded on a plant studied by Micheli. Smith (1810, pl. 2136) again figured it and described it from Micheli's material and notes which had been communicated to him by Professor O. Targioni-Tozetti long after the death of Micheli. Whence the original material was derived is uncertain, but it seems likely to have been the Adriatic Sea since Micheli lived at Florence. In such a case, it is probable that it is not the species which Greville referred to his *Punctaria plantaginea* but nearer to *P. latifolia* Grev. There seems to be little reason for doubting that the *Punctaria plantaginea* as Greville understood it is also a *Punctaria* in the sense of J. G. Agardh (*loc. cit.*).

J. G. Agardh has proposed a segregate from *Punctaria*, viz., *Homoeostroma* to receive the plant from Cherbourg, described and figured as *Punctaria latifolia* by the French phycologists, Thuret and Bornet (1878,p . 13, pl. 5). Whereas both the *Punctaria latifolia* and the *P. plantaginea* of Greville have the external layer on each surface of the frond distinctly smaller and more deeply colored than the internal layers, in the *P. latifolia* of Thuret and Bornet (but not of Greville) the external layers are of the same sized cells as those of the interior and slightly, if at all, more deeply colored. In our experience, however, there are forms difficult of placing in case *Punctaria* and *Homoeostroma* are considered separate genera.

There remain for consideration the relations of *Punctaria* and *Desmotrichum*. Kuetzing (1845, p. 244) founded the latter genus on *D. balticum*, a slender, yet membranaceous form with hairs borne singly and gametangia conical and practically superficial, at least judging from his figures (Kuetzing, 1843, pl. 20 II, figs. 2, 4. 5–8). Reinke, however, considers Kuetzing's *D. balticum* to be a monosiphonous species although rarely it may be two to four cells wide, while *D. undulatum* (J. Ag.) Reinke is the broader species. Aside from the slender character of the frond, the strongly projecting or even superficial gametangia and the hairs borne singly seem to distinguish the genus. We find, however, strongly projecting, even superficial gametangia in broad species with hairs in groups. We also find certain delicate, but broad species with single, promptly deciduous hairs, and we find species in which there is no indication of hairs, even traces of deciduous ones. Consequently we do not feel certain of any constant difference among these three genera, viz., *Punctaria*, *Homoeostroma* and *Desmotrichum*. We also do not find any definite distinctions to separate Shuh's *Rhadinocladia* (1900, pp. 111, 112) from the simpler *Desmotrichums* (cf. especially Kylin, 1907, pp. 66–68), nor are we able to distinguish satisfactorily Kuetzing's *Diplostromium* (1843, p. 298) while J. G. Agardh's *Nematophloea* (1896, p. 12), if Kuetzing's figure (1856, pl. 45, I) is to be considered typical, seems to have nothing to distinguish it from Kuetzing's *Phycolapathum* (excluding synonymy of type species, pro parte) and *Punctaria*. *Phycolapathum* Kuetzing (1843, p. 299, pl. 24, II) is founded on Greville's *Punctaria latifolia*, although *Laminaria debilis* Ag. is quoted, possibly erroneously, as a synonym. The plate of Kuetzing represents a *Punctaria*. We have, therefore adopted the name *Punctaria* for all of our species, but we have seen none of the slender *Desmotrichum* type on our coast. *Punctaria* has received the sanction of the International Botanical Congress (Rules, 1912, p. 76) for the generic name.

Key to the Species

1. Fronds with numerous marginal crenulate lobes.......... 2
1. Fronds with entire, smooth or undulate or coarsely ruffled margins.......... 3
    2. Fronds large, up to 50 cm. long, chartaceous, composed of 6–7 layers of cells..........6. **P. chartacea** (p. 521)
    2. Fronds small, 10 cm. long, composed of 4 layers of cells..4. **P. lobata** (p. 519)
3. Fronds broadly expanded, up to 30 cm. broad, very fragile....7. **P. expansa** (p. 521)
3. Fronds narrower, up to 10 cm. broad.......... 4
    4. Fronds narrowly linear, distinctly stipitate, smooth, entire.......... 5
    4. Fronds irregular, more or less broadly expanded, obscurely stipitate, with undulate or ruffled margins.......... 6
5. Fronds epiphytic, base broadly cuneate, apex not laciniate..1. **P. hesperia** (p. 517)
5. Fronds saxicolous, long stipitate, base narrowly cuneate, the apex deeply laciniate..........2. **P. fissilis** (p. 518)
    6. Fronds with undulate, much ruffled margins....5. **P. occidentalis** (p. 520)
    6. Fronds with smooth or slightly undulate margins....3. **P. latifolia** (p. 519)

1. **Punctaria hesperia** S. and G.

Plate 37, fig. 30, and plate 49, fig. 18

Fronds 1.5–2.5 cm. high, 5–10 mm. wide, solitary or in small clusters, tapering at the base to a very short stipe and to a blunt apex, 35–50μ (up to 80μ) thick, composed of 4–6 layers of cells, those of the two middle layers much larger than those of the cortical layer; cortical cells thin walled, 4–5 sided in surface view, 18–22μ diam. containing numerous parietal disk-shaped or small band-shaped chromatophores, medullary cells thin walled, closely joined, the length and breadth dimensions greater than the cross-dimensions, containing a few disk-shaped chromatophores; zoosporangia numerous, promiscuously scattered among the gametangia on both surfaces of the frond; gametangia very numerous, closely congested at times or scattered without order; projecting hairs very delicate, in small groups, early deciduous.

Growing on *Phyllospadix*. Pacific Grove, California.

Setchell and Gardner, Phyc. Cont., 1924, p. 3.

This species is apparently not abundant, however the plants are small and inconspicuous, and quite probably ephemeral. Of all of our species, thus far discovered, this one fruits most abundantly. The larger part of the surface cells become transformed into reproductive cells. The type, as stated above, comes from Pacific Grove, but we have two other collections from our territory, viz., growing on *Phyllospadix* at Victoria (Gardner, no. 3849*b*) and one from San Pedro (Mrs. H. D. Johnston, Herb. Univ. Calif., no. 99456) on *Zostera* which may be referred here, at least provisionally.

2. **Punctaria fissilis** S. and G.

Fronds fragile and flabby, ligulate, 12–15 cm. high. 10–16 mm. broad, 65–70μ thick, tapering at the base to a very delicate distinct stipe 10–14 mm. long, attached by a small parenchymatous disk, light brown in color, more or less deeply lacerated into linear laciniae, composed of four layers of cells of fairly uniform size arranged in more or less longitudinal rows, with thin walls and very small disk-shaped chromatophores arranged closely along the walls; zoosporangia and gametangia unknown; hairs present in small groups.

Port Clarence, Alaska.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 4.

The flaccid nature of the fronds, the long, delicate stipe, their laciniate habit, the arrangement of the cortical cells in fairly regular longitudinal rows along with the other combination of characters, characterize this as a distinct species. *P. fissilis* seems to have its nearest relations with *P. glaciale* Rosenv. and *P. plantaginea* (Roth) Grev. We have not been able to examine any of the material from Yakutat Bay collected by Saunders and reported under *P. plantaginea* (1901, p. 420). We have not seen any typical *P. plantaginea* from our territory and suspect that possibly his *P. plantaginea* may be found to belong to *P. fissilis*.

3. **Punctaria latifolia** Grev.

Fronds gregarious, flaccid, adhering firmly to paper, 1–3 dm. high, 2–7.5 cm. wide, 70–85μ thick, linear to obovate, attenuated at the base; color yellowish to light brown; composed of four layers of cells, the outer layers smaller than the inner; gametangia projecting but slightly above the surface; zoosporangia unknown.

Occasional in quiet sandy coves (fide Saunders).

Greville, Alg. Brit., 1830, p. 52; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 240. *Homoeostroma latifolium* Saunders, Alg. Harriman Exp., 1901, p. 420.

We have examined a few small specimens of a *Punctaria* collected by Saunders at Metlacatla and on Baranoff Island, Alaska, and published (*loc. cit.*) as *P. latifolia,* which seem to belong to this species. We are referring them here with some doubt on account of their much reduced size as compared with Wyatt's no. 9, of the Algae Danmonienses, which we are taking as fairly typical of the species. The measurements of the cross-section of the fronds and the shapes and sizes of the cells composing the four layers agree very well with those of her distribution, both being 70μ to 80μ in diameter.

4. **Punctaria lobata** (Saunders) S. and G.

Fronds broadly linear, lanceolate or ovate, 10 or more cm. long, 1–5 cm. wide, narrowed below to a short stipe of a dark olive brown color, composed of 4 layers of cells, the 2 inner layers larger than the outer layers; edges deeply and irregularly lobed, the lobes irregularly cut and divided; zoosporangia scattered over the whole surface of the plant; gametangia unknown.

Attached to *Zostera marina.* Prince William Sound and Sitka, Alaska.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 12. *Homoeostroma lobatum* Saunders, Alg. Harriman Exp., 1901, p. 420.

We have not seen any material belonging to this species and are including it here without comment, having previously made the above combination (*loc. cit.*).

5. **Punctaria occidentalis** S. and G.

Plate 35, fig. 6, and plate 80*b*

Fronds moderately rigid, linear-lanceolate or oblanceolate to broadly ellipsoidal, usually tapering at the base to a short stipe about 5 mm. long, attached by a small disk, 1.5–2 dm. high, 3–10 cm. broad, 40–180μ thick, with undulate and coarser ruffled margins, of a light brown color, soon changing to green on exposure, composed of 2–7 layers of cells, thickest in the median region, gradually thinner toward the margins; cells of medulla largest diminishing slightly toward the surfaces, cortical cells being the smallest; zoosporangia cuboidal to subspherical, scattered on both sides of the frond, 30–40μ (up to 70μ) diam., very slightly bulging on the outer surface; gametangia numerous, scattered promiscuously on both sides of the frond among the zoosporangia and usually protruding beyond the surface about one-half their length; hairs unknown.

Growing on *Zostera,* in the upper sublittoral belt. Monterey, California.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 4. *Homoeostroma latifolia* Saunders, Phyc. Mem., 1898, p. 159, pl. 30, figs. 4, 5. *Punctaria latifolia* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 873; Tilden, Amer. Alg. (Exsicc.), no. 355.

We have not been able to observe the young fronds of this species, but the fruiting fronds have no hairs so far as we have been able to ascertain. Rosenvinge (1910, p. 121) has found a similar condition in his *Punctaria glacialis.* The surface is moderately sticky and the plants adhere firmly to paper on drying.

As cited above, this species has been referred to *P. latifolia* since its discovery on our coast some years ago. We have not been able to examine any of the material upon which Greville founded the species. We have, however, examined a specimen distributed by Wyatt (no. 9) from Torbay on the southeast coast of England near the type locality. Since no other species have been cited from this general locality, and Wyatt's specimen agrees so well with Greville's original description, we are assuming this to be typical *P. latifolia* and using it as a basis of comparison. Our plants are much larger and thicker and have a larger number of layers of cells all of which are much more variable in shape than those of Wyatt's distribution. The cortical cells which do not produce zoosporangia and gametangia usually divide horizontally into two. The fructiferous cells remain undivided. The undivided cortical cells are about the same shape and size as the medullary cells which also vary in shape and size.

6. **Punctaria chartacea** S. and G.

Plate 45, fig. 79, and plate 81

Fronds more or less finely bullate, membranaceous, chartaceous, linear to broadly elliptical, base often cordate, margins finely fimbriate, 25–35 cm. (up to 50 cm.) long, 8–12 cm. (up to 30 cm.) broad, mature plants 90–120μ thick, attached by a very small disk; composed of 6–7 layers of cells, the surface cells being much smaller than the medullary cells; cell walls thick, of light brown color, with intercellular spaces among the medullary cells; color dark brown, not changing on drying, not adhering at all to paper; hairs, zoosporangia and gametangia unknown.

Growing on Eel grass in the lower littoral and upper sublittoral belts. Sitka, Alaska.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 4.

This species of *Punctaria* was found in great abundance, both attached and floating. A large number of specimens were examined in the last part of June and no reproductive cells could be found. Neither were any hairs observed.

7. **Punctaria expansa** S. and G.

Plate 49, fig. 19

Fronds gregarious, broadly expanded, more or less circular in outline, 20–30 cm. broad, 100–130μ thick, very fragile, of medium brown color, fading to green very soon after removal from water, composed for the most part of four layers of cells, the medullary cells being much larger than the cortical cells; neither the medullary nor the cortical cells arranged in any definite series; cortical cells four to six sided and 30–40μ diam. in surface view; zoosporangia and gametangia on the same frond, the former projecting but slightly beyond the surface, the latter more or less conical and projecting one-half or more of their length beyond the surface; hairs present but sparse.

Growing in a small quiet cove at the head of Penn's Cove, Whidbey Island, Washington.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 5. *Punctaria latifolia* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 240 (in part).

Punctaria expansa is apparently a very rare though distinct species, the foregoing material referred to being the only collection known. The habit of growth is the same as that of a group of fair sized *Ulvas.* It was found growing in a secluded cove in which the water rises and falls but slightly through a small channel with the change of tide, and is not disturbed by the action of wind. The plants are exceedingly fragile, being scarcely tough enough to hold their own weight when first removed from the water. They give up their brown color soon after being removed from the water when they superficially resemble almost perfectly an expanded *Ulva.* The fruit, especially the zoosporangia in our specimens, is decidedly sparse, likewise the hairs.

We have been able to examine a few small young specimens of *Homoeostroma undulatum* collected and thus labeled by Saunders (1901, p. 419). They are not fruiting, are densely covered with diatoms and do not soak out readily. We are, therefore, on account of the state of the material, unable to place it and hence are not including it in our list of species.

FAMILY 8. ASPEROCOCCACEAE FOSLIE

Fronds ligulate or saccate, simple, differentiated into two kinds of tissue, an inner one, composed of nearly colorless cells and an outer cortical color bearing one; growth trichothallic at first, later intercalary; hairs present, and in some species, paraphyses; zoosporangia on full-sized, or macroscopic, plants; gametangia, so far as known, on reduced, but not microscopic plants, not so definitely collected into sori as is the case with the zoosporangia; both zoosporangia and gametangia projecting from the surface and collected into sori scattered all over the frond except at the base.

Foslie, Mar. Alg. Norway, Cont. I, 1890, p. 88. *Asperococceae* Zanard., Sagg. Class. Nat. Ficee, 1843, p. 10 (in part); Farlow, Mar. Alg. New England., 1881, p. 88.

The Asperococcaceae, as limited to those ligulate, bullose, or nearly spherical forms, solid or hollow, with the zoosporangia in distinct and elevated sori, projecting and accompanied, usually at least, by distinct paraphyses or hairs and in having the gametangia, so far as known, in usually less definite sori and on plants more or less reduced in size, but still macroscopic, is closely related in its early trichothallic, later intercalary growth to the Striariaceae, Punctariaceae, and Scytosiphonaceae, so that it is occasionally difficult to determine exactly where to place a particular genus. The genus *Asperococcus,* as exemplified by *A. bullosus* Lamour. is distinct and definite as is also *Soranthera ulvoidea* Rupr., and both of these are typical as to hollow frond, manner of growth and type of sorus which is definite in outline, with paraphyses and zoosporangia intermingled and with a group of hairs more or less centrally located. The genus *Halorhipis* of Saunders has also projecting sori with zoosporangia, but *H. Winstonii* (C. L. Anderson) Saunders has less definite sori and is without paraphyses but provided with hairs. The Californian species seems to belong in Asperococcaceae because of its superficial and projecting zoosporangia, and because of its general structure and appearance ought to be placed near to *Asperococcus compressus* Griff. We have seen no gametangia on the plants of any of our species, but judging from the statements of Buffham (1891), Sauvageau (1895), and Kuckuck (1899), the gametophyte may be very much reduced, a tendency toward, but by no means approximating, the microscopic gametophyte known to occur in some of the other Melanophyceae.

Key to the Genera

1. Fronds ligulate, solid........18. **Halorhipis** (p. 523)
1. Fronds cylindrical or more or less spherical, hollow........ 2
    2. Fronds cylindrical or slightly clavate, more or less twisted........ ....20. **Myelophycus** (p. 527)
    2. Fronds spherical, sessile........19. **Soranthera** (p. 525)

18. **Halorhipis** Saunders

Fronds solid, ligulate, arising from a disk-shaped holdfast, differentiated into two fairly distinct tissues, a medulla of several layers of larger, nearly colorless, closely united, more or less cylindrical cells extending lengthwise of the frond, and surrounding this a cortical or surface tissue composed of more or less cuboidal, color bearing cells; zoosporangia superficial among hairs and collected into minute sori scattered abundantly over both sides of the frond except toward the base; gametangia unknown.

Saunders, Phyc. Mem., 1898, p. 160.

Halorhipis was proposed by Saunders to receive a single species found at Pebble Beach, Monterey County, California. The genus is closely related to *Haloglossum* Kuetz.

The genus *Haloglossum* was founded by Kuetzing (1843, p. 340) based upon the material of *Asperococcus compressus* Griffiths (*in* Hooker, 1833, p. 278) from the southern shores of England. He changed the name to *Haloglossum Griffithsianum* which accordingly becomes the type of the genus. The chief distinction between *Haloglossum* and *Asperococcus* lies in the character of the interior of the frond. The former is ligulate and solid and the latter is saccate. Mrs. Griffiths expressly states (*loc. cit.*) "there is not the slightest tendency to be tubular or inflated," in speaking of *A. compressus.* We feel inclined to keep the two genera separate, based mainly upon this character, although the method of reproduction in the two is similar. The genus *Halorhipis* is very similar in appearance and structure to *Haloglossum*, but the sori are destitute of paraphyses although the protruding zoosporangia are aggregated about a cluster of hairs.

Halorhipis Winstonii (C. L. Anderson) Saunders

Plate 35, fig. 8

Fronds mostly aggregated into tufts, thin, membranaceous, lanceolate to obovate or spatulate, 8–20 cm. high, 2–5 cm. wide, about 200μ thick, with very slender filamentous stipes; color dark olive green; zoosporangia collected into sori mostly in slight depressions, ellipsoidal, obovate or pyriform, 30–45μ long, 20–30μ broad; sori numerous, variable in shape and size, linear to irregular in outline; hairs in groups in the sori; gametangia and paraphyses unknown.

Growing on the fronds of *Egregia Menziesii* and on rocks. Known only from a single locality, Pebble Beach, Carmel Bay, California.

Saunders, Phyc. Mem., 1898, p. 161, pl. 28; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 532. *Punctaria Winstonii* C. L. Anderson, Some new and some old algae, 1894, pp. 358, 359. *Asperococcus Winstonii* Svedelius, *in* Engler and Prantl, Natürl. Pflanzenfam., Nachtr. z. 1 Th., Abt. 2, 1910, p. 158 (by implication).

This plant, although known for only a little over a quarter of a century, has had a somewhat varied history. It was first described by C. L. Anderson (*loc. cit.*) who saw in it affinities with the genus *Punctaria* Grev. Saunders (*loc. cit.*) next studied it and came to the conclusion that a new genus, *Halorhipis,* should be erected for its reception. It was distributed in the same year under that name in the Phycotheca Boreali-Americana as no. 532. In 1910, as above stated, Svedelius placed it in the genus *Asperococcus* Lamour. Our studies, while leading us to retain the genus *Haloglossum* Kuetzing, discarded by most of the later phycologists, and to place *Asperococcus compressus* Griff. in that genus as a species distinct from all others, yet also lead us to keep *Halorhipis Winstonii* distinct because of the lack of the pluricellular paraphyses so characteristic of both *Asperococcus* and *Haloglossum*. It differs from a *Punctaria*, as we understand that genus, in having the thallus decidedly differentiated into two sorts of tissues, and in having the zoosporangia superficial.

19. **Soranthera** Post. and Rupr.

Fronds spherical and solid in the juvenile stage, later becoming hollow, inflated and membranaceous, sessile, attached by a rather broad and penetrating base, composed of two kinds of tissue, an inner one 4–5 cells deep, of large, nearly colorless cells, and a surface layer of small, angular, color bearing cells; reproduction by zoosporangia in very distinct, conspicuous sori, scattered promiscuously over the surface of the frond; paraphyses pluricellular; hyaline hairs grouped in the center of the sori; gametangia unknown.

Postels and Ruprecht, Illustr. Alg., 1840, p. 19.

The type species of the genus is *S. ulvoidea* discovered "Ad insulam Sitcha, parasitica in fronde Rhodomelae Laricis," (fide Postels and Ruprecht, *loc. cit.*). The question of parasitism of the genus has been investigated by Miss E. S. Barton and was discussed by her in an article in the Journal of the Linnaean Society (1898, p. 479). She questions the statement quoted above from Postels and Ruprecht as to the parasitism of the species, taken in the sense that we understand parasitism. However, her investigation shows that the fronds are attached by a mass of rhizoidal filaments which surround the host, many of which actually penetrate into the cells even far into the interior of the host. She saw and figured what she interpreted as "haustoria." Whether these plants and many others among all four of the large sections of the algae which penetrate in a similar way, actually obtain food from the host has not been satisfactorily determined, so far as we are aware.

Soranthera ulvoidea Post. and Rupr.

Fronds membranaceous, comparatively thin, oval, ellipsoidal or nearly spherical, entire or irregularly lobed, up to 7 cm. diam.; color olive brown; sori abundant, conspicuous, distributed fairly evenly over the whole free surface of the frond; zoosporangia clavate, 70–100μ long, interspersed among numerous clavate, pluricellular paraphyses which surpass them in length.

Growing on species of *Rhodomela* and *Odonthalia*, frequently in tide pools, in the littoral belt. Common along the whole coast from Unalaska, Alaska, to southern California.

Postels and Ruprecht, Illus. Alg., 1840, p. 19; Kjellman, Om Beringh. Algfl., 1889, p. 47, pl. 7, figs. 4, 5; Saunders, Phyc. Mem. 1898, p. 165, pl. 29, figs. 4, 5; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 244.

Two forms have been segregated as follows:

Soranthera ulvoidea f. **typica** S. and G.

Plate 39, figs. 40, 41, and plate 83*b*

Fronds nearly regular in outline, membrane thicker, oval to spherical, up to 7 cm. diam.

Growing on species of *Rhodomela* and *Odonthalia*. From Pacific Grove, California, northward into Bering Sea, and more common in the southern part of the range than f. *difformis*.

Setchell and Gardner, *loc. cit.;* Kjellman, *loc. cit.;* Saunders, *loc. cit.,* Alg. Harriman Exp., 1901, p. 422; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 417; Tilden, Amer. Alg. (Exsicc.), no. 245.

Soranthera ulvoidea f. **difformis** S. and G.

Fronds gregarious, membrane thinner, usually smaller than the above, variously and deeply lobed.

Growing on the same hosts as the two preceding, but is more common on the northern part of the range, from Cape Flattery northward.

Setchell and Gardner, *loc. cit.;* Collins, Holden and Setchell, *loc. cit.,* no. 1130.

Forma *difformis* seems to prefer either brackish or muddy water or is induced by such medium.

Soranthera ulvoidea Post. and Rupr. is a very common species along the entire Pacific coast of North America from Pacific Grove, California, northward. Careful search has failed to reveal the gametangia.

20. **Myelophycus** Kjellm.

Fronds filiform, attached by numerous rhizoidal filaments densely interwoven, solid throughout when young, later becoming hollow above; growth trichothallic (?), later usually intercalary; fronds composed of three kinds of tissue, an inner, colorless layer of a few rows of large, rounded, isodiametric, or elongated cells, outside of which is a layer of small prismatic, thick-walled cells giving rise to a dense mass of erect, assimilating filaments (paraphyses ?); zoosporangia immersed among the assimilating filaments; gametangia unknown; hairs present in the juvenile stage.

Kjellman, *in* Engler and Prantl, Natürl. Pflanzenfam., 1893, 86 Lief., p. 202, Om Fuc. *Myelophycus,* 1893, pp. 1–11.

The type species of the genus is *M. caespitosum* from the coast of Japan. The species of our coast seems to agree in all generic requirements. Kjellman has followed the neuter gender of the Greek noun, phykos, although the Latin form would indicate a grammatical masculine. It seems best, however, to follow Kjellman as being more in accord with the proper usage.

We place this genus in Asperococcaceae with considerable doubt. The species may prove to be the zoosporangial forms of gametangial plants similar to *Chordaria Gunjii* Yendo.

Myelophycus intestinale Saunders

Fronds solitary or loosely caespitose, 1–15 dm. high, 2–4 mm. diam., solid in the juvenile stage, hollow at maturity above the short, solid stipe, cylindrical, abruptly attenuated at the tip, but later eroded, usually twisted, unbranched, dark reddish brown in color; central tissue composed of 2–3 layers of elongated, cylindrical, colorless cells merging toward the outside into 3–4 irregularly arranged rows of thick-walled, cuboidal cells, these in turn giving rise to numerous paraphyses composed of 4–8 thick-walled cells and to zoosporangia; zoosporangia ellipsoidal to obovate scattered over the frond except the stipe, 45–60μ long, 20–30μ broad.

Growing attached to rocks in the lower littoral and upper sublittoral belts. Shumagin Islands, Alaska, to Puget Sound, Washington.

"*Myelophycus intestinalis*" Saunders, Alg. Harriman Exp., 1901, p. 420; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 241.

Myelophycus intestinale presents a different aspect when young from that of the older plant. This is seen particularly at the tips which are long acuminate when young, but blunter and often worn away in age. The younger plants seem less conspicuously twisted than the older. Our plant has fewer layers of cells in the intermediate layer and shorter cortical filaments than the *M. caespitosum* of Japan.

Myelophycus intestinale f. **tenue** S. and G.

Plate 40, fig. 50

Fronds densely caespitose, inconspicuously twisted, 1.5–2.5 cm. high, 0.25–0.75 mm. diam.; zoosporangia broadly ellipsoidal, 40–45μ long, 30–35μ broad.

Growing on rocks, usually in shaded localities, and where the spray dashes against the rocks, along high-tide level. Coos Bay, Oregon, to central California.

"*Myelophycus intestinalis* f. *tenuis*" Setchell and Gardner, *in* Gardner, New Pac. Coast Mar. Alg. I, 1917, p. 385.

FAMILY 9. STRIARIACEAE KJELLM.

Fronds filiform, solid, more or less branched, trichothallic, monosiphonous at first, later usually of two sets of tissues, the inner of larger, colorless, more or less elongated cells, the outer a single layer of medium sized cells placed in horizontal rows and having chromatophores; unilocular zoosporangia and plurilocular gametangia superficial or projecting beyond the surface in sori of more or less definite circumscription and usually in transverse rows; with or without paraphyses.

Kjellman, Handbok I, 1890, p. 53.

It seems best to follow Kjellman and keep the seemingly very distinct genera, *Stictyosiphon*, *Striaria* and their near relatives separate from the Asperococcaceae and the Scytosiphonaceae and retain them among the Striariaceae. Both the gametophytes and the sporophytes are known and are similarly macroscopic, but conditions are otherwise in the other two families just mentioned. In the Asperococcaceae there are dissimilarities in size, at least in some species, between the individuals bearing gametangia and those bearing zoosporangia, although neither is properly microscopic so far as known. Among the Scytosiphonaceae, only the gametangial form is known, suggesting that the zoosporangial form may be heteromorphic, whether microscopic or eliminated by some method of syncopation may not even be surmised.

Two genera have been reported from the western coast of North America, but there is so much doubt about one of them (*Striaria*, as indicated below) that we have taken only one under serious consideration.

21. **Striaria** Grev.

Greville, Algae Brit. Syn., 1830, p. XLIII. *Striaria attenuata* (Ag.) Grev. Greville (*loc. cit.*). *Solenia attenuata* Agardh., Syst., 1824, p. 187.

A hand lens examination of the single scanty specimen from Orcas Island, Washington, in the Herbarium of Trinity College, Dublin, referred to *Striaria attenuata* by Harvey (1862, p. 160) left the impression that it may belong rather under *Stictyosiphon tortilis* than under *Striaria*. It was very slender and seemed to be sterile.

22. **Stictyosiphon** Kuetz.

Fronds attached by numerous branched rhizoids, mostly growing in dense clusters, filiform, branched, terminating in one or more hyaline hairs, solid in the juvenile stage, fistulose below, growth intercalary; plant body consisting of parenchymatous cells, the interior of more or less elongated, rectangular, colorless cells and the exterior of a single cortical layer of color bearing cells; reproduction by unilocular zoosporangia and plurilocular gametangia produced by the transformation of certain cortical cells, solitary or more or less aggregated, borne on similar macroscopic plants.

Kuetzing, Phyc. Gen., 1843, p. 301.

The type species of the genus is *S. adriaticus* with the type locality Trieste. The northern species added later seem to belong under the same genus so that there is no necessity for retaining the genus *Phloeospora* of Areschoug (1873, p. 164). The species of *Stictyosiphon* differ principally from those of *Striaria* in not having paraphyses intermingled with the reproductive organs in their sori.

Stictyosiphon tortilis (Rupr.) Reinke

Fronds filiform, long attenuate, closely aggregated, repeatedly and alternately branched, the branches bearing minute ramuli mostly opposite, 5–8 cm. high, often with a small, longitudinal, central cavity in the lower portions; cortical cells with branched band-shaped chromatophores; color dark olive brown; zoosporangia and gametangia scattered or aggregated into more or less transversely arranged groups.

Port Clarence, Golofin Bay and Unalaska Bay, Alaska.

Reinke, Algenfl. westl. Ostsee, 1889*a*, p. 55, Atlas, 1889, p. 47, pls. 31, 32; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 987. *Phloeospora tortilis* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 245. *Scytosiphon tortilis* Ruprecht, Tange, 1851, p. 373.

The plants of Bering Sea appear to belong in the form cycle of this Arctic species. We seem to remember having seen specimens from farther south along our coast, but cannot definitely place them.

Family 10. SCYTOSIPHONACEAE Foslie

Fronds cylindrical and hollow, flattened and solid, or more or less globular and hollow, main growth in length at first trichothallic, later intercalary, simple, of two or three tissues, one of internal hyphae in *Endarachne*, but of large colorless cells in others, second, an intermediate layer of large colorless cells, surrounded by an outer layer of small, mostly cuboidal, colored cells in longer or shorter anticlinal rows; zoosporangia unknown; gametangia in extended and confluent sori of indefinite outline, palisade-like, of equal length and closely packed together, not projecting beyond the surface; hairs in groups; unicellular paraphyses (?) present in some species.

Foslie, List Mar. Alg. Isle of Wight, 1892, p. 13. *Scytosiphoneae* Thuret, *in* Le Jolis, Liste des alg. mar. de Cherb., 1863, pp. 14 and 67.

Thuret seems to have been the first to have stabilized the genus *Scytosiphon* and to have recognized it as the type of a group corresponding to a family. Foslie, so far as we may learn, first used the family ending as now usually adopted.

The Scytosiphonaceae are close to the several preceding families as has been noted previously. The method of growth is very similar, but only the gametangia are known in the genera attributed to this family and they are in expanded and indefinite sori which do not project above the surface of the frond nor are they associated with pluricellular paraphyses. The Punctariaceae possess the simplest members of this series and they have both zoosporangia and gametangia, these commonly produced on the same individual. In the Asperococcaceae, gametangial plants are rarely found and are smaller than the zoosporangial plants. In the Striariaceae both zoosporangial and gametangial plants are found. While in the Scytosiphonaceae, although most of the species are common and widespread, no zoosporangial plants have been detected.

Key to the Genera

1. Fronds solid and strap-shaped........ 2
1. Fronds hollow and cylindrical, flattened, globose or difform........ 3
    2. Interior composed of hyphal tissue........25. **Endarachne** (p. 538)
    2. Interior composed of parenchymatous tissue........24. **Ilea** (p. 535)
3. Fronds cylindrical or flattened........23. **Scytosiphon** (p. 531)
3. Fronds globose or difform........ 4
    4. Membrane entire........26. **Colpomenia** (p. 539)
    4. Membrane reticulately perforated........27. **Hydroclathrus** (p. 542)

23. **Scytosiphon** Ag. (emend. Thuret)

Frond unbranched, solid when young, later tubular, cylindrical or compressed, constricted at short intervals or smooth throughout, consisting of two layers of cells, an inner of thick-walled, vertically elongated, colorless cells, and an outer of small, rounded, cuboidal, assimilating cells, the latter giving rise to the plurilocular gametangia covering the entire surface, except at the base, and to scattered unicellular paraphyses (?) and hairs when present; growth intercalary near the base.

Agardh, Dispos. Alg. Suec., 1811, p. 24 (fide Pfeiffer) (pro parte); Thuret, Rech. sur les zoospores, 1850, p. 239.

The genus *Scytosiphon* originally included what we now call *Dictyosiphon foeniculaceus*, *Chorda Filum* and *Scytosiphon Lomentaria*. Thuret seems to have been the first to restrict the generic name to the *Chordaria Lomentaria* Lyngbye and to point out the generic characteristics. O. Kuntze (1898, pp. 430 and 434) has proposed the generic name *Tubicutis* but the International Rules (Briquet, 1912, p. 76) decided in favor of the retention of *Scytosiphon*.

Scytosiphon Lomentaria (Lyngb.) J. Ag.

Plate 44, figs. 72, 74

Fronds usually fasciculate, sometimes solitary and scattered, 15–30 cm. (up to 60 cm.) high, 3–6 mm. diam., cylindrical, at intervals more or less deeply constricted, attenuated below into a small solid stipe, attached by a small disk; color dark brown to olive green; plurilocular gametangia forming a compact palisade layer over the surface of the frond; paraphyses (?) scattered among the gametangia.

Growing on rocks in the whole of the littoral belt. Common along the entire Pacific coast from Port Clarence, Alaska, to southern California.

J. G. Agardh, Sp. Alg., vol. 1, 1848, p. 126; Thuret, Rech. sur les zoospores, 1850, p. 239 (1851, p. 30, Repr.), pl. 29, figs. 1–4; Setchell, Alg. Prib. Islands, 1899, p. 591; Saunders, Phyc. Mem., 1898, p. 163, pl. 31, figs. 8–10, Alg. Harriman Exp., 1901, p. 421; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 243; Okamura, Icon. Japan. Alg., 1908, p. 144, pl. 30. *Chorda Lomentaria* Lyngbye, Hydrophyt. Dan., 1819, p. 74, pl. 18, E.

Scytosiphon Lomentaria, if all the forms referred to it belong under it, is a widespread and variable species. It varies from a centimeter or two to twenty-five or more centimeters in height and from a millimeter or two up to ten millimeters in thickness. It may vary from clearly cylindrical to decidedly flattened and it may vary from regularly or irregularly and pronouncedly constricted (especially in the larger plants) to those with no trace of constriction whatever. It may be covered almost uniformly with gametangia or, rarely, the gametangia may be segregated into distinct and limited sori. The gametangia may be longer or shorter, with variations from two up to twenty-five or more longitudinal uniseriate loculi. It has been the custom to separate the var. *complanata* Rosenvinge, but this occurs in a major and minor form, as do all the variants with the exception perhaps of the typical form (f. *typicus*) which is constricted, but while this varies much in size, it never occurs among the true minor forms of the species. The larger and smaller forms of each series of forms differ from one another in the size of the cells of the inner layer, and in the length (absolute and in number of loculi in each longitudinal series) as well as in diameter of the gametangia. In order to coördinate the variables as mentioned above, we have tabulated them in the following key, rather to give a view of the combinations of characters than that they should be considered of any definite taxonomic importance, since intermediate forms are, by no means, absent.

Key to the Forms

1. Plants constricted at intervals, medium to large........................1. f. **typicus** (p. 533)
1. Plants not constricted.. 2
    2. Plants cylindrical.. 3
    2. Plants complanate.. 5
3. Plants 6 cm. or more high; interior cells large; gametangia long................................ ....2. f. **cylindricus major** (p. 533)
3. Plants less than 6 cm. high; interior cells small; gametangia short........................ 4
    4. Sori covering the frond..................................3. f. **cylindricus minor** (p. 533)
    4. Sori restricted, definite............................4. f. **cylindricus maculatus** (p. 534)
5. Plants large, 6 cm. or more; inner cells large; gametangia long................................ ....5. f. **complanatus major** (p. 534)
5. Plants small, less than 6 cm.; inner cells small; gametangia short................................ ....6. f. **complanatus minor** (p. 534)

The occurrence or non-occurrence of hairs is such a variable character as is also the presence or absence of the "unicellular paraphyses" (possibly hypertrophied gametangia ?) in all of our variants of the species that we have not found it possible to use either structure in any of them as a diagnostic character of much significance.

1. **Scytosiphon Lomentaria** f. **typicus** S. and G.

Plate 39, fig. 45, and plate 44, fig. 75

Plants of the largest size of the genus, both as to length and diameter, dark brown to olive green in color, more or less regularly and deeply constricted; paraphyses (?) cylindrical to slightly clavate, not projecting beyond the gametangia, with chromatophores often collected at the outer end; gametangia with 10–15 loculi.

Growing on rocks in pools in the lower littoral belt. Port Clarence, Alaska, to southern California.

Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 323*b*; Tilden, Amer. Alg. (Exsicc.), no. 246.

2. **Scytosiphon Lomentaria** f. **cylindricus major**

Fronds from 6–25 cm. long. 1.5–2.5 mm. diam., not constricted, cylindrical, long-attenuated at both ends, light brown in color.

Growing on rocks in the lower littoral or in tide pools in the upper littoral belts. Central California.

Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1389. *Chordaria attenuata* Tilden, Amer. Alg. (Exsicc.), nos. 347*a*, 347*b*?

The cylindrical unconstricted forms seem to be fairly well established both as regards habitat and form. They grow in tide pools, often even above high-tide level, and the size seems to be materially influenced by the size and depth of such pools. In these pools where they are frequently to be found, they are generally far removed from the typical form which grows usually in deep tide pools in the middle and lower littoral belts.

3. **Scytosiphon Lomentaria** f. **cylindricus minor**

Fronds less than 6 cm. high, 1–1.5 mm. diam., cylindrical, unconstricted.

Growing on rocks along high-tide line in localities exposed to wave action. Central California (San Francisco).

4. **Scytosiphon Lomentaria** f. **cylindricus maculatus**

Plate 42, figs. 61, 62

Fronds 3–4 cm. high, cylindrical, not constricted, dark brown in color; gametangia collected into definite, larger or smaller sori.

Growing on rocks exposed to heavy surf along high-tide level. Central California (San Francisco).

Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1235.

This form is distinguished by the presence of gametangia in groups, giving the small fronds a warty appearance. It grows in exposed situations in which the rocks are kept more or less moist continuously by the spray, but for the most part the plants are not submerged in pools.

5. **Scytosiphon Lomentaria** f. **complanatus major**

Fronds flat, 9–14 cm. high, 1–2.5 mm. wide, dark brown in color, soon changing to green on removal from the water.

Growing on rocks in the lower littoral belt. Pebble Beach, Carmel Bay, Monterey County, California.

6. **Scytosiphon Lomentaria** f. **complanatus minor**

Plate 44, fig. 74

Fronds 3–5 cm. high, up to 1.5 mm. wide, irregular and variable in thickness, cylindrical below and solid or hollow, flattened above and hollow, light brown in color; gametangia composed of 5–7 loculi, completely dissolving at maturity leaving the medulla clean; medulla composed of two layers of cells, variable in size, much longer than broad; hairs and paraphyses absent.

Growing on stones along high-tide level or above. Fort Point, San Francisco, California.

This form is a short-lived winter and spring form, usually maturing in February and March, so far as our experience shows. It has been detected for many years in the above mentioned habitat, often found growing on wood as well as on a stone wall.

24. Ilea Fries

Fronds solid, or rarely with occasional small cavities, membranaceous, considerably flaccid, simple, ligulate, tapering at the base to a small, solid stipe, attached by a parenchymatous disk-shaped holdfast, or by rhizoids, differentiated into two distinct tissues, a medulla composed of more than one layer of mostly large, more or less colorless cells and a cortex of small, cuboidal, color bearing cells; the cortical cells on both surfaces giving rise by numerous horizontal divisions to gametangia with uniseriate loculi, gametes escaping by the complete dissolution of the entire wall; zoosporangia unknown; paraphyses (?) and hairs present in some species.

Fries, Flor. Scan., 1835, p. 321 (pro parte); not *Ilea* Fries, Syst. Orb. Veg., part 1 (pl. homon.), 1825, p. 336; not *Ilea* J. G. Agardh, Till Alg. Syst., afd. 3, 1883, p. 114. *Phyllitis* Kuetzing, Phyc. Gen., 1843, p. 342 (not *Phyllitis* Hill). *Petalonia* Derbès et Solier, Sur les org. repr. des alg., 1850, p. 265.

As to the confusion and the different views concerning the adoption of *Ilea* as the name for this genus, one may consult Nordstedt (1911, p. 265) and M. A. Howe (1914, p. 51). *Petalonia* is preferable from the point of view of possible confusion, but *Ilea* seems to have the right of way. The genus tends toward complanate forms of *Scytosiphon* in certain forms which, while not completely hollow, nevertheless are not completely solid. The type species is *Ilea Fascia* (Muell.) Fries, whose type specimens come from somewhere on the coast of Norway. In the genus *Ilea*, a condition exists very similar to that found in *Scytosiphon* and in *Colpomenia*, that is, of a number of fairly striking form-types between which it is extremely difficult to make other than very arbitrary distinctions. We are inclined to recognize a single species, *Ilea Fascia*, and refer the other described species or forms to it.

Ilea Fascia (Muell.) Fries

Plate 44, figs. 68–71, 73

Fronds attached by a small, parenchymatous disk, often fasciculate and several disks coalescing, thin, plane or at times more or less crisped, linear-lanceolate to oblanceolate, often rounded and more or less eroded above, 6–12 cm. (up to 25 cm.) high, mostly 1.5–2.5 cm. wide, but at times up to 12 cm. wide, exceedingly variable in thickness;

gametes escaping by the simultaneous dissolution of the entire cell walls of the gametangia.

Growing on rocks and on *Phyllospadix* in the littoral belt. Occurring in its various forms from Unalaska, Alaska, to southern California.

Fries, Flor. Scan., 1835, p. 321. *Phyllitis Fascia* Kuetzing, Phyc. Gen., 1843, p. 142, pl. 24, III, figs. 1–6, *in* Linnaea, vol. 17, 1843, p. 97; Saunders, Alg. Harriman Exp., 1901, p. 421; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 243; Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 199. *Petalonia Fascia* Kuntze, Rev. Gen. Pl., vol. 3, 1898, p. 419; Howe, Mar. Alg. Peru, 1914, p. 50. *Fucus Fascia* Mueller, *in* Flor. Dan., 1778, pl. 768.

So far as we have been able to ascertain, typical *Ilea Fascia* has neither hairs nor paraphyses. The *Phyllitis Fascia* of Okamura (1901, pl. 10) shows a group of hairs among plurilocular gametangia. Later, however, he distributed this plant under *Endarachne Binghamiae*, in his Algae Japonicae Exsiccatae, no. 86, referring to his previous publication (*loc. cit.*) as a synonym.

The size of the plants, as noted by different authors, is exceedingly variable, as the foregoing diagnosis shows. We have included plants up to 25 cm. long, and up to 12 cm. wide. The thickness varies with age in the same plant, and varies in different collections of plants. Mueller's *Fucus Fascia* (*loc. cit.*), as illustrated, is about 20 cm. long and 5 mm. broad. The f. *zosterifolia* in size, form, and in being interruptedly and slightly hollow, approaches *Scytosiphon Lomentaria* f. *complanatus* of medium size.

We suggest the arrangement of the forms of the species in the following key:

1. Frond broad, stipe distinct 2
1. Frond narrow to almost filiform, almost stipeless 3
    2. Tapering gradually at the base to a short stipe .... 3. f. **caespitosa** (p. 537)
    2. Tapering abruptly at the base to a short stipe .... 2. f. **debilis** (p. 537)
3. Frond flat, solid throughout 4
3. Frond with few small internal spaces .... 4. f. **zosterifolia** (p. 537)
    4. Frond flat, attached by a solid disk .... 1. f. **typica** (p. 537)
    4. Frond nearly filiform, attached by rhizoids .... 5. f. **filiformis** (p. 537)

With the exception of the last, the forms thus far described for the genus, whether as species or varieties, seem to be represented in our territory.

1. **Ilea Fascia** f. **typica** S. and G.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 12.

f. *typica* is founded on *Fucus Fascia* Mueller, Fl. Dan., 1778, pl. 768. The plants distributed in Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1131, are fairly representative of the typical form. It extends along the coast from Puget Sound, Washington, to southern California.

2. **Ilea Fascia** f. **debilis** S. and G.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 12.

f. *debilis* is founded on *Laminaria debilis* Agardh. We have a few specimens representative of this form from San Juan Island, Washington. They measure up to twelve centimeters wide and twenty-five centimeters long.

3. **Ilea Fascia** f. **caespitosa** S. and G

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 13.

f. *caespitosa* is founded on *Laminaria caespitosa* J. G. Agardh, Sp. Alg., I, 1848, p. 130, and is well illustrated in Thuret and Bornet, Etudes Phyc., 1878, pl. 4. The plants distributed in Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 736 may be considered to represent this form. It is known only in the extreme northern portion of our region.

4. **Ilea Fascia** f. **zosterifolia** S. and G.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 13.

f. *zosterifolia* is founded on *Phyllitis zosterifolia* Reinke, Algenfl. westl. Ostsee, 1889*a*, p. 61. This form has been detected in but a single locality on our coast, viz., Pebble Beach, Carmel Bay, Monterey County, California.

5. **Ilea Fascia** f. **filiformis** S. and G.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 13.

f. *filiformis* is founded on *Phyllitis filiformis* Batters, *in* Linn. Soc. Journ. Bot., vol. 24, 1888, p. 451, pl. 18, figs. 1–6. This form has not been detected on our coast.

25. **Endarachne** J. Ag.

Fronds plane, entire, ecostate, solid, attached by a small solid disk, composed of three quite distinct tissues, a surface tissue of more or less cuboidal cells holding the plastids, merging below into larger, thick-walled, slightly parenchymatous cells which in turn merge into the medulla, composed of very thick-walled, densely intertwined, branched filaments extending longitudinally for the most part; reproduction by plurilocular gametangia forming a palisade layer over the whole frond except the stipe; paraphyses unknown; hairs in fascicles.

J. G. Agardh, Analecta Alg., Cont. 3, 1896, p. 26.

The type species of the genus is *Endarachne Binghamiae* collected by Mrs. Bingham in the vicinity of Santa Barbara, California. So far as is known at present, this is the only species of the genus.

In the genus *Ilea,* the central cells of the medulla are, at times, more or less elongated, but there is no such conspicuous development of hyphal tissues as is to be found in the present genus. *Endarachne* resembles forms of *Ilea Fascia* so closely in general appearance that it is necessary to examine sections to distinguish them with certainty.

Endarachne Binghamiae J. Ag.

Plate 38, figs. 37, 38, and plate 83*a*

Fronds usually aggregated into clusters, 10–18 cm. high, 1–3 cm. broad, linear to broadly spatulate, at times irregular in outline, usually eroded above at maturity, with cuneate base and distinct, small, short stipe; color dark brown, young plants usually turning green on drying; gametangia formed by horizontal division of surface cells, 44–50μ long, 4–5μ diam., with uniseriate loculi, all enclosed by a common cuticular layer.

Growing on rocks in the middle and upper littoral belts. Southern California and as far as Ensenada, Lower California.

J. G. Agardh, Analecta Alg., Cont. 3, 1896, p. 26, pl. 1, fig. 5; Saunders, Phyc. Mem., 1898, p. 162, pl. 30, figs. 6, 7; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1593; Okamura, Alg. Japon. Exsicc., no. 86. *Phyllitis Fascia* Okamura, Illus. Mar. Alg. Japan, vol. 1, 1901, pl. 10.

26. **Colpomenia** Derb. and Sol.

Frond solid in the juvenile stage soon becoming hollow, rather thin and membranaceous, whole when young, becoming irregularly, more or less lacerated in age, consisting of two tissues, an inner tissue of large, rounded, nearly colorless, thin-walled cells and a cortical tissue of small, more or less cuboidal, assimilating cells; plurilocular gametangia in early stage of development growing around groups of hair filaments, later spreading over the entire surface of the frond; paraphyses (?) unicellular, clavate, scattered.

Derbès and Solier, Mém. phys. alg., 1856, p. 11.

This is the third genus among the Scytosiphonaceae to show a multitude of variations without sharp distinctions and no less than five forms, varieties, or species have been described and named. The type of the genus is conceived of as nearly a globular plant, thin-walled and while, at times, slightly bullose, at least neither thick-walled nor provided with conspicuously projecting, wart-like or finger-shaped lobes. Nevertheless, such variations occur, especially on our coast, where the variation within the genus seems to have reached its maximum. We have placed all of these species, varieties, and forms under one species, with a series of varieties, much as we have done in the case of *Scytosiphon* and *Ilea*, but these variations, being more pronounced, have been segregated into varieties and forms rather than into forms and subforms. Nevertheless they may be simply environmental effects or "ecads."

Colpomenia sinuosa (Roth) Derb. and Sol.

Plate 45, figs. 82–86

Frond sessile, attached by a broad base, thin and membranaceous, 4–10 cm. diam., filled with water when young, later collapsed and somewhat complanate, spherical to irregular in form, 0.25–0.35 mm. thick; color dark brown; cortical layer of cells consisting of 1–2 rows of cuboidal or polygonal cells, the inner layer of 2–5 rows of larger, more or less rounded cells; plurilocular gametangia 18–22μ long, 5–8μ broad, the loculi frequently in two rows.

Growing on rocks and on other algae in the middle and lower littoral belts. Common along the whole Pacific coast, from Yakutat Bay, Alaska, to southern California.

Derbès and Solier, Mém. phys. alg., 1856, p. 11, pl. 22, figs. 18–20; Saunders, Phyc. Mem., 1898, p. 164, pl. 32, figs. 7, 8, Alg. Harriman Exp., 1901, p. 421; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 242; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 278; Tilden, Amer. Alg. (Exsicc.), no. 522. *Ulva sinuosa* Roth, Cat. Bot., vol. 3, 1806, p. 327, pl. 12.

The type of the species was collected at Cadiz by Mertens and from the figures and what we know of the plants of that region is evidently of the more regularly globular or lobed, thin-walled, more or less smooth form of the species, although the description of Roth might seem to apply to the more thick-walled and rugose form. The typical form is less common on our coast but is found in certain localities. As stated above, it seems best, after a study of all of our west coast material, to consider all of our forms under one species and we have arranged them according to the following key:

1. Fronds thin, membranaceous, surface nearly smooth.. 2
1. Fronds thick, chartaceous, surface bullose or strongly lobed.................................. 3
    2. Fronds approximately globose, very thin and smooth..1. f. **typica** (p. 540)
    2. Fronds elongated or irregular, somewhat thicker and less smooth.............. ....2. f. **expansa** (p. 540)
    2. Fronds expanded to several decimeters, thin but with short, spine-like tubercles...3. f. **expansissima** (p. 541)
3. Fronds sinuose, strongly bullose and tuberculate, but never lobed........................ ....4. var. **tuberculata** (p. 541)
3. Fronds extending into one to several long, finger-like lobes.................................. ....5. var. **deformans** (p. 542)

1. **Colpomenia sinuosa** f. **typica** nom. nov.

The typical form is thin, about 25–30μ thick, fairly regular in form, usually attached at one place to a filamentous alga, and growing, most commonly, in fairly quiet waters. The clusters of hairs are not sunk in the tissue of the frond and the layers of colorless cells are few (usually 2 to 3).

2. **Colpomenia sinuosa** f. **expansa** Saunders

Fronds aggregated forming expansions of indefinite size and shape, 0.35–0.45 mm. thick, inner layers of cells composed of 5–7 rows of cells.

Near Avalon Bay, Santa Catalina Island, California.

Saunders, Phyc. Mem., 1898, p. 164, pl. 32, figs. 4–6; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 825.

The f. *expansa* is a variation of the typical form in which the frond is more ample, less regular in shape, usually creeping over filamentous algae and forming secondary attachments. It has a smooth surface in the sense of not being tuberculate or conspicuously lobed. It is somewhat thicker than the typical form, with the clusters of hairs sunk in tissues. The layers of colorless cells are greater in number than in the typical form (usually 5 to 7).

3. **Colpomenia sinuosa** f. **expansissima** S. and G.

Fronds 3–6 dm. diam., thin, sinuose, with minute, spine-like projections.

Floating in billowy masses in San Francisquito Bay, Lower California.

Setchell and Gardner, Mar. Alg. Gulf of Calif., 1924, p. 726.

This form is probably an extreme of f. *expansa,* but it has only been found floating. It is thinner and less even in outline and surface, but is similar in every other way. The only specimens are sterile and show no hairs.

4. **Colpomenia sinuosa** f. **tuberculata** (Saunders) S. and G.

Fronds sessile, hollow, rigid and somewhat coriaceous, very irregular in shape and size, usually somewhat flattened, 5–10 cm. diam., 1–2 mm. thick; surface much convoluted, wrinkled and folded, at maturity covered with blunt warts or tubercules; color dark brown; cortex of 3–5 rows of cuboidal cells, the inner layer of 5–8 rows of large, irregular, thin-walled cells; plurilocular gametangia 20–25μ long, 3–4μ wide; paraphyses 22μ long, 5μ wide.

Growing on rocks and on other algae, often aggregated in large, brain-like masses, in the middle of the littoral belt. From Unalaska, Alaska, to La Paz, Lower California.

Setchell and Gardner, Alg. N.W. Amer., 1903, p. 242; Howe, Phyc. Stud. V, 1911, p. 495; Setchell and Gardner, Mar. Alg. Gulf of Calif., 1924, p. 725. *Colpomenia tuberculata* Saunders, Phyc. Mem., 1898, p. 164, pl. 32, figs. 1–3; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 826.

The *Colpomenia tuberculata* Saunders is thick-walled, of general globose form, but with the distribution of growth areas interrupted in such a way as to give rise to bullosities and tumor-like warts. Sometimes these swellings develop and fall out, leaving holes or lacunae, a suggestion of the process in *Hydroclathrus clathratus.*

5. **Colpomenia sinuosa f. deformans** S. and G.

Fronds rigid, erect, membranaceous, cavernous, lower part tuberculate in the juvenile state, later developing one or more irregularly cylindrical, sack-like, at times flattened, projections from the upper surface, 1–7 cm. high, surface of frond smooth, somewhat lacerated when aged; color dark brown.

Attached to rocks and to other algae by a broad sessile base, in the lower littoral belt. Ranging from Cook Inlet, Alaska, to the Gulf of California.

Setchell and Gardner, Alg. N.W. Amer., 1903, p. 242, pl. 18, figs. 13–15; Mar. Alg. Gulf of Calif., 1924, p. 726, pl. 19, figs. 61, 62. *Scytosiphon bullosus* Saunders, Phyc. Mem., 1898, p. 163, pl. 31, figs. 1–7, Alg. Harriman Exp., 1901, p. 421; Tilden, Amer. Alg. (Exsicc.), no. 351.

The *Scytosiphon bullosus* Saunders always arises from a sinuous, lobed base which may be so small as to seem almost like a disk, but varies to a *Colpomenia sinuosa* type of considerable size. We have already discussed this elsewhere (1903, p. 243, pl. 18, figs. 13–15). When the long finger-like lobes are reduced to one and the surface is smooth, it is the typical form of Saunders, but more often the long lobes are several and unequal and, at times, all are short. It seems that certain areas grow more rapidly and this differentiation completes the series from the forms of var. *typica* to the extremes of var. *deformans*.

27. **Hydroclathrus** Bory.

Fronds spherical or irregularly ovate, hollow, similar to those of *Colpomenia*, entire when young, at first becoming fenestrate, but broken later into a well formed lattice work, the meshes being variable in shape and size; reproduction by plurilocular gametangia scattered over the whole outer surface of the frond; hairs growing in groups in shallow depressions over the outer surface of the frond.

Bory, *in* Dict. class., vol. 8, 1825, p. 419.

The type and only known species of the genus is *Hydroclathrus clathratus*. The completeness of the perforation of the thallus of the single species of the genus *Hydroclathrus* readily separates it from the various forms of *Colpomenia*, although odd plants of *C. sinuosa* var. *tuberculata* often become considerably, but not regularly, perforated through spotwise localization of growth. The origin of the holes has not been investigated. When first visible, they are very small and it seems likely that they originate through the death, or quiescence, of a cell or small group of cells in the midst of a rapidly growing area, as is the case in some other perforated algae.

Hydroclathrus clathratus (Bory) Howe

Fronds very irregular in form, in age much lacerated, 5–16 cm. diam., sessile, attached to the substratum by a broad base, sometimes several bases confluent, differentiated into two layers of cells; the apertures varying much in size and form and the frond involute along their margins; color yellowish brown; hairs in small tufts in the center of expanded sori.

Growing in tide pools in the lower littoral belt. On the west coast of Mexico near the mouth of the Gulf of California.

Howe, *in* Britton and Millspaugh, Bah. Flor., 1920, p. 590; Setchell and Gardner, Mar. Alg. Gulf of Calif., 1924, p. 727. *Hydroclathrus cancellatus* Bory, *in* Dict. class., vol. 8, 1825, p. 419; Harvey, Phyc. Austral., 1859, Tab. 98; Mitchell, *in* Murray, Phyc. Mem., part 2, 1893, pp. 53–56, pl. 15, figs. 2–4. *Encoelium clathratum* (Bory) Agardh, Sp. Alg., vol. 1, part 2, 1822, p. 412. *Fucus clathratus* Bory, MS., fide Agardh, *loc. cit.*

The single species of *Hydroclathrus* is tropical and widespread in both the Atlantic and the Pacific oceans. Our specimens, from the Gulf of California, are old and we have been unable to detect any gametangia.

FAMILY 11. ÆGIRACEAE FAM. NOV.

Fronds erect, more or less branched, from slightly to decidedly gelatinous; main growth in length trichothallic, with central axes monopodial and cortical axes sympodial, of two or three tissues, (1) medullary of larger and longer colorless longitudinal filaments, easily separable or compact, (2) intermediate of broad but short colorless cells, and (3) cortical of longer or shorter distinct anticlinal filaments, often curved and enlarged upwards; both unilocular zoosporangia and plurilocular gametangia known (in some species at least) and borne on similar (macroscopic) plants.

The family which we have felt constrained to designate as Ægiraceae is to be separated both from the Chordariaceae (in the narrower sense of *Chordaria* as limited by the type *C. flagelliformis*) and from the "Mesogloiaceae" (also in the narrower sense of the genus *Mesogloia*, as limited by the type species of the genus *M. vermiculata*) both because of the method of terminal growth ("trichothallic" as contrasted with "subapical") and because neither in *Chordaria* nor *Mesogloia* (as limited to conform with the type species in each case) are plurilocular gametangia known, while they are known (or reported) in the typical species of *Myriocladia* and *Liebmannia*. There seems to be represented here a distinct group agreeing in characteristics of typical trichothallic apical growth and with very similar macroscopic gametophytes and sporophytes although more exact knowledge of the types of these genera is extremely desirable, since the various statements are perplexing and authentic material difficult (or impossible for us) to obtain. We have made, therefore, an arrangement of our genera and species based on the most certain information available to us. It is to be borne in mind that *Mesogloia* (based strictly on the type of the species) has been removed to the Chordariaceae where it is close to, if not identical with, the genus *Chordaria*. Other species than the type, referred by different authors to *Mesogloia* are referred variously to *Liebmannia*, *Ægira*, *Myriocladia*, *Myriogloia* and *Chordaria*.

Key to the Genera

1. Gametangia arranged unilaterally on the upper portions of the cortical filaments ....28. **Ægira** (p. 544)
1. Gametangia not unilateral, arising from the lower portions of the cortical filaments..29. **Meneghiniella** (p. 548)

28. **Ægira** Fries

Fronds branched, filiform, with trichothallic growth, composed of a medulla of colorless, branched filaments firmly agglutinated, giving rise to short, cortical, assimilating filaments and to basal zoosporangia, or to gametangia unilaterally arranged on their outer extremities or, to both zoosporangia and gametangia.

Fries, Syst. Orbis, 1825, p. 342. *Cladosiphon* Kuetzing, Phyc. Gen., 1843, p. 329. *Castagnea* Derbès and Solier, Sur les organes repr. des algues, 1850, p. 269. *Eudesme*, J. Agardh, Till Alg. Syst. II, 1880, p. 29.

Kuetzing founded the genus *Cladosiphon* (1843, p. 329) on a Mediterranean species, *C. mediterraneus*, which seems definitely, as stated below, to be either the same or most certainly closely related to, the species on which Derbès and Solier founded their *Castagnea*.

J. G. Agardh (1882, p. 40) took up *Cladosiphon* from the point of view of Meneghini's *Liebmannia Posidoniae,* a species seemingly at present, at least, to belong to another genus (*Meneghiniella*) from the type of Kuetzing.

Derbès and Solier founded the genus *Castagnea* on a species they named *C. polycarpa,* presumably from the neighborhood of Marseilles, but the locality is not mentioned. This species has the gametangia produced as outgrowths from the convex sides of the upper cells of the curved cortical filaments and this peculiarity is made a part of the diagnosis of the genus. Derbès and Solier state that their genus *Castagnea* is readily distinguishable from the related genera *Liebmannia, Stilophora,* and *Nereia* by the form of the filaments associated with the organs of fructification in that they are cylindrical and not terminated by large swollen cells. *Castagnea polycarpa* Derbès and Solier has been variously and usually doubtfully referred by later writers and we have found no reference to the existence of an authentic specimen. Derbès and Solier compare its appearance to that of a stunted *Liebmannia.* In their later (?) paper, Derbès and Solier (Sur les organes repr. des algues, 1850, p. 269, pl. 33, figs. 12, 13) seem inclined to consider their *C. polycarpa* closely related to, if not identical with, the "*Cladosiphon fistulosum*" of Kuetzing, a binomial unknown to us, but presumably the *Mesogloia fistulosa* Zanard. (*in* Meneghini, 1843, p. 292) and considered by Kuetzing (1849, p. 547) to be a synonym of his *Cladosiphon mediterraneus.* There is certainly suspicion here that *Castagnea* and *Cladosiphon* may have been founded on the same type species. In the absence of that exact proof which is difficult to obtain other than from type specimens and experience from type localities, we feel justified in considering these two genera as identical in foundation. We may call attention to the fact that Bornet (1892, p. 236) has placed the *Cladosiphon mediterraneus* Kuetzing under *Castagnea.*

The genus *Eudesme* was founded by J. G. Agardh (1882, p. 29) on the *Mesogloia virescens* Carmichael, i.e., at least technically. There is good reason to believe that Agardh did not restrict his ideas to type, but had a composite idea as to the nature of his *E. virescens.* He speaks of an "axis solidescens" whereas *Eudesme* has been applied as typically including species whose axial filaments are readily separable from one another (cf. Kjellman, 1893, pp. 225, 226) and as they are, to a certain extent at least, in what may be considered to be typical *E. virescens,* viz., Alg. Danm., no. 49; but even here there is a definite pseudoparenchymatous axis (cf. also Harvey, Phyc. Brit., pl. 82, 1847). Agardh also emphasizes in his generic diagnosis the formation of gametangia as projecting ramelli arising from the upper cells of the cortical filaments. The illustrations of Thuret (1850, pl. 27) show exactly the type of cortical filaments and gametangial formation upon which, as distinctive characters, Derbès and Solier founded their genus. So far as we are able to discover, the three genera, *Castagnea, Cladosiphon*, and *Eudesme* are to be united and, since *Cladosiphon* is the earliest name, unless we adopt *Ægira* Fries of doubtful status, we might feel compelled to use *Cladosiphon* as the name of the genus to which we may assign species usually referred to *Castagnea* or to *Eudesme*. *Cladosiphon,* as we understand Kuetzing's type species, *Cl. mediterraneus* (*Mesogloia fistulosa* Menegh., *Castagnea fistulosa* (Menegh.) Derb. and Sol., *C. polycarpa* Derb. and Sol. and *Castagnea mediterranea* (Kuetz.) Bornet) is however, usually understood in the sense of J. G. Agardh (1882, pp. 40 and 42). J. G. Agardh, on the other hand, based his idea of *Cladosiphon* on *Liebmannia Posidoniae* Meneghini (1843, pp. 300–304, pl. 5, fig. 1) which has its gametangia situated very differently from those of the members of the *Cladosiphon-Castagnea-Eudesme* complex. Meneghini's species seems to have the gametangia arising as transformed branches of the cortical filaments and slender, with uniseriate loculi, not pronouncedly siliquaeform as in *Liebmannia* and not arising unilaterally from the upper cells of the cortical filaments as in the complex we are discussing. We have one species, from the Gulf of California, seemingly cogeneric with Meneghini's *Liebmannia Posidoniae* for which we have proposed the generic name *Meneghiniella* (Phyc. Cont. VII, 1924, p. 5).

It remains to consider the oldest name possible for this *Cladosiphon-Castagnea-Eudesme* complex and that is *Ægira* Fries (1825, p. 342). Fries founded his genus on the *Linckia Zosterae* Lyngbye (1819, p. 194, pl. 66, fig. C) which may or may not be the *Rivularia Zosterae* Weber and Mohr (1810, p. 367). The plant of Lyngbye has been variously interpreted by J. G. Agardh (1848, p. 53) and Areschoug, who had an authentic specimen for comparison (Areschoug, Alg. Scand. Exsicc., ser. 1, no. 67, and 1842, pp. 228–230). The evidence is well discussed by Kylin (1907, pp. 85–87). While there may be reasonable doubt as to whether Lyngbye's plant is the same as *Eudesme virescens* (Carm.) J. Agardh, or *Eudesme Zosterae* (J. Ag.) Kylin, it is to be placed in the *Cladosiphon-Castagnea-Eudesme* complex which ought, therefore, to take the name *Ægira* (cf. also, M. A. Howe, 1918, p. 505).

Since the foregoing was written, we have been allowed, through the kindness of Professor C. H. Ostenfeld, to examine one of Lyngbye's specimens of *Linckia Zosterae.* It is clearly very closely related to *Eudesme virescens* as we understand it. We, therefore, feel justified in assuming that *Ægira* is synonymous with *Eudesme.*

Ægira virescens (Carm.) S. and G.

Plate 42, figs. 59, 60

Fronds very flaccid and gelatinous, 8–20 cm. (up to 45 cm.) high; branches arising from the main frond at wide angles, numerous, variable in length, usually enlarging above, blunt; the ultimate ramuli short, arising almost at right angles; medullary filaments few to many very loosely bound together, composed of cells very variable in size even in the same filament, up to 55μ diam., 1.5–2.5 times as long as the diameter, constricted at the cross-walls, with numerous, small, disk-shaped chromatophores, giving rise to longer or shorter lateral, colorless, branched filaments bearing in turn the loose fascicles of free, branched, assimilating filaments, zoosporangia, and long colorless hairs, the latter terminating the colorless branches; cortical assimilating filaments slender, branched, tapering slightly at the apices, terminal ramuli 10–15 cells long, fascicled, arcuate, cells cylindrical below, becoming slightly moniliform above, 15–20μ diam.; hairs numerous, long, terminating the lateral branchlets from the medullary filaments; zoosporangia broadly ellipsoidal, short cylindrical, obovate to rhombic-ovate, arising near the outer ends of the colorless lateral filaments, 70–90μ (up to 120μ) long, 25–65μ broad; gametangia short, lateral and seriate, secund on the cortical filaments.

Growing on rocks and on eel grass in the littoral and sublittoral belts. Shumagin Islands to Sitka, Alaska.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 11. *Eudesme virescens* Saunders, Alg. Harriman Exp., 1901, p. 423 (?); Setchell and Gardner, Alg. N.W. Amer., 1903, p. 249. *Liebmannia* sp. Saunders, *loc. cit.*, p. 424, pl. 49 (?). *Mesogloia virescens* Carmichael, *in* Hooker, Engl. Fl., vol. 2, 1833, p. 387.

While we suspect that the plant referred by Saunders to *Eudesme virescens* and so referred to by us in our Algae of Northwestern America (*loc. cit.*), may be the same species as that collected by one of us at Sitka, we have not been able to examine a specimen to make certain. Our plants show no gametangia but have zoosporangia and the vegetative structure of *Eudesme* J. Ag. A careful comparison of *Wyatt's Mesogloia virescens*, no. 49 (Alg. Danm.) with our various specimens shows so much variation in dimension of zoosporangia and peripheral filaments that we feel nearly safe in referring all to the European species which we refer, for reasons given above, to *Ægira*.

29. **Meneghiniella** S. and G.

Fronds cylindrical, more or less profusely branched, flaccid and lubricous, with growth trichothallic; medulla composed of numerous colorless filaments compactly coalescing, giving rise to an abundance of short, usually arcuate, color bearing, cortical filaments, whose lower branches are transformed into linear, plurilocular gametangia, with nearly uniseriate loculi, and usually more or less fasciculate; zoosporangia uncertain.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 5. *Cladosiphon* J. Agardh, Till Alg. Syst., II, 1882, p. 40 (not of Kuetzing).

The genus described above is founded on a plant growing in the Gulf of California. It seems, however, that our type must be cogeneric with the *Liebmannia Posidoniae* Meneghini, whose type locality is Naples and which was selected by J. G. Agardh as typical of Kuetzing's genus *Cladosiphon*. We have shown above the results of our attempt to determine the type of *Ægira*, which have led us to the conclusion that the genus, as founded by Fries, includes the later genera published under the names of *Cladosiphon, Castagnea*, and *Eudesme*. Our plants seem to be typically trichothallic and have longer or shorter, slender, linear gametangia, which are, at times, very slightly swollen at, or about, the middle. The gametangia arise near the base of the cortical filaments and are more or less fasciculate. As we interpret Meneghini's figures of *Liebmannia Posidoniae* (1843, pl. 5, fig. 1), he has represented the gametangia on the upper side of figure *b* and also in figure *c*. A confusion is introduced, however, in his representation of the contracted contents of the swollen terminal cells of the cortical filaments (figs. *b*, *d*, *e*, and *f*) by which they are made to seem to agree with the gametangia of *Liebmannia Levillei* J. Ag. The figures of J. G. Agardh (1882, pl. 2, figs. 3*a*, 3*b*) represent the cortical filaments with their swollen terminal cells and their gametangia of his *Cladosiphon zostericola* of Australia which seems clearly to be referred to *Meneghiniella*. The genus *Meneghiniella*, in our estimation, included *M. Brandegeei* S. and G. (type), *M. Posidoniae*

(Menegh.) S. and G. (*Liebmannia Posidoniae* Meneghini, 1843, p. 300, pl. 5, fig. 1), *M. zostericola* (J. Ag.) S. and G. (*Cladosiphon zostericola* J. G. Agardh, 1882, p. 43, pl. 2, figs. 3*a*, 3*b*), and possibly *M. erythraea* (J. Ag.) S. and G. (*Cladosiphon erythraeum* J. G. Agardh, 1848, p. 55).

Meneghiniella Brandegeei S. and G.

Plate 47, fig. 11, and plate 49, fig. 16

Fronds very slender, soft and flabby, 8–16 cm. high, up to 600μ diam., irregularly and alternately branched, with branches coming off at wide angles; medullary filaments composed of large thin-walled, colorless cells up to 100μ diam. and several times longer than the diameter, firmly agglutinated, becoming much smaller toward the periphery; cortical assimilating filaments simple, clavate, free, not compact, more or less arcuate, composed of 7–12 moniliform cells; gametangia fasciculate with uniseriate loculi for the most part, 40–50μ long, 7–10μ diam.; zoosporangia and hairs unknown.

Habitat unknown. La Paz, Lower California.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 5.

The specimens on which this species, as well as the genus, are founded are not as representative as could be desired, but the characters are plain both as to the structure of the frond and the shape, position, and the structure of the gametangia which can clearly be determined. The tips of the filaments indicate trichothallic growth.

FAMILY 12. HETEROCHORDARIACEAE FAM. NOV.

Main fronds erect, with main axis and lateral branches of limited growth; growth in length subapical as in the Chordariaceae; axes of three tissues: (1) medullary or central of elongated parallel, colorless cells; (2) intermediate of shorter colorless cells, and (3) cortical of short, anticlinal rows of colored cells, the distal cell being more or less swollen; zoosporangia and gametangia on full-sized, similar plants.

It seems something like violent procedure to separate this family from the Chordariaceae, but the presence of full-sized gametangial plants in this family and the lack of any such plants among the Chordariaceae (as limited by us) is certainly significant, in view of the more recent indications as to the relative characteristics of the gametophyte and sporophyte among the Melanophyceae.

30. **Heterochordaria** S. and G.

Main fronds cylindrical, at first solid, later becoming hollow and at times slightly swollen, not forked but densely clothed on all sides with longer or shorter, subcylindrical or slightly flattened, ramuli, few to many arising from a thin prostrate, profusely branched or lobed, parenchymatous thallus firmly adhering to rocks; interior of fronds composed of thick-walled, colorless, parenchymatous cells surrounded by small color bearing surface cells in anticlinal rows; zoosporangia situated among numerous paraphyses and scattered hairs; gametangia arising through the transformation of approximately the lower two-thirds of the cortical filaments.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 6.

The finding of both zoosporangia and gametangia on macroscopic plants of *Chordaria abietina* Rupr., and the finding only of zoosporangia on the well known *Chordaria flagelliformis* (Muell.) Ag. indicates the extremely strong probability of a fundamental difference between *C. abietina* and *C. flagelliformis* as to the character of the gametophyte. In view of our present attitude as to the bearing of such a difference on the taxonomic position of the two plants, it seems desirable to make *C. abietina* the type of a new genus and a new family of the Ectocarpales and to place *C. flagelliformis* and its allies of the Chordariaceae (in restricted sense) in another order, the Chordariales and near to the Dictyosiphonales to which they (the Chordariaceae as we restrict them) seem fairly closely related.

There may be associated with this family, another genus, or even two, viz., *Ruprechtiella* Yendo (Trav. Mus. Bot. de l'Acad. Imp. Sci. St. Petersb., vol. 10, 1913, p. 117) which may be the same as *Analipus* Kjellm., and the *Chordaria Gunjii* Yendo (Nyt. Mag. Naturvidensk., vol. 51, 1913, p. 280) which may simply be the gametangial form of some species of *Myelophycus*.

Heterochordaria abietina (Rupr.) S. and G.

Plate 36, figs. 18, 19, and plate 91

Erect fronds, 10–30 cm. high, flaccid, gregarious, many arising from a single, widespreading, profusely branched, parenchymatous horizontal thallus; main axis slightly compressed above, terete below, thickly beset on all sides with radiating ramuli 1–5 cm. long, tapering at both ends, cylindrical to narrowly linear, both main axis and ramuli solid when young, becoming more or less fistulose when old; color dark olive brown; erect fronds annual, base perennial; zoosporangia ellipsoidal to obovoid, numerous, sessile on the parenchymatous cells or at times lateral near the base of the paraphyses, 50–60μ long, 30–40μ broad, paraphyses numerous, clavate, 70–85μ long, terminal cell much enlarged, pyriform to spherical; gametangia very compact, covering the whole surface of the ramuli, without paraphyses or hairs, pluriseriate, terminating in a 2–3-celled, sterile, usually clavate tip; plants dioecious.

Common on rocks in the middle and lower littoral belts. Ranging from St. Lawrence Island in the Bering Sea to central California (near Point Conception).

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 6. *Chordaria abietina* Ruprecht, MS. *in* Farlow, List Mar. Alg. U. S., 1876, p. 357; J. Agardh, Till Alg. Syst., part 2, 1882, p. 74, pl. 3, figs. 2*a*, 2*b*; Saunders, Alg. Harriman Exp., 1901, p. 424; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 251, pl. 18, figs. 16, 17; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 281; Tilden, Amer. Alg. (Exsicc.), no. 348; Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 94.

Heterochordaria abietina (Rupr.) S. and G. is one of the very frequently occurring algae of western North America from Point Conception in California northwards. It has two striking peculiarities, viz., the possession of a well developed horizontal thallus from which the erect fronds arise and also of the gametophyte of the same size as the sporophyte. The horizontal thallus is often a fair sized and reasonably conspicuous structure, at times several centimeters in diameter, spreading at the periphery and consisting of overlapping narrow, blunt and emarginate lobes. From certain appearances, it seems possible that it may be perennial. In the sporophyte, the zoosporangia seem to be confined to the ramuli, and this seems to be the case also with the gametangia of the gametophyte which have not been seen to occur on the main axis. J. G. Agardh (1882, p. 74, pl. 3, figs. 2*a*, 2*b*) has figured and described the gametangia and Okamura (1910, p. 122, pl. 85, figs. 14, 15) has figured and described both the zoosporangia and the gametangia. We have previously (1903, pp. 251, 252, pl. 18, figs. 16, 17) figured and described the horizontal thallus.

FAMILY 13. CHNOOSPORACEAE FAM. NOV.

Fronds elongated, solid, slender, more or less compressed, more or less regularly dichotomous or proliferous from the margins, growth subapical, not trichothallic, of two sets of tissues, an inner of large cells, an outer of one or more layers of small colored cells in short anticlinal rows; hairs in clusters arising from the bottoms of shallow pits ("cryptostomata"); zoosporangia unknown; gametangia uniseriate, arising about the clusters of hairs and spreading over the surface, at times into confluent sori.

The genus *Chnoospora* is usually ranked as of uncertain position ("incertae sedis"), but by some placed in the Encoeliaceae, a family now abandoned and with its members distributed and separated. In its sori, surrounding the hair clusters, it resembles closely those of *Colpomenia*, but in habit and terminal growth it is very different from that genus and its near relatives. The frond is not directly to be compared with that of any brown alga at present known to us. The slender, compressed and regularly dichotomous frond at once sets it apart. The subapical method of terminal growth relates it more nearly to *Heterochordaria*, but *Chnoospora* is known only with gametangia as are the members of the Scytosiphonaceae. The method of subterminal growth is like that of the genus *Stilophora*, but it is very different from that genus in not having free cortical filaments. *Chnoospora* may be considered to be a further development of the cylindrical Scytosiphonaceae, with the loss of the terminal hair and the growth in length localized. It certainly seems best, at present, to place *Chnoospora* in a family of its own.

The structure and the fructification were first described by Ethel Sara Barton (1897). Börgesen (1924, p. 264) calls attention to the resemblance of the growth point to those of *Scytothamnus australis* and *Coilodesme bulligera*. Both of these plants probably are to be referred to the Chordariales since they possess only zoosporangia of a distinct unilocular type and it is to be suspected that they have microscopic gametophytes.

31. **Chnoospora** J. Ag.

Fronds cylindrico-compressed, solid, ecostate, profusely branched, attached by a solid holdfast; branching dichotomous, fastigiate; fronds differentiated into two tissues, the center of larger, colorless prismatic cells, elongated longitudinally, surrounded by two layers of small cells containing the endochrome; reproduction by plurilocular gametangia surrounding depressions containing tufts of extruding hairs, and, by extension at times, nearly covering the fronds.

J. G. Agardh, Nya Alg., 1847, p. 7.

The type species of the genus is *C. pacifica* from St. Augustin, Mexico, listed later by J. G. Agardh as *C. fastigiata* var. *pacifica*. *Chnoospora* is the only genus we feel inclined to refer to the family Chnoosporaceae, for the reasons given above in discussing the family.

Chnoospora pacifica J. Ag.

Fronds densely caespitose, many arising from a solid disk-shaped holdfast, of the same diameter throughout except at the slightly attenuated apices, 2.5–7.5 cm. high, 2 mm. wide, 1 mm. thick; branches forming acute angles.

J. G. Agardh, Nya Alg., 1847, p. 7; Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 728. *Chnoospora fastigiata* var. *pacifica* J. G. Agardh, Sp. Alg., 1848, pp. 171, 172. Barton, On the fruit of *Chnoospora fastigiata*, 1898*a*, p. 507. *Sargassum piluliferum* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 537*b*.

The material upon which this species, as well as the genus, was founded was collected by Professor F. M. Liebmann at St. Augustin, in the southern portion of the state of Oaxaca, on the Pacific coast of Mexico. This is a tropical locality and the *Chnoospora* was accompanied by several other marine algae described also in the same paper. J. G. Agardh also described a species of *Chnoospora,* at the same time, from La Guayra on the Caribbean Sea which he named *C. atlantica.* In 1848, he united these two species as varieties under a new name, *C. fastigiata.* The name *C. pacifica* has the rights of priority and we have retained it. It seems widespread in the Pacific and Indian oceans, although possibly appearing in a number of forms. It seems likely that *C. pannosa* J. G. Agardh, from Hawaii, is simply a pannose growth form of *C. pacifica. C. atlantica* J. Ag. from the Caribbean has the fronds dilated under the axils and may be a distinct species. *C. implexa* Hering is doubtful and may very possibly prove to be of quite a different genus, but there are forms of our own coast species approaching it in habit.

Order 3. DESMARESTIALES ord. nov.

Frond erect, filamentous or membranaceous, cylindrical to slightly compressed, ligulate or even broadly membranaceous; growth terminal, trichothallic; frond clothed with densely crowded exserted, simple or branched, colored, monosiphonous filaments (hairs) when young or in the growing portion, these filaments early or tardily deciduous as age advances; tissues several; reproduction by zoosporangia; gametangia unknown, probably borne on a microscopic gametophyte.

The possession of longer or shorter, exserted, colored, monosiphonous filaments, especially on young plants or younger portions of perennial plants, has always been considered as characteristic of *Desmarestia* and the related genus *Arthrocladia*. It also is characteristic of the later described and very nearly related genus *Phaeurus* Skottsb. There have been several other algae with this permanent or partially transient covering of colored monosiphonous filaments, viz.: *Mesogloia Andersonii* Farlow, *Myriocladia Sciurus* Harv., *M. Chorda* J. Ag., *M. grandis* Howe, *M. callitricha* Rosenv., *M. Kuromo* Yendo, and possibly *M. capensis* J. Ag. and *Mesogloia natalensis* Kuetz. The first two seem to have been investigated by Kuckuck, who did not live to publish his results, but some of his notes and sketches were used by Oltmanns (1922, pp. 19–22). From these we learn that Kuckuck had assigned *Mesogloia Andersonii* Farlow (at least in part) and *Myriocladia Sciurus Harv.* to a new genus "*Myriogloea*" and had proposed for these a distinct family, presumably named Myriogloiaceae. Reserving the discussion of the different species until later, we may state that it seems best to adopt Myriogloiaceae, as of Kuckuck and assign it to our newly established order Desmarestiales, since the terminal growth is most typically trichothallic exserted hairs are prominent, monosiphonous and colored, and the reproduction is typically only by zoosporangia.

Key to the Families

1. Cortical filaments free .... 14. **Myriogloiaceae** (p. 555)
1. Cortical filaments coalescent into a tissue .... 15. **Desmarestiaceae** (p. 558)

FAMILY 14. MYRIOGLOIACEAE KUCKUCK

Fronds filamentous, erect, cylindrical, solid or later tubulose, central strands of large colorless cells, peripheral of two sorts, free, short, cortical filaments with rounded terminal cell and exserted monosiphonous filaments, with basal meristematic cells and outer cells provided with phaeoplasts and, consequently colored; colorless hairs absent; terminal growth conspicuously trichothallic; zoosporangia arising at the base of the cortical filaments, unilocular; gametangia unknown.

Kuckuck, *in* Oltmanns, Morph. und Biol. der Algen, ed. 2, vol. 2, 1922, p. 19 (by implication). Myriogloeeae Oltmanns, *loc. cit.*

The family thus far is credited with a single genus, *Myriogloia*, although it is far from certain that *Mesogloia Andersonii* Farlow is cogeneric with *Myriocladia Sciurus* Harv., as a glance at Kuckuck's figures (*loc. cit.*, p. 22, fig. 312, 1 and 2) will indicate. The very robust plants assigned to *Myriocladia Sciurus* Harv., *M. Chorda* J. Ag., and *M. grandis* Howe may, or may not, belong to the same genus as *Mesogloia Andersonii* Farlow and *Myriocladia callitricha* Rosenv. We feel reasonably certain in referring the two last species to *Myriogloia*, which is absolutely distinct from *Myriocladia* J. Ag., as typified by *M. Lovenii* J. Ag., designated type of the genus, at least if one credits Kuckuck's sketches (cf. Oltmanns, 1922, p. 37, fig. 328 and p. 38, fig. 329) as having been drawn from correctly determined specimens. Influenced by these sketches and the various descriptions (notably that of Kylin, 1907, pp. 88–90, fig. 21), we are inclined to refer *Myriocladia* J. Ag., as limited to *M. Lovenii*, to the Myriogloiaceae as here established, as a second genus, distinguished by having its axis made up of a single longitudinal and persistent cell row (monosiphonous axis), whereas in *Myriogloia* this condition is soon lost, the frond becoming polysiphonous or hollow below, and in the thicker species (*Myriocladia Sciurus*, *M. Chorda*, and *M. grandis*) the medullary portion is probably polysiphonous from the first (cf. Kuckuck's figure 312, 2, on p. 22 of Oltmanns, 1922) and remains solid. So far as our opportunities are concerned, there is insufficient material to follow out a detailed investigation and we cannot proceed farther than the above suggestions. Oltmanns, however, keeps *Myriocladia* (1922, p. 34) distinct and establishes a special tribe, Myriocladieae, for it under the family Spermatochnaceae. *Spermatochnus*, however, has a distinct apical cell.

32. **Myriogloia** Kuck.

Fronds cylindrical, more or less profusely branched, flaccid and lubricous, with distinct trichothallic growth; medulla composed of numerous colorless, equally large filaments slightly coalescent, giving rise to numerous, narrow, long descending filaments and to an abundance of short, straight or uncinate, cortical, colored filaments and long, exserted, hair-like, assimilating filaments with cells densely congested with chromatophores; reproduction in macroscopic plants by zoosporangia borne among the cortical filaments.

Kuckuck, MS (fide, Oltmanns, Morph. und Biol. der Algen, 1922, p. 19 *et seq.*).

We have already explained the situation in regard to this genus and its position. It is closely related to *Myriocladia* but lacks the distinct and persistent monosiphonous axial filament. Its relation to the southern hemisphere Pacific species of *Myriocladia* is to be considered, with the strong possibility that, upon careful study, they may be segregated generically. *Myriogloia,* in restricted sense, probably includes three species: *M. Andersonii* (Farlow) Kuckuck (*Mesogloia Andersonii* Farlow, Report U. S. Fish Comm. 1876, p. 715), *M. callitricha* (Rosenvinge) S. and G. (*Myriocladia callitricha* Rosenvinge, Grönl. Havalger, 1893, p. 855), and *M. capensis* (J. Ag.) S. and G. (*Myriocladia capensis* J. G. Agardh, Spec. Alg. vol. I, 1848, p. 54). If the *Mesogloia natalensis* Kuetzing is to be united with the last, the gametangia (?) depicted in Kuetzing's figure (Tab. Phyc., vol. 8, pl. 10, fig. II, *e*), if they really occur in the plant described and figured, call into question our disposition of this entire family.

Myriogloia Andersonii (Farlow) Kuck.

Plate 47, figs. 8–10, plate 48, figs. 12–14, plate 49, fig. 17, and plate 76

Frond very gelatinous, solitary or gregarious, cylindrical, 8–30 cm. (up to 50 cm. high), 1–3 mm. diam., profusely branched; branches mostly alternate, long and filiform, very slightly attenuated at the extremities, when young beset on all sides with relatively long, monosiphonous, conspicuous filaments with band-shaped chromatophores, disappearing when older; color dark olive brown; cortical filaments moniliform, mostly uncinate, 6–9 celled, upper cells enlarged; unilocular zoosporangia developing at the base of the cortical filaments, uniformly distributed over the frond, pyriform, 36–45μ long, 18–21μ broad.

Growing on rocks in the lower littoral and upper sublittoral belts, or in tide pools higher up. The present known range is from Sitka, Alaska, to San Diego, California.

Kuckuck, *loc. cit.* *Mesogloia Andersonii* Farlow, New Alg. U. S., 1889, p. 9, pl. 87, fig. 2; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 250; Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 163; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 925. *Chordaria flagelliformis* Tilden, Amer. Alg. (Exsicc.), no. 349.

Much variation in the size of plants of *Myriogloia Andersonii* has been noted in collections from different localities. Tilden's plant (*loc. cit.*) is only about seven centimeters long and quite slender. No. 163 of Farlow, Anderson and Eaton (*loc. cit.*) is a young plant with abundance of hair filaments and is about twenty-five centimeters long. No. 925 of Collins, Holden and Setchell (*loc. cit.*) is an older plant, more robust throughout, about twenty centimeters long. Plants from Point Arena, California, in the Herbarium of the University of California, measure about fifty centimeters long. Likewise variations in the size of the mature zoosporangia are very noticeable, some collections having them twice as long as those in others. The specimens distributed by Farlow, no. 163, 1881, are entirely clothed with brown exserted filaments. Farlow, however, in his description (1889, p. 9) states that it was supposed that all the specimens distributed were fertile and speaking of projecting filaments says: "In my specimens preserved in alcohol, they are not to be seen." We have been able to examine the alcoholic specimens referred to and find some, although scanty, exserted filaments. We find specimens of all conditions from being densely clothed with hairs to those with very few, but none in which they are entirely absent. We have tried to find out whether these various forms may be separated by any other characters than frequence or scarcity of exserted filaments, but can find none applying satisfactorily. We have, therefore, placed all of our Pacific coast material under the one species. Judging from what Oltmanns states from the imperfect notes in his possession, Kuckuck has two entities from the *Mesogloia Andersonii* Farlow, viz., *Myriogloia Andersonii*, as stated above, and *Chordaria Andersonii* (cf. Oltmanns, 1922, pp. 20 and 23, fig. 313, 4). Of the latter, we have no further knowledge, although Oltmanns says "*Chordaria Andersonii* Kuckuck mscr. (*Mesogloia Andersonii* Farlow)." There is nothing in Farlow's material, either dried or in alcohol, which corresponds in methods of growth to Kuckuck's figure.

Family 15. DESMARESTIACEAE Kjellm.

Fronds erect, sparsely branched in some species, profusely branched in others, from cylindrical through compressed to broadly membranaceous, solid, arising from a simple monosiphonous branched filament of trichothallic growth in length, soon becoming complex through the downward growth of closely applied branching corticating filaments which results in the production of several distinct tissues; central monosiphonous and branching filament remaining distinct, although, at times, becoming obscured through thylose growth filling the cavities of the large cells; tissues outside the central monosiphonous axis, various, usually large celled and more or less regular, the outer being smaller and forming a distinct outer tissue of one, or few, layers of cells; zoosporangia known in only a few species scattered or in small patches, arising by direct transformation of the outer cells; plants mostly undergoing change of color (to verdigris green) and odor ("sharp") soon after being removed from the water and exercising a bleaching effect on other algae with which they come into contact.

Kjellman, Enum. Pl. Scand., 1880, p. 10, Alg. Arctic Sea, 1883, p. 261.

The Desmarestiaceae form a very distinct group and one which is readily separable from that of the Myriogloiaceae. It represents a very distinct type of frond development, at least so far as the final product is concerned. There are two centers of distribution, viz., North Atlantic and North Pacific as contrasted with the Antarctic and Subantarctic regions, and it is doubtful whether there are any species common to the two centers.

There are, at present, referred to the Desmarestiaceae three genera, *Desmarestia,* the type genus, *Arthrocladia,* by some referred to a separate family, and the *Phaeurus* of Skottsberg. The first is from both Arctic and Anarctic centers, the second is North Atlantic (European and American) while *Phaeurus* is from Fuegia. While the Myriogloiaceae are seemingly the more primitive and related to such forms as Ægiraceae, the Desmarestiaceae are more complex, at least, with *Phaeurus* as the more simple and the ligulate *Desmarestias* as the more complex.

33. **Desmarestia** Lamour.

Fronds attached by a solid, parenchymatous disk, exceedingly variable in size, with a longer or shorter, usually cylindrical stipe, more or less profusely branched, wholly or in part terete or slightly flattened or decidedly complanate and ligulate to broadly expanded and membranaceous, with or without a midrib; branching distichous and either wholly opposite or alternate, or both opposite and alternate; fronds composed of a single fundamental axial filament of cylindrical cells and more or less profusely branched, colored and projecting beyond the surface at the apices and along the margin and in the juvenile stage, early deciduous, with trichothallic growth, surrounded in the frond by one or more layers of large colorless cells enclosed by a cortical tissue of small assimilating cells; reproduction by zoosporangia composed of slightly transformed surface cells, inconspicuous.

Lamouroux, Essai, 1813, p. 23.

The genus *Desmarestia* may be divided into three groups, sometimes reckoned as distinct genera, or at least it may be divided into two genera. The cylindrical or at most only slightly flattened species with mostly opposite branching, constitute *Dichloria*, while the flattened forms are retained under the name of *Desmarestia*, or the subgenus *Eudesmarestia*, with branching mostly alternate. The *Dichloria* group has the hairs scattered as in *Phaeurus*, but unlike that genus, soon loses them. In the *Eudesmarestia* group, the hairs are branched and are the very tips of incipient branches, some, or even many, of which do not develop into permanent structures. In *Phaeurus* the hairs are scattered, but are more permanent and persistent for a longer time than in the *Dichloria* group. In *Arthrocladia*, the hairs are in whorls, branched, persistent, and possibly represent the tips of incipient branches. One well-known characteristic of the species of *Desmarestia* may well be emphasized and that is their habit of turning verdigris green on drying. This color is associated also with their power to bleach other algae in contact with them. The change of color is followed, sooner or later, by decomposition. This happens quickly in the more slender species of the *Virides*-section and fairly early in the members of the *Herbaceae*-section, but affects only the younger and more delicate portions of the members of the *Aculeatae*-section.

The genus *Desmarestia* is well represented on the Pacific coast of North America, extending in its various species from the Bering Sea on the north to Santa Catalina Island off the coast of southern California on the south, so far as is known of its distribution at present. The species of both the ligulate and the filiform groups manifest a degree of variability which has up to date made it exceedingly difficult to determine specific limits. It is evident from the relatively good supply of herbarium material at our disposal, that more than mere superficial resemblances must be resorted to in order to make a satisfactory disposition of the group. Knowledge of the entire life-history is highly essential. Little is known of reproduction. The character of the hairs, present only in the early stages of growth—absent in most of our herbarium specimens—is, so far as our experience shows, of marked constancy and would doubtless be of decided assistance in classification. The histological structure, very difficult to restore after the material has once been thoroughly dried, certainly will prove of decided value in establishing specific entities when studied in fresh material.

We have made use of all of these different phases as far as the material and time at our disposal permits and have come to the following conclusions regarding the number, arrangement, and distribution of the Pacific coast species.

Key to the Species

1. Fronds filiform and either terete or compressed 2
1. Fronds ligulate or membranaceous (Herbaceae) 6
    2. Fronds terete or in part subterete, branching mostly opposite (Virides) 3
    2. Fronds compressed or subterete below, branching mostly alternate (Aculeatae) 5
3. Fronds profusely branched; tylloses few or wanting 4
3. Fronds moderately branched; tylloses filling central tube to near tip .... 3. **D. farcta** (p. 562)
    4. Branches long, attenuated, successive orders gradually reduced in size .... 1. **D. media** (p. 561)
    4. Branches slightly attenuated, blunt, successive orders abruptly changing to smaller size .... 2. **D. pacifica** (p. 562)
5. Fronds up to 15 dm. high and 3 mm. wide, with aculeate margins, moderately branched .... 4. **D. latifrons** (p. 563)
5. Fronds up to 7 dm. high and 1.5 mm. wide, with smooth margins and profusely branched .... 5. **D. intermedia** (p. 564)
    6. Fronds unbranched or with a few short branches at the base .... 10. **D. foliacea** (p. 569)
    6. Fronds regularly branched 7
7. Fronds membranaceous, up to 1 m. wide .... 9. **D. latissima** (p. 568)
7. Fronds ligulate, up to 1 dm. wide 8
    8. Fronds more than 3 m long with prominent aculeae along the margins .... 8. **D. munda** (p. 567)
    8. Fronds less than 3 m. long, smooth or with fine aculeae along the margins .. 9

9. Fronds up to 8 dm. high, 6–8 mm. wide, without distinct lateral veins, stipe cylindrical, 3–4 mm. diam. .... 6. **D. ligulata** (p. 566)
9. Fronds up to 2.5 m. high and 2 cm. wide, with distinct lateral veins, stipe flattened and short .... 7. **D. herbacea** (p. 566)

Section 1. Virides

Desmarestia, subgen. **Dichloria** (Grev.) DeToni.

Fronds cylindrical or only very slightly compressed; branching mainly opposite.

DeToni, Syll. Alg., vol. 3, 1895, p. 456. *Dichloria* Greville, Alg. Brit., 1830, p. 39.

1. **Desmarestia media** (Ag.) Grev.

Fronds cylindrical, considerably cartilaginous, branching very profusely and opposite throughout; color dark brown, nearly black on drying; branches of 5–6 orders, each successive order gradually reduced in size, composed of an axial row of relatively large cells surrounded by 2–3 layers of large, more or less irregular, elongated cells surrounded in turn by a single palisade layer of cortical assimilating cells, the terminal ramuli long-attenuate and acute.

Growing on rocks in the upper sublittoral belt. Unalaska, Alaska.

Greville, Alg. Brit., 1830, p. xl; Pease, P. S. M. S. Publ., vol. 1, 1917, p. 386. *Desmarestia aculeata* f. *media* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 246; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1036. *Sporochnus medius* Agardh, Sp. Alg., vol. 1, 1820, p. 153, Icones Alg. Ined., 1821, pl. 16. *Desmarestia viridis* Saunders, Alg. Harriman Exped. 1901, p. 422 (?).

Desmarestia media var. **tenuis** S. and G.

Fronds cylindrical and with opposite branching throughout, very profusely branched, 3–4 dm. high, stipe 2–3 mm. diam., ultimate ramuli very slender and flaccid, 200–250μ diam.; axial filament of the fronds very large, 100–125μ diam., surrounded by a single layer of large, colorless cells between the axial filament and the small cortical cells.

Growing on stones, etc., in the upper sublittoral belt. Alaska (Juneau) to Puget Sound, Washington.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 7.

There has been considerable confusion as to this species which was described by C. A. Agardh from specimens said to have been collected at Unalaska by Chamisso. Our specimens were collected at Unalaska and in general seem to answer definitely to the description and specimens of Agardh. The fronds are nearly exactly cylindrical throughout, the branching is almost entirely opposite and the branches decrease in size gradually for each successive order of ramifications. In habit, branching, and in structure, *D. media* is clearly related to *D. viridis*, but is a more ample and a coarser plant. It is clearly distinct in habit, branching and structure from any of the *aculeata*-group. Cross-sections do not show the dense external palisade-layer of cells of the *D. aculeata* and its allies. The variety *tenuis* is typically a much more slender plant, but is, nevertheless, coarser and more rigid than any of the forms of *D. viridis*. The variety seems to be more southern in its range than the type of the species.

2. **Desmarestia pacifica** S. and G.

Fronds slightly compressed below, terete above, branching opposite throughout, each succeeding order of branches much reduced in size; subterminal branches 5–8 cm. long, tapering upwards but very slightly, clothed with many, mostly opposite, blunt, ultimate ramuli, 2–5 mm. long; axial filament 40–50μ diam., surrounded by two layers of larger cylindrical to subcylindrical cells; cortical layer not definitely delimited.

Santa Catalina Island, southern California.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 6.

We have only a single and imperfect specimen upon which to base this new species, but, while it closely resembles *Desmarestia media*, each successive order, the branches of which do not taper appreciably upwards, gives the plant a characteristic seemingly very distinct.

3. **Desmarestia farcta** S. and G.

Fronds cylindrical throughout, at least 5 dm. high; branches long, opposite throughout, not attenuated, blunt, of 3–4 orders, 0.5–1 mm. diam.; stipe and holdfast unknown; primary cylinder composed of cylindrical cells 20–25μ diam. in the center of a distinct "stele" of 3–4 layers of larger cylindrical cells 35–45μ diam., these surrounded by 2–3 layers of large colorless cells irregular in form, 100–125μ diam., and surrounded in turn by the cortex of colored, radially elongated cells; reproduction and hairs unknown.

Cast ashore. Argyle, San Juan County, Washington.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 7.

We have but two portions of what may be a single ample plant of this species upon which to base this description. The character of the holdfast and of the lower parts of the frond cannot be chronicled at this time, but the characters of the parts which we have are so pronounced as to leave little doubt that the species has hitherto been overlooked and is undescribed. One of the incomplete specimens, probably a portion of the same plant, is in the collection of the Marine Biological Station at Friday Harbor, Washington, and we are able to examine it through the courtesy of Professor T. C. Frye. The densely "stuffed" condition of the cells of the central monosiphonous axis begins within two or three cells of the tip of each axis through the growth of tylloses, a condition not noted by us in any other of the specimens available to us.

Section 2. Aculeatae

Desmarestia, subgen. **Eudesmarestia** DeToni.

Fronds compressed to slightly flattened, never strictly flattened-foliaceous, foliaceous, or cylindrical; branching alternate, occasionally opposite below.

DeToni, Syll. Alg., vol. 3, 1895, p. 457 (in part).

4. **Desmarestia latifrons** (Rupr.) Kuetz.

Plate 90

Fronds of a firm, rigid consistency, dark brown in color, moderately branched, flattened throughout except the base of the stipe, several main lateral branches often exceeding in length the central axis, midrib manifest only in the lower older parts, 8–15 dm. high, 2–3 mm. wide; branches of 3–4 orders, those of the fourth order foliaceous above, reduced to small aculeae below or entirely absent; hairs opposite, branched, arising from every cell of the central axial filament, closely congested along the entire margin of the corticated frond and of the ramuli except at their stipitate bases.

Growing on rocks in the lower littoral and the upper sublittoral belts. Central Oregon (Coos Bay) to central California (Point Sur).

Kuetzing, Tab. Phyc., vol. 9, 1859, p. 40, pl. 95; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 279; Farlow, Anderson and Eaton, Alg. Exsicc. Amer-Bor., no. 121. *Spinularia latifrons* Ruprecht, Tange, 1851, p. 375.

The type locality of *D. latifrons* is, according to Ruprecht (*loc. cit.*)., Fort Ross, California. We have not seen any specimens from the type locality, although we have both collected algae in that vicinity. The species, as at present known, does not seem to be very abundant, but is scattered sporadically from Coos Bay, Oregon, to Point Sur, Monterey County, California.

As far as our experience goes, it is one of the most stable, least variable species of the genus, and can readily be told from all other known species. The hairs are relatively long, very abundant and remain on until the plants are nearly maximum growth. These are replaced in part by numerous prominent teeth or aculeae at maturity. The fronds are decidedly rigid and of a dark color.

Desmarestia latifrons resembles *Desmarestia intermedia* more than any other of the *Aculeatae*, but is definitely flattened rather than compressed, and is not at all either membranaceous or foliaceous. It seems to be a very distinct species of the central Californian coast (extending over into the southern Oregon coast at Coos Bay), but is scarce even in its own territory. The species is related to *D. aculeata* (L.) Lamour., but more closely to *D. intermedia* P. and R., but is broader and more flattened than either.

5. **Desmarestia intermedia** P. & R.

Fronds subcoriaceous, up to 6 dm. high and 1.5 mm. wide, dark brown in color, almost black on drying, very profusely branched, subopposite and fasciculate below, strictly alternate above; stipe and lower parts cylindrical to subcylindrical; ramuli decidedly compressed and lanceolate, densely clothed in the juvenile stage with relatively long hairs with alternate or opposite branching; frequently, especially in the lower parts and in the older plants, two or more branches arising at the same node and on the same side of the frond.

Growing on rocks in the upper sublittoral belt. Bering Sea to Puget Sound.

Posters and Ruprecht, Illus. Alg., 1840, p. 13, pl. 26 (Excl. Synonymy); *Desmarestia aculeata* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 246 (in part); Tilden, Amer. Alg. (Exsicc.), no. 352. Possibly, Saunders, Alg. Harriman Exp., 1901, p. 422.

Desmarestia intermedia has usually passed for *D. aculeata,* true representatives of which do not seem to occur on our coast. *D. aculeata* is characterized, at least in typical forms, by having its shorter and even longer branches margined by short branches of limited growth, asuming the form of spines. *D. intermedia,* however seldom has what appear to be genuine aculeae, i.e., short rigid spine-like branches of very limited growth such as are characteristic of *D. aculeae* and *D. latifrons,* usually there being little, if any, appearance of this sort. One characteristic of *D. intermedia* is the fasciculate branching below. The groups of branches springing from one point are subopposite, i.e., arise near one another, but one bunch is inserted higher on the axis whence both arise and not exactly on the opposite side. The plants we have assigned to this species vary from fairly broad (type) to medium (var. *fuscescens* P. and R., *loc. cit.*) and on to the most slender and almost terete forms (var. *teretifolia* P. and R., *loc. cit.*).

Postels and Ruprecht (*loc. cit.*) seem to feel certain that the *nomen nudum* of Mertens, *Fucus pseudoaculeatus,* refers to their plant, having probably examined a specimen, but they consider the other three quotations, viz., *Sporochnus medius* Ag., *Trinitaria confervoides* Bory, and *Desmarestia media* Grev., as dubious. The first and the last refer, in our opinion, to what we call *Desmarestia media.* The middle plant is presumably another species, having been assigned to a plant of the southern hemisphere.

Section 3. Herbaceae

Desmarestia, subgenus **Eudesmarestia,** De-Toni (*loc. cit.*), in part.

Fronds ligulate to broadly membranaceous or foliaceous; branching abundant to very sparse or none, opposite or subopposite.

De-Toni, Syll. Alg., vol. 3, 1895, p. 457.

There is a very considerable variation in length, width, and branching in our west American plants of the Herbaceae and there are very considerable difficulties in the way of classifying them either as distinct species or as varieties. Miss Vinnie Pease (1917 and 1920) has made an effort in this direction and we have considered her account and the opinions she has expressed therein, very carefully. As a result of our study of the literature and of the specimens, we have decided to mark off the more striking plants of our coast as more or less distinct species.

6. **Desmarestia ligulata** (Lightf.) Lamour.

Plate 87

Fronds plumose, up to 8 dm. high (in our territory), 6–8 mm. wide, firmly attached by a relatively large disk; primary axis closely beset with opposite, primary branches throughout, exceedingly variable in size and complexity of branching, some of which extend beyond its apex; ramuli all opposite, closely crowded, of 4–5 orders, the ultimate reduced to fine teeth or aculeae, all very decidedly flattened; midrib barely discernible in the primary axis and main laterals; hairs very abundant, with short, very acute, opposite branches, giving rise along the margins of the ultimate branches to numerous small acute ramuli, many of which disappear at maturity.

Growing on rocks in the upper sublittoral and lower littoral belts among and in the vicinity of the San Juan group of islands, Washington.

Lamouroux, Essai, 1813, p. 25; Harvey, Phyc. Brit., vol. 1, 1847, pl. 115; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 247; Pease, P.S.M.S. Publ., vol. 1, 1917, p. 388, and vol. 2, 1920, p. 314; Wyatt, Alg. Danmon., no. 55; Le Jolis, Alg. mar. Cherb., no. 268; Hauck and Richter, Phyk. Univ., no. 420. *Fucus ligulatus* Lightfoot, Flora Scotia, vol. 2, 1777, p. 946, pl. 29.

There may be still a question as to whether typical *Desmarestia ligulata* occurs on our coast. Pease (1920, p. 316) has argued that it does and we have adopted her opinion. There does occur on the island of San Juan and apparently in abundance a narrow, branched plant with short filiform stipe without prominent midvein, and lacking lateral veins, which seems to correspond to Lightfoot's figure of *Fucus ligulatus* and description and with British plants. The type locality is on the Scottish coast and is probably on the Firth of Forth.

7. **Desmarestia herbacea** (Turner) Lamour.

Plate 88

Fronds ligulate, 1.5–2.5 m. long, 1–2 cm. wide, the rhachis and the primary branches with a distinct, conspicuous midrib; stipe very short, almost immediately flattened; branches of 3–4 orders, each order much reduced but exceedingly variable in size, the primary branches often reaching the size of the rhachis, but interspersed with branches only a few centimeters long; all of the branches, though relatively wide, tapering at the base to a small, distinct, almost cylindrical connecting stipitate portion, and rounding at the apices; the branches exceedingly abundant in the juvenile stage, and all densely clothed at the apices and along the margins with acute hairs, the main terminal hairs with profuse opposite branching.

Growing in tide pools in the lower littoral and upper sublittoral belt. Kodiak Island, Alaska, to southern California (La Jolla).

Lamouroux, Essai, 1813, p. 25; Kuetzing, Tab. Phyc., vol. 9, 1869, pl. 100; Pease, P.S.M.S. Publ., vol. 1, 1917, p. 389; *Ibid.*, vol. 2, 1920, p. 340, pl. 54, fig. 3, pl. 60, figs. 1–5. *Desmia herbacea* Postels and Ruprecht, Illus. Alg., 1840, p. 13. *Desmarestia ligulata* var. *herbacea* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 79*b*. *Desmarestia ligulata* Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 166. *Fucus herbaceus* Turner, Hist. Fuc., 1809, pp. 77, 78, pl. 99.

The exact locality from which the material forming the type of the species of *D. herbacea* was collected is not known. Turner (*loc. cit.*), says, "North-west coast of America. Mr. Menzies." There is much variation in the size of the fronds as they occur along our coast. Turner says, "two feet or more long." We have seen specimens two and a half meters long. Some specimens, apparently mature, from La Jolla and from Pacific Grove, California, in our herbarium are almost as narrow as the specimens from San Juan County, Washington, which we have referred to *D. ligulata*. Other specimens approach very nearly to the narrow forms of *D. munda* as we have limited that species. However, the typical and abundant specimens are quite distinct from either of these species. They are midway between the two species as regards the number and character of the branches. Typical plants also show distinct, often heavy, lateral veins, at least on all the broader axes.

8. **Desmarestia munda** S. and G.

Plate 89

Fronds attached by a firm parenchymatous disk, ligulate, relatively rigid and coriaceous, up to 8 m. long, 4–10 cm. wide, glossy yellowish brown in color, sparingly branched at maturity; midrib prominent in the stipe and lower parts, becoming very inconspicuous or appearing only as a mere nerve above; branches usually of 2 but in part 3 orders, the largest primary branches arising near the base at times as long as the central rhachis, and even wider in part, tapering rather abruptly to a small cylindrical connection at the base, acuminate or rounded above, the margins of all bearing very prominent, rather distant spine-like projections with more or less rounded angles above; stipe flattened almost to the base.

Growing principally on rocks, just below extreme low water level down to ten fathoms or more in depth. From Puget Sound, Washington, and probably considerably farther north, to southern California (San Pedro).

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 7. *Desmarestia ligulata* var. *herbacea* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 247; Tilden, Amer. Alg. (Exsicc.), no. 244; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. LXXIX A (not B). *Desmarestia latissima* Pease, P.S.B.S. Publ., vol. 2, 1920, p. 319 (in part).

Desmarestia munda is a long and moderately broad plant, with indistinct midvein, usually faint above, and lateral veins branching and disappearing before reaching the margins. The texture of the living plant is firm and its surface is smooth, shining, and usually free from epiphytes and epizoa. It is for this reason that we have chosen the specific designation. Pease (1920, p. 319) has published a *Desmarestia latissima* as of Setchell and Gardner and states that the type is in the Herbarium of the University of Minnesota. We are not responsible for the type, which we have not yet seen, but from the description in Pease, conclude that it includes *D. munda* as we establish it, as well as a plant to which we did assign the provisional name *D. latissima*. The latter is the plant to which we limit the name, *D. latissima*. In our opinion, our *D. latissima* is sufficiently distinct from *D. munda* to justify keeping them separate.

9. **Desmarestia latissima** S. & G.

Fronds membranaceous, broadly expanded, 3–4 m. long, up to 12 dm. wide, sparsely branched, exceedingly fragile; branches similar to the main axis, of one order only, or possibly at times a few small secondary branches, abruptly tapering at the base to a very slender connection with the main frond, rounded at the outer end, midrib and lateral veins inconspicuous.

Growing in quiet water in bays and on mud flats, in the upper sublittoral belt. San Juan County, Washington.

Setchell and Gardner, *in* Pease, P.S.B.S. Publ., vol. 2, 1920, p. 319 (in part).

This is by far the largest species of *Desmarestia* yet discovered, and seems, as far as known to us, to inhabit relatively quiet water, at times merely resting on mud flats where the water is rarely disturbed except as it rises and falls with the tidal movements. One of its distinguishing characters is its very large size. The most noticeable feature about it, however, is its exceedingly fragile nature. It is very crisp and brittle, wholly unable even to bear more than a fraction of its own weight without being ruptured. It is further characterized by the paucity of branches, as a rule bearing only a few primary laterals. This plant fully merits the name *Desmarestia latissima*, as already given by us, and is a plant of entirely different color, texture, habit, and place of growth from our *D. munda*.

10. **Desmarestia foliacea** Pease

Fronds membranaceous, unbranched, attached by a small disk, tapering below to a very delicate cylindrical stipe, up to 1 m. long, 15 cm. wide, margins irregularly sinuate with occasional sinuate teeth, midrib evident, with opposite branches which break up into fine veinlets.

Growing in the upper sublittoral belt. San Juan County, Washington.

Pease, P.S.B.S. Publ., vol. 2, 1920, p. 322, pl. 58, figs. 5–10, pl. 61, figs. 1–5. *Desmarestia tabacoides* Pease, P.S.B.S. Publ., vol. 1, 1917, pl. 84, figs. 2–7.

We are not acquainted with this plant and know it chiefly through the above mentioned publications. There is a plant in the Herbarium of the University of California (Gardner, no. 2321) dredged in ten fathoms off Canoe Island, San Juan County, Washington, which may possibly belong here. The plant was attached to a clam shell by a relatively small, flat disk, has a small cylindrical stipe, a blade about four meters long and three decimeters wide. There are, however, a few small, short branches arising near the base, differing in this respect from the type material as described by Miss Pease.

Through the kindness of Miss Pease, we have received, since writing the foregoing, two sheets of specimens of *Desmarestia foliacea* from Professor Josephine Tilden, of the University of Minnesota. The species seems closely related to *D. tabacoides* Okam., but differs in size, shape, lobing and venation.

Order 4. CHORDARIALES ord. nov.

Fronds erect, cylindrical, branched or unbranched, arising from a discoid holdfast or from an expanded and lobed horizontal thallus, with terminal, but subapical, growth, of three sets of tissues, central core of vertical rows of elongated cells (often disappearing leaving the erect filaments hollow), an intermediate layer of cells slightly longer than broad or thick, and an outer layer of longer or shorter assimilating filaments, more or less distinct or combined into a cortical tissue, near, or at, whose bases the zoosporangia are formed; zoosporangia immersed among the assimilating filaments; colorless hairs generally present; gametangia and gametophytes unknown, the later presumably microscopic.

In pursuance of the idea stated elsewhere, that those groups of Melanophyceae closely related in general vegetative structure and particularly with the same method of growth in length in which no member is known to occur with gametangia, are to be suspected of possessing microscopic gametophytes, we have established the order Chordariales with the family Chordariaceae as the typical family, which includes *Chordaria*, typified in *Chordaria flagelliformis* (Muell.) Ag., as the type genus. The method of growth is that designated as subapical, as distinguished from trichothallic (e.g.,Ectocarpales and Desmarestiales) on the one hand and truly apical (e.g., Sphacelariales, Dictyosiphonales, etc.) on the other. The meristematic cells are situated in short apical filaments similar to the external assimilatory filaments, but are not terminal in those filaments, being situated two or three, or occasionally more, cells below the terminal cell. In other respects the structure approaches that of the Ægiraceae and the Myriogloiaceae where, however, the growth is trichothallic and both macroscopic sporophytes and macroscopic gametophytes are known. From Heterochordariaceae, the families of this order differ in lacking, so far as known, a macroscopic gametophyte. While the family Chordariaceae can be assigned to the order Chordariales, as the type family, yet the close relationship of the genera *Coilodesme* and *Scytothamnus* lead us to add a family for the first (Coilodesmaceae) and one for the second (Scytothamnaceae), although we have no members belonging to the latter within our territory.

Key to the Families

1. Assimilating filaments distinct .... 16. **Chordariaceae** (p. 570)
1. Assimilating filaments united into a cortical tissue .... 17. **Coilodesmaceae** (p. 577)

FAMILY 16. CHORDARIACEAE REICHENB. (in part)

Fronds erect, cylindrical, branched or simple, arising from discoid holdfasts or from lobed and expanded horizontal thalli, composed of three tissues or layers, an inner, of elongated, usually slender filaments (often disappearing and leaving a hollow center), an intermediate, of large, rounded, or somewhat elongated cells, and an outer cortical layer, of short, anticlinal, assimilating filaments, distinct from one another, but enclosed in an enveloping jelly; zoosporangia immersed among the cortical filaments; gametangia and microscopic (?) gametophyte unknown.

Reichenbach, Conspectus Regn. Veg., 1828, p. 25 (in part; fide Pfeiffer, Nomen. Botan., vol. 1, 1873, p. 732, et auct. var.); Harvey, Ner. Bor. Amer., I, 1852, p. 121 (in part). *Chordarieae* Agardh, Syst. Alg., 1824, p. xxxvi (in part).

The family of the Chordariaceae, while actually very distinct from all others of the Melanophyceae except that of the Heterochordariaceae because of its subterminal growth and frond structure, has been the recipient of several families in which the growth is clearly trichothallic. We may assume with reason, we think, that the subapical method is intermediate between the apical and the trichothallic yet distinct from each of them. The outer, cortical, layer of short, but distinct, anticlinal filaments distinguish this family from both the Coilodesmaceae and the Scytothamnaceae.

KEY TO THE GENERA

1. Fronds simple (in our species) or very sparingly branched.......... 2
1. Fronds, typically, much branched..........34. **Chordaria** (p. 571)
    2. Fronds composed of a flattened, sterile part and an erect, fertile part..........35. **Analipus** (p. 575)
    2. Fronds not composed of two parts..........36. **Gobia** (p. 576)

34. **Chordaria** Ag. (emend Grev.)

Fronds cylindrical, filiform, branched, more or less rigid and cartilaginous to slightly lubricous, solid or at times becoming fistulous in age, composed of two tissues, a medulla and a cortex; growth subapical; medulla composed of relatively large, colorless, longitudinally arranged, firmly agglutinated filaments, with numerous small filaments, especially abundant in the center of the frond, interspersed; cortical assimilating filaments short, firmly agglutinated; reproduction in macroscopic plants by zoosporangia borne among the cortical filaments.

Agardh, Syn. Alg. Scand., 1817, p. xii and p. 12, *lim. mut.;* Greville, Alg. Brit., 1830, p. 44.

The name *Chordaria* was first proposed by Link in 1809 to include a series of different plants, none of which, however, belong to this entity as now constituted. C. Agardh (1817, p. xii) modified the limits of the genus to include *C. rotunda*, *C. divaricata*, *C. flagelliformis*, *C. cabrera*, and *C. Filum* and three other doubtful species. Of these *C. flagelliformis* is the only northern species of the series now generally included under the genus, but some authors also include *C. divaricata.* Greville (1830, p. 44, pl. 7) was the first definitely to establish the present limits of the genus by pointing out a type, viz., *C. flagelliformis.*

Key to the Species

1. Fronds flagelliform, cylindrical throughout 2
1. Fronds irregular in diameter, flattened at the branching....3. **C. dissessa** (p. 574)
    2. Fronds relatively robust, up to 9 dm. high, usually with many long, slender, primary branches..........1. **C. flagelliformis** (p. 572)
    2. Fronds slender, up to 3.5 dm. high, primary branches patent, scattered along the whole main axis up to 4 cm. long..........2. **C. gracilis** (p. 573)

1. **Chordaria flagelliformis** (Muell.) Ag.

Fronds attached by a small disk, solitary or in groups, lubricous, solid, 2–5 dm. (up to 9 dm.) long, branching close to the base into many branches of nearly equal length, or the main axis percurrent giving rise to numerous alternate branches, shorter above; branches usually of 3 orders; peripheral assimilating filaments 6–8 cells long, with terminal cell nearly spherical, and with numerous hyaline hairs interspersed; color dark olive brown, nearly black; zoosporangia ovoid to pyriform, arising at the base of the cortical filaments.

Growing on rocks in the upper sublittoral belt.

Agardh, Syn. Alg. Scand., 1817, p. 12 and p. xii. *Fucus flagelliformis* Mueller, Flor. Dan., 1771, pl. 650.

This species in its various forms seems to be exclusively boreal, though extending much farther south on the Atlantic shore than on the Pacific shore of North America. It is very common on the American and European shores of the North Atlantic. It has been reported as far north as the Spitzbergen Islands and in the Baltic Sea. The following forms have been reported within our territory.

Chordaria flagelliformis f. **typica** Kjellm.

Plate 39, fig. 44

Fronds much branched, primary branch arising near the base, usually longer than the others, main axis nearly percurrent.

Growing on rocks in the upper sublittoral belt. Bering Sea (St. Lawrence Island) to Sitka, Alaska.

Kjellman, Om Spets. Thall. II, 1877*a*, p. 28; Reinke, Atlas, 1889, pl. 39, figs. 1–7; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 250; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1037.

Chordaria flagelliformis f. **ramusculifera** Kjellm.

Fronds cylindrical, up to 30 cm. long, slender, with scattered, short, simple branches 1–1.5 cm. long, arising nearly perpendicular to the main axis; cortical filaments 5–6 cells long, distinctly clavate, terminal cell moderately swollen; zoosporangia elliptical, 55–60μ long, 25–30μ wide.

Growing in the sublittoral belt. St. Lawrence Island, Alaska.

Kjellman, Om Spets. Thall. II, 1877*a*, pp. 29, 30, pl. 1, figs. 10–12; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 251.

Chordaria flagelliformis f. **chordaeformis** Kjellm.

Fronds simple or sparsely branched; cortical filaments nearly cylindrical with terminal cell slightly swollen; zoosporangia 60–70μ long, 25–30μ broad.

Kjellman, Om Spets. Thall. II, 1877*a*, pp. 28, 29, pl. 1, figs. 13–15; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 251.

This form has been reported by Kjellman in the upper sublittoral belt at Konyam Bay, Siberia, and may be expected to occur in our waters.

2. **Chordaria gracilis** S. and G.

Plate 84

Fronds 2.5–3.5 dm. high, with a single main percurrent axis 400–500μ diam. arising from a disk; primary branches numerous, short, scattered along the entire length of the main axis and alternately arranged on all sides, up to 4 cm. long, standing almost at right angles to the main axis; secondary branches 3–6 mm. long, standing at wide angles with the primary branches; color light brown; zoosporangia unknown; cortical filaments short, composed of 2–3 cells with a subspherical terminal cell.

Growing in abundance on stones. West shore of Amaknak Island, Unalaska, Alaska.

Setchell and Gardner, Phyc. Cont., 1924, p. 8.

The slender percurrent axis bearing numerous short, almost equal, lateral branches over most of its length with short branchlets and all axes patent to one another, give the plants of the single collection available a very distinctive appearance. The plants are young and sterile, but the structure of the frond, the terminal subapical growth and the discoid holdfast indicate its affinities with *Chordaria*. In the Algae of Northwest America (1903, p. 248) we placed this plant under *Dictyosiphon foeniculaceus* (Huds.) Grev., an untenable position, since the subterminal growth and other details of structure plainly show its different nature.

3. **Chordaria dissessa** S. and G.

Plate 41, fig. 57, and plate 75

Fronds attached by a small disk, 15–25 cm. high, up to 2 mm. thick, moderately and alternately branched, usually wider at the branching, but swollen in some parts and contracted in others, older parts at times fistulous, olive brown in color, composed of a medulla of longitudinal filaments giving rise to a cortex of short assimilating filaments; filaments of the medulla composed of large, colorless, closely compact, thick-walled cells up to 120μ diam. in the central part of the frond, many times longer than the diameter, becoming much shorter and narrower toward the periphery; cortical erect filaments cylindrical, simple or branched, not closely compact, 4–6μ diam., composed of 2–4 cells, terminal cell swollen and globular; hairs unknown; branches of each different order reduced in size, terminal ramuli long-attenuate and acute, angles mostly wide and rounded; zoosporangia obovoid to ellipsoidal, 36–42μ long, 28–32μ broad; gametangia unknown.

Growing on eel grass in the middle and lower littoral belts. East Sound, Orcas Island, Washington.

Setchell and Gardner, Phyc. Cont., 1924, p. 8. *Castagnea divaricata* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 249 (not *C. divaricata* (Ag.) J. Ag.).

The resemblance between *Chordaria dissessa* and *C. divaricata* (Ag.) Grev. is superficially close, but the former has its main axes less regularly cylindrical, is less profusely branched, seems less gelatinous, with fewer or no hairs and has the assimilating cortical filaments shorter and of fewer cells, being 2–4 celled, while in *C. divaricata* they are 4–6 even more celled. The aspect of *C. dissessa* is that of a coarser, less abundantly branched, plant than is that of *C. divaricata.*

35. **Analipus** Kjellm.

Thallus composed of an expanded, more or less deeply lobed, pseudoparenchymatous, sterile, basal portion attached to the substratum by numerous, unicellular or multicellular, rhizoidal filaments, and giving rise above to simple, more or less cylindrical, solid or fistulous, fertile fronds; fertile fronds composed of a dense mass of pseudoparenchymatous cells with a few chromatophores giving rise on the surface to short, densely congested, cortical, assimilating filaments and to numerous zoosporangia; gametangia unknown.

Kjellman. Om Beringh. Alg., 1889, p. 48.

The type and only known species of the genus is *A. fusiformis* from Bering Island.

Analipus fusiformis Kjellm.

Fertile fronds 2–6 cm. high, 1–3 mm. diam., one to several arising from the upper side of the same horizontal base; the sterile base profusely and deeply lobed, terminal lobes rounded and blunt, attached by short, somewhat branched, monosiphonous hairs; cortical filaments of fertile fronds 3–5 cells long, clavate, with enlarged, rounded, terminal cell; zoosporangia arising from the base of the paraphyses, globose to ellipsoidal, 35μ long, 25μ broad (fide Kjellman), up to 65μ long.

Growing on rocks. St. Paul Island, Bering Sea, Alaska.

Kjellman, Om Beringh. Alg., 1889, p. 49, pl. 7, figs. 6–12; Setchell, Alg. Prib. Isl., 1899, p. 591; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 252.

The material reported here seems to be almost identical with that found at Bering Island, the type locality, and reported by Kjellman. The zoosporangia are somewhat larger than the dimension given by Kjellman, some being as long as 65μ.

Analipus seems to belong to the Chordariaceae as we have limited it, and we have been able to assure ourselves that the method of growth in length is subapical and, consequently, that the agreement with

Chordaria in family characteristics is close. In case *Ruprechtiella filiformis* (Rupr.) Yendo (Trav. Mus. l'Acad. Imp. Sci. St. Petersb., vol. 10, 1913, p. 118) proves to be identical, generically at least, with *Analipus fusiformis* Kjellm., *Analipus* must be removed to the Heterochordariaceae.

36. **Gobia** Reinke

Frond filiform, more or less lubricous, simple or branched, hollow except in the very young stage, growth apical or subapical, composed of an inner tissue of loosely anastomosing colorless filaments giving rise to short, compact, vertical, assimilating filaments, to zoosporangia and to scattered colorless hairs; gametangia unknown.

Reinke, Algenfl. westl. Ostsee, 1889*a*, p. 65.

The type of the genus, and the only other species known except the following, is *Gobia baltica*, based upon material of *Cladosiphon balticus* Gobi (Brauntange finn. Meerbus., 1874, p. 12).

The growth in length of the species of *Gobia* is said to be from an apical cell at first, but this soon ceases and intercalary growth sets in (cf. Reinke, 1889*a*, pp. 65, 66). If we are correct in referring the *Mesogloia simplex* Saunders to Reinke's genus *Gobia*, with which it seems to agree in details of structure, we are probably also correct in interpreting the growth of the genus as being subapical in that the apical cell in very young plants and in very young branch initials very early cuts off a subapical cell which takes on the principal meristematic function. The same thing happens in *Chordaria* and presumably also in *Myelophycus* and in *Analipus*. This is very different from the situation in *Dictyosiphon*, where the terminal cell retains its meristematic function and activity as long as active growth in length continues. *Gobia*, from this point of view, differs from the other genera of the Chordariaceae in the loosely placed anastomosing filaments of its inner tissues.

Gobia simplex (Saunders) S. and G.

Plate 42, fig. 58, and plate 78*b*

Fronds olive brown, 5–12 cm. high, 2–3.5 mm. diam., simple, cylindrical or in part decidedly clavate, often arcuate, very blunt, solid in the juvenile stage, soon becoming hollow except at the very base of the apex, attached by a small disk; central filaments loose, colorless, anastomosing freely, 25–35μ diam.; cortical filaments straight, perpendicular to the main axis, the terminal segments composed of 2–4 cells.

terminal cell pyriform, 30–35μ long, 18–22μ diam., with large chromatophores; zoosporangia obovoid to ellipsoidal, 40–50μ long, 30–38μ broad; hairs sparse, 4.5–5.5μ diam.

Growing on *Heterochordaria abietina* (Rupr.) S. and G. Extending from Cook Inlet, Alaska, to Vancouver Island.

Setchell and Gardner, Phyc. Cont., 1894, p. 12. *Mesogloia simplex* Saunders, Alg. Harriman Exp., 1901, p. 423, pl. 50, figs. 3, 4; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 250.

The measurements given in the diagnosis apply to the collection from Sitka. Saunders (*loc. cit.*) gives 25–35μ long and 15–25μ broad for the dimensions of the zoosporangia. Those in the collection of Polley and Butler in the Herbarium of the University of California (no. 99329) from Vancouver Island, have zoosporangia up to 80μ long. Otherwise they agree well with the Sitka plants. Small immature specimens of this plant were found growing on *Heterochordaria abietina* distributed by Miss J. E. Tilden (Amer. Alg., no. 348 sub *Chordaria abietina*).

Gobia simplex differs from *Gobia baltica* in being simple and in its tendency to be somewhat enlarged above. *Gobia simplex* has always been found growing on *Heterochordaria abietina* S. and G.

FAMILY 17. COILODESMACEAE FAM. NOV.

Fronds membranous, tubular or ligulate, growth subterminal at least in early stages, possible terminal at the beginning, composed of at least two tissues, inner composed of more or less elongated cells, becoming smaller outwards and passing into short anticlinal filaments firmly agglutinated into a cortical assimilating tissue; zoosporangia immersed in the cortical tissue but extending to, or near to, the surface; gametangia unknown and gametophyte presumably microscopic.

Coilodesmeae Kjellman, *in* Engler und Prantl, Die natürl. Pflanzen fam., 1 Th., 2 Abt., 1893, p. 200.

Stroemfelt (1886, p. 47) assigned his new genus *Coilodesme* to the *Chordariaceae*, as then understood, and as an intermediate type between the Chordarieae and the Scytosiphoneae. In vegetative structure, *Coilodesme* is more highly differentiated than *Chordaria*, in that its cortical filaments have lost their distinctness and are combined into a definite tissue in which the zoosporangia are immersed. The method of growth has not been carefully or completely determined but seems (cf. Oltmanns, 1922, p. 62, fig. 354, 2) to be subterminal.

No species of *Coilodesme* has as yet been seen with gametangia and this suggests the extreme possibility of a microscopic gametophyte. This combination of characters leads us to suggest the new family Coilodesmaceae of the order Chordariales.

Key to the Genera

1. Fronds solid, ligulate ....38. **Phaeostrophion** (p. 585)
1. Fronds hollow, complanate or saccate..37. **Coilodesme** (p. 578)

37. **Coilodesme** Stroem.

Fronds saccate, complanate from the beginning or more or less flattened in age, linear to ovate or obovate in outline, rounded above, tapering more or less at the base into a longer or shorter solid stipe, with small disk-shaped holdfast or with penetrating rhizoids epiphytic, parasitic or saxicolous, composed of two tissues, the inner consisting of large, irregular, thick-walled cells, with few chromatophores, the outer cortical portion consisting of a few to many layers of smaller color-bearing assimilating cells arranged more or less in radial rows; hairs absent; unilocular zoosporangia developed within the cortex, scattered over the whole surface of the frond except the stipe and extreme basal portion; paraphyses absent; gametangia unknown.

Stroemfelt, Meeresalg. Isl., 1886*a*, p. 173.

The type species of the genus is *C. bulligera*, of Icelandic origin.

The species of *Coilodesme* seem to divide themselves fairly definitely into two groups, the one saxicolous, the other epiphytic. Of the epiphytic plants in the collections available to us, all are from the western coast of North America or the northeastern coast of Asia and seem to differ from one another essentially according to their host plant, only one host plant having more than one species associated with it. This is not surprising, since Rathbone (Journ. Linn. Soc., 1904, p. 674, pl. 24, figs. 5, 6) has shown the actual penetration of the host and our own investigations have demonstrated an intimate metabolic relation. The parasitism of all the epiphytic species of our coast is also striking in that the hosts are all members of the related genera, *Halidrys*, *Cystoseira*, and *Cystophyllum*, each of which seems to have one or more species of *Coilodesme* peculiar to it. Okamura (Icones Jap. Algae, vol. IV, no. 3, 1918, p. 55, pl. 144, figs. 10–13) figures and describes a *Coilodesme Cystoseirae* growing on *Cystophyllum hakodatense* at Akkeslie, Japan. From the data presented, we are inclined to question the reference of this plant to *C. Cystoseirae* as interpreted by us, but careful comparison is necessary to determine exactly the nature of Ruprecht's *Asperococcus Cystoseirae* and its relation to the Japanese plant on the one hand and the Alaskan plant on the other. Ruprecht states that the type of *A. Cystoseirae* is parasitic on *Cystoseira Lepidium* but not on *C. thyrsigera*.

Key to the Species

1. Fronds complanate from the beginning, rigid, membrane up to 375μ thick, epiphytic, stipe short .... 6. **C. rigida** (p. 584)
1. Fronds inflated at first, collapsing, especially when ruptured, membrane less than 250μ thick 2
    2. Fronds ample, up to more than 1 m. long, and 1 dm. broad, epiphytic, stipe short .... 1. **C. californica** (p. 579)
    2. Fronds smaller in all proportions 3
3. Fronds narrowly cylindrical, up to 8 mm. diam., and 8 dm. long, epiphytic, stipe short .... 5. **C. Cystoseirae** (p. 583)
3. Fronds more or less irregular, subcylindrical 4
    4. Fronds finely corrugated, subsessile, epiphytic, stipe short .... 3. **C. corrugata** (p. 582)
    4. Fronds undulate, decidedly stipitate 5
5. Fronds saccate, slightly undulate, saxicolous, stipe slender, elongated .... 2. **C. bulligera** (p. 581)
5. Fronds flattened, decidedly bullose, with ruffled margins, saxicolous, stipe slender, elongated .... 4. **C. polygnampta** (p. 582)
5. Fronds moderately bullose, epiphytic, stipe slender .... 7. **C. sitchensis** (p. 584)

1. **Coilodesme californica** (Rupr.) Kjellm.

Plate 46, figs. 1, 2, and plate 86

Fronds flabby and fragile, smooth when young, more or less wrinkled, or bullate, and ruffled along the margins at maturity, inflated in the juvenile stage, soon collapsing because of ruptures, usually at the apex, chiefly cylindrical, rounded above, tapering rather abruptly at the base to a very short stipe 1–2 mm. long, variable in size from a few decimeters to over a meter long, up to 12 cm. wide, 175 to 215μ thick, composed of an inner tissue of 4–5 layers of large, colorless cells intermixed with smaller cells, and a cortical tissue of cells in anticlinal rows, 2–4 cells in a row; zoosporangia very irregular in form and size, 40–45μ long; color light brown, changing to greenish on exposure.

Epiphytic on Cystoseira and Cystophyllum. Puget Sound region to southern California (San Pedro).

Kjellman, Undersök. Slägtet *Adenocystis*, 1889*a*, pp. 4–8, figs. 1–8 (excl. specimen); Saunders, Phyc. Mem., 1898, p. 160, pl. 29, figs. 1–3, Alg. Harriman Exp. 1901, p. 422; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 241; Collins, Mar. Alg. Vancouver Isl., 1913, p. 106;

Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), Fasc. A, no. I; Tilden, Amer. Alg. (Exsicc.) no. 354.

Adenocystis (*Lessonii* var.?) *californica* Ruprecht, Tange Och., 1851, p. 291. *Coilodesme amplissima*, Setchell, Algae novae I, 1912, p. 232.

The question as to the identity of the *Adenocystis* (*Lessonii* var.?) *californica* of Ruprecht (*loc. cit.*) rests upon an imperfect description on the part of Ruprecht. The more definite statements of Kjellman and his illustrations seem to indicate that the plant intended was, at least, not ample, but in fact short and with a comparatively long slender stipe, dark brown, and an epiphyte. This was the inference of Setchell (1912, pp. 231, 232) although the herbarium specimens selected under that impression did not thoroughly correspond. Yendo (1913, pp. 279, 280) has stated that Kjellman's Bering Island plant (*loc. cit.*) does not agree with Ruprecht's type, which does agree with Tilden's plant (no. 354, American Algae) from Vancouver Island which Setchell (*loc. cit.*) had referred to his *Coilodesme amplissima*. Yendo makes no statements as to characters or differences and his opinion is so little in agreement with the figures quoted by Ruprecht (viz., *in* Voy. Coquille, Bot. Atlas, 1826, pl. 11, fig. 2) that we hesitate to prefer his judgment to that of Kjellman. The important character separating the *Coilodesme californica* of Kjellman and the *C. amplissima* of Setchell is the stipe, comparatively long and slender in Kjellman's plant and practically wanting in Setchell's species. Ruprecht's plant, however, was epiphytic on *Cystoseira osmundacea*, as is *C. amplissima*, while Kjellman's plant is said to be epiphytic on larger algae. *C. amplissima* is widespread along the coast from Yakutat Bay, Alaska, to San Pedro, California. From the maze of uncertainty, it seems best to adopt Yendo's statement as to the identity of Ruprecht's plant and to regard *C. amplissima* as a synonym under *C. californica*.

Coilodesme californica, as identified by Yendo, is an ample saccate species, the largest of the genus, with delicate walls, usually light yellowish brown in color, with extremely short stipe and parasitic on *Cystoseira osmundacea* and *Cystophyllum geminatum*. It extends from the Puget Sound region and possibly even from Yakutat Bay, Alaska (Saunders, 1898, p. 422), although the more northern references are subject to suspicion as to possible confusion with our *C. sitchensis*. Its southern limit is at San Pedro, California, so far as shown by available specimens. It is the only species as yet detected on the coasts of central and northern California where is situated Fort Ross, the designated type locality of the species.

2. **Coilodesme bulligera** Stroem.

Plate 45, figs. 77, 78

Fronds usually fasciculate, 5–12 cm. high, 15–22 mm. wide, 75–85μ thick, moderately firm, acuminate or rounded above, gradually narrowed below into a delicate stipe about a decimeter long, composed of 1–2 layers of large, thin-walled, colorless cells within and a cortical tissue of three layers of cells in vertical filaments or anticlinal rows; color dark brown, plants adhering firmly to paper on drying.

Growing on rocks in the lower littoral belt, Shumagin Islands, Alaska, to Coos Bay, Oregon.

Stroemfelt, Meeresalg. Isl., 1886*a*, p. 173, Om Algenveg. vid Isl. Kuster, 1886, p. 48, pl. 2, figs. 9–12; Saunders, Alg. Harriman Exp., 1901, p. 422; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 923*a*; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 240 (in part).

The saxicolous species of *Coilodesme* are found in the Arctic Ocean where it joins the North Atlantic (Iceland and Greenland) and in the northern portion of our own territory. Coos Bay, Oregon, is as far south as any has been found. The specimens collected by Gardner at Coos Bay agree well in habit and structure with some collected at Dixon Harbor, Alaska (somewhat northwest from Cape Spencer) by G. B. Rigg. The habit of both sets of plants is close to those collected and referred to *C. californica* by Kjellman at Bering Island (cf. Kjellman, 1889*a*, figs. 1–3) but his were epiphytic and, consequently, to be suspected as being of some different species. The plants already mentioned agree also with the plant distributed by DeAlton Saunders from "Alaska" under 923*a* of the Phycotheca Boreali-Americana (at least in two copies in our possession) and with certain specimens collected by Gardner at Whidbey Island (no. 201). These plants all agree fairly well with the Stroemfelt figure of *Coilodesme bulligera* in being gradually and insensibly attenuated into a distinct slender, comparatively long stipe and in having the cortical layer of anticlinal rows of cells of three to four each and each terminating outwardly in a larger, dark brown, rounded cell. We are, consequently, referring all these to Stroemfelt's species, but with some uncertainty. It is to be noted that 923*b* of the Phyc. Bor.-Amer. is referred by us to our *C. polygnampta*.

3. **Coilodesme corrugata** S. and G.

Plate 46, figs. 3, 4

Fronds very fragile and flaccid, very closely wrinkled all over the surface, 3–7 cm. long, 8–14 mm. broad, 40–55μ thick, attached to the host by (penetrating?) rhizoidal filaments, rounded above, attenuated below into a short delicate stipe; color light brown; internal tissue composed of 2 layers of large, irregular, colorless cells and the cortical tissue composed of 2–3 layers of small, angular cells; zoosporangia irregular in form, usually broader than long.

Epiphytic upon *Cystoseira neglecta* S. and G. In the upper sublittoral belt. Santa Catalina Island, southern California.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 8.

This is the smallest and most delicate species of the genus, and seems related to *C. amplissima* in general outline and structure. These characters, together with the delicate wrinkling and its occurrence on a distinct and not common host, lead us to keep it distinct. Apparently it is quite limited in its distribution.

4. **Coilodesme polygnampta** S. and G.

Plate 82

Fronds usually densely fasciculate, 1–4 dm. high, 1–5 cm. broad, moderately firm, complanate, at least at maturity, with definitely undulate and crisped margins, attached to rocks by a small, parenchymatous, disk-shaped holdfast, rounded and blunt above, tapering more or less abruptly at the base into a definite, small, solid, cylindrical stipe, dark reddish brown in color; histologically the interior tissue is composed of about 2-3 layers of colorless cells, the cortical tissue is composed of about 3 layers of small, assimilating cells in anticlinal rows.

Growing on rocks in the lower littoral and upper sublittoral belts. Bering Sea.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 9. *Coilodesme bulligera* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 240 (in part); Collins, Holden and Setchell, Phyc. Bor-Amer. (Exsicc.), no. 923*b*.

The plants referred from our Pacific Coast to *Coilodesme bulligera* Stroemf., do not all seem, on further study and careful comparison, to be the same as those of Iceland and Greenland. Our specimens from Bering Sea are more ample, broader, tapering more abruptly into the slender stipe (at least in older specimens) than is represented in the figure of Stroemfelt (1886, pl. 2, fig. 9) or as compared with a specimen from Greenland distributed by Rosenvinge. In Stroemfelt's figure and in Rosenvinge's specimen, the cortex is made up of closely packed anticlinal rows of 3–4 cells each and each row ends outwardly in a somewhat larger, dark brown, rounded cell. In the Bering Sea plant, the anticlinal rows are not recognizable, or are at most of only two cells, the outer deep colored cell usually sitting immediately upon the larger transparent outer cells of the inner layer. The typical form of our plant which we consider a distinct species is represented by no. 923*b* of the Phycotheca Boreali-Americana, and the type locality is Amaknak Island in the Bay of Unalaska.

5. **Coilodesme Cystoseirae** (Rupr.) S. and G.

Fronds flaccid, irregularly cylindrical, blunt at the apices, tapering abruptly into a short stipe about 2 mm. long, 1–4 dm. (up to 8 dm.) high, 3–8 mm. diam., broad, usually inflated, composed of 2 layers of large, thin-walled, colorless cells on the interior and 2 layers of small, cuboidal, cortical cells; zoosporangia ovoid, 15–20μ long, 11–14μ wide.

Epiphytic on *Cystophyllum geminatum.* Kukak Bay and Yakutat Bay, Alaska.

Setchell and Gardner, Alg. N.W. Amer., 1903, p. 241; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1128. *Coilodesme linearis* Saunders, Alg. Harriman Exp., 1901, p. 421, pl. 48; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 824. *Asperococcus Cystoseirae* Ruprecht, Tange Och., 1851, p. 370; not *Encoelium Cystoseirae* Kuetzing, Tab. Phyc., vol. 9, 1859, pl. 6, fig. IV, *e–h.*

This species of *Coilodesme* may readily be distinguished from all other known species of the genus by its relatively narrow and long cylindrical fronds, gradually attenuated at the base to a short stipe. According to Saunders, it replaces the broader plant which he referred to *C. californica* (probably our *C. sitchensis*) on the coast of Alaska to the westward of Yakutat Bay. The dimensions given by Ruprecht for his plants are far under those of the plants referred by us to his species, but his plants were probably very young, similar to the very young and slender individuals included by Saunders (*loc. cit.*) in the group figured by him. Ruprecht's plants, also, showed no reproductive bodies.

6. **Coilodesma rigida** S. and G.

Plate 45, fig. 76, and plate 79*b*

Fronds rigid, more or less coriaceous, complanate from the beginning, and smooth, thickened along the margins, attenuated toward the base into a thick, short stipe, broadened and rounded above, 5–10 cm. (up to 25 cm.) high, 1–2.5 cm. wide, 300–375μ thick, light brown in color; inner tissue composed of large, colorless, thick-walled cells intermingled with numerous smaller filaments extending irregularly in all directions, but toward the surface becoming smaller, perpendicular to the surface and dividing di-trichotomously, terminating in anticlinal rows of small, cortical cells; zoosporangia irregular in form, several times longer than broad.

Epiphytic on *Halidrys dioica* Gardner in the upper sublittoral belt. Redondo to San Diego, southern California.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 9.

Coilodesme rigida is one of the smaller species of the genus. It is very firmly attached to the host by numerous deeply penetrating rhizoidal filaments. It may readily be distinguished by its rigid, smooth, thick frond, usually thickest along the margin at maturity, and by its complanate form from the beginning. It is of a decidedly dark brown color, complanate from its early stages and, apparently, confined to *Halidrys dioica* as a host plant. The plant is smooth even on the margins which, in the adult plant, are decidedly thickened.

7. **Coilodesme sitchensis** S. and G.

Fronds thin and flaccid, inflated, moderately undulate, 15–25 cm. high, 3–6 cm. wide, cylindrical to slightly clavate, tapering abruptly at the base into a slender short stipe; color dark reddish brown, especially so on drying, internal tissue of 2 layers of large cells, cortex of 2-3 layers of smaller cells, radially elongated, both tissues bearing chromatophores.

Growing on *Cystophyllum geminatum* (Ag.) J. Ag. Sitka, Alaska.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 9.

Coilodesme sitchensis occurs on the same host as *C. linearis* and *C. californica*. From the former it is to be distinguished by its broader and more bullose habit and from both by its longer and more definite stipe. It is also darker in color than *C. californica* and rather more bullose and undulated on the margins after collapsing. It may be this species which was reported by Saunders on "*Cystophyllum Lepidium*" in localities north of the Puget Sound region.

38. **Phaeostrophion** S. and G.

Fronds ligulate, solid, polystromatic, more or less stipitate, attached by a small disk; central tissue composed of elongated cells, irregular in shape and size, merging on each side into smaller parenchymatous cells which in turn merge into palisade-like cortical cells; reproduction by zoosporangia on both surfaces of the frond immersed in the cortex extending to but not projecting beyond, the surface; gametangia and hairs unknown.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 10.

The genus *Phaeostrophion* resembles very closely the genus *Endarachne* in size, general shape and consistency of the frond, but is quite different from that genus in its histological characters and in its method of reproduction. The development of the frond of *Phaeostrophion* has not been determined since only old battered specimens are available. The outer ends seem to be the oldest, judging from the more or less battered condition in which the specimens were found. The tissues are almost parenchymatous throughout, but there is a slight tendency in the center of the old fronds to a thick-walled filamentous condition, in this respect resembling the central tissue of *Endarachne*, in which the whole central tissue is composed of narrow intertwined filaments.

In *Endarachne* the small surface cells divide tangentially to build up the solid palisade layer of gametangia, but in *Phaeostrophion* certain cells of the inner layers of the cortex are transformed directly into zoosporangia. In this last character *Phaeostrophion* resembles very closely the genus *Coilodesme* which, however, is always hollow. In its parenchymatous character, and in having larger cells in the center and smaller toward and on the surface, it closely approximates to the condition prevailing in the fronds of *Ilea* Fries.

The structure of the frond in connection with the method of reproduction would seem to be sufficient to relate *Phaeostrophion* to the members of the Coilodesmaceae, in which family we propose to place it.

Phaeostrophion irregulare S. and G.

Plate 38, fig. 36, plate 50, fig. 8, and plate 85

Fronds linear to linear-spatulate, frequently much distorted and irregularly notched or lobed; 15–25 cm. (up to 40 cm.) high, 1.5–4 cm. wide; base long and gradually attenuate, becoming very slender at the small disk-shaped holdfast; zoosporangia numerous, elongate-polygonal to regularly ellipsoidal, 38–44μ long, 26–34μ broad; gametangia and hairs unknown.

Growing on rocks in pools in the middle of the littoral belt. Mouth of Coos Bay, Oregon, and Bolinas Bay, California.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 10.

The plants collected at Coos Bay were all much smaller than those found growing at Bolinas. It was supposed at the time of collecting that the former were rather rigid specimens of *Ilea* Fries and no microscopical examination was made. Later they were soaked out and the structure found to be practically the same as that of the plants from Bolinas. Although collected nearly two months earlier, the Coos Bay plants have zoosporangia which seem to be as nearly mature as those of the plants from Bolinas. In neither collection have any zoospores been seen, but the protoplast seems on the verge of transformation. The zoosporangia are very numerous and are scattered quite uniformly over the whole of both surfaces of the frond except the stipitate portion.

Order 5. DICTYOSIPHONALES ord. nov.

Fronds cylindrical, filiform, repeatedly branched, solid or fistulose, attached by a solid parenchymatous disk, composed of two, or in some cases three, tissues, an inner of elongated slender or stouter cells, and an outer of shorter, nearly iso-diametric or somewhat flattened cells; growth from a distinct apical cell; hairs scattered singly over the entire surface of the frond, soon deciduous; zoosporangia unilocular, embedded in the cortex, borne on macroscopic plants; gametangia plurilocular on microscopic filamentous gametophytes.

The species of the genus *Dictyosiphon* (including *Coilonema*) are to be distinguished by the possession of an apical cell which persists as long as growth in length continues, when it seems to be replaced, in some instances at least, by a hair (cf. Kuckuck, *in* Oltmanns, 1922, pp. 60, 61). The species of *Dictyosiphon*, also, were never known except as to the macroscopic plant with zoosporangia until Sauvageau

(1917, pp. 829–831) announced the discovery of a reduced, practically microscopic gametophyte, filamentous like a dwarfed *Ectocarpus* with plurilocular gametangia giving rise to motile gametes which either fuse or develop parthenogenetically. Such a gametophyte is intermediate between the reduced, yet still macroscopic, gametophyte in some of the Asperococcaceae, and the very much modified gametophyte of the Laminariaceae. Besides the Dictyosiphonaceae, it may be desirable also to include in the Dictyosiphonales, the family of the Spermatochnaceae, at least as limited to species with growth from a single apical cell, in which case our diagnosis of the order must necessarily be modified.

FAMILY 18. DICTYOSIPHONACEAE DE-TONI

Characters of the order

De-Toni, Syst. Uebers. Fucoid., 1891, p. 179; Syll. Alg., vol. 3, 1895, p. 448; Kjellman, *in* Engler and Prantl, Die natürl. Pflanzenfam., 1 Th., 2 Abt., 1893, p. 212. *Dictyosiphoneae* Kuetzing, Sp. Alg., 1849, p. 484; Thuret, *in* Le Jolis, Liste alg. mar. Cherb., 1863, p. 72 (all in part).

We have restricted the Dictyosiphonaceae to the species of *Dictyosiphon* in the broader sense as including *Coilonema* Aresch. The genera *Gobia* and *Scytothamnus* seem to us to be more properly assigned to the Chordariales, since the growth in length is subapical rather than strictly terminal. The resemblances between the Dictyosiphonaceae and the Spermatochnaceae consist in having growth in length from an apical cell and producing only zoosporangia on macroscopic plants. The genus *Dictyosiphon* is readily recognized and delimited, but with the species, it is otherwise. We have restudied the specimens from our coast and arranged them as best we may.

39. **Dictyosiphon** Grev.

Fronds attached by a small parenchymatous disk, terete, filiform, with several orders of branches arising alternately from all sides, solid or at times fistulose, growing from an apical cell, composed of two tissues, a central core of longitudinally elongated, colorless cells, surrounded by a tissue of small, more or less polygonal, color bearing cells; reproduction by zoosporangia embedded in the cortical tissue; colorless hairs abundant.

Greville, Alg. Brit., 1830, p. 55.

The type and only species mentioned by Greville is *D. foeniculaceus.* The type locality is "Mona Island" (Isle of Man) (cf. Dillenius, 1741, p. 16).

Key to the Species

1. Fronds relatively small and delicate, with opposite branching..1. **D. tenuis** (p. 588)
1. Fronds more robust, chiefly with alternate branching.. 2
    2. Fronds with slender, attenuated branches.. 3
    2. Fronds with fewer, shorter, thicker, blunt branches................................ ....4. **D. hippuroides** (p. 589)
3. Hispid with slender, short ultimate branchlets....................2. **D. hispidus** (p. 588)
3. Not as above..3. **D. foeniculaceus** (p. 589)

1. **Dictyosiphon tenuis** S. and G.

Fronds very fragile and flaccid throughout, 5–10 cm. long, with main axis percurrent and 225–250μ diam.; branches opposite, of 3–4 orders, flagelliform; ultimate ramuli blunt, 40–50μ diam.; sporangia scattered, completely submerged in the cortical tissue.

Golofin Bay, Alaska.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 10. *Dictyosiphon foeniculaceus* f. *americanus* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 248 (not of Collins).

We have but a few specimens of this species upon which to base the diagnosis. They were collected by Mr. R. C. McGregor in 1900. The species is based principally upon the delicate character of the fronds, the main axis being only about a quarter of a millimeter in diameter, and upon the prevailing opposite branching, alternate branching prevailing in the other species. Our plant is much more slender than the plants referred by Collins to his f. *americanus* of *D. foeniculaceus* which also lacks the regularly opposite branching.

2. **Dictyosiphon hispidus** Kjellm.

Fronds delicate and flaccid, freely branched on all sides into several relatively long, primary, flagelliform branches, these in turn irregularly branched, all clothed with numerous, short, subulate or cylindrical, ultimate ramuli, tubular below, solid above; olive brown in color, darker on drying.

Growing on *Chordaria* in the lower littoral belt. Orca, Alaska.

Kjellman, Algenveg. Murm. Meer., 1877, p. 47, Spets. Thall. II, 1877*a*, p. 39, pl. 2, fig. 1. *Dictyosiphon foeniculaceus* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 248 (in part).

A single collection from Orca in the Prince William Sound region of Alaska is all we have of this species and this was earlier (1903, p. 248) referred by us to *D. foeniculaceus.* The abundance of short branchlets over the plant, however, give it the hispid appearance of Kjellman's species. Certain of the specimens we refer to *D. foeniculaceus* approach it, but do not seem by any means, to equal it in hispidity.

3. **Dictyosiphon foeniculaceus** (Huds.) Grev.

Plate 40, figs. 47–49

Fronds solitary or occasionally several arising from a confluent disk-shaped holdfast, terete, repeatedly much branched, beginning close to the base, 15 cm. to 4 dm. high; branches either alternate or occasionally opposite, the different orders much reduced in size, the ultimate being very fine, short and subulate, all gradually attenuated; when young the ultimate branches covered with a dense growth of fine hairs; superficial cells small, rounded or angular, irregularly disposed or at times in long, longitudinal rows; zoosporangia spherical or ellipsoidal, distributed at random over the surface of the frond.

Growing on stones and on other plants, in the middle and lower littoral belts. From Bering Sea, Alaska, to Puget Sound, Washington.

Greville, Alg. Brit., 1830, p. 56, pl. 8, figs. 1–4; Saunders, Alg. Harriman Exp., 1901, p. 422; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 248 (in part); Harvey, Phyc. Brit., pl. 326. *Conferva foeniculacea* Hudson, Fl. Angl., 1762, p. 479.

This species has more slender as well as coarser forms. It is larger and more robust than *Dictyosiphon tenuis* and lacks the small slender ultimate branchlets arranged along the branches which give character to *D. hispidus.* All three of these species differ from *D. hippuroides* in having more tapering branches which decrease in size with each order of branching.

4. **Dictyosiphon hippuroides** (Lyngb.) Kuetz.

Frond solid, or occasionally slightly fistulose below, filiform, rigid, moderately branched, 15–60 cm. high, up to 1.25 mm. diam.; branches of different orders very similar, flagelliform, tapering but slightly; surface cells in the lower part of the frond arranged in horizontal series, but irregular above; color dark brown.

Growing on rocks in the lower littoral belt. Apparently rare in our territory. Reported from St. Paul Island and from near Iliuliuk, Unalaska, Alaska.

Kuetzing, Tab. Phyc., vol. 6, 1856, p. 19, pl. 52, II; Setchell, Alg. Prib. Is., 1899, p. 591; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 248. *Dictyosiphon Chordaria* f. *gelatinosa* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 248 (not Stroemfelt). *Scytosiphon hippuroides* Lyngbye, Hydr. Dan., 1819, p. 63, pl. 14 B.

D. hippuroides resembles *D. foeniculaceus* very closely, and is often confused with it. It is a coarser plant generally, is less profusely branched, each order of branches approximating the same size, and is less tapering. Collins (Rhodora, 1900, p. 164) states that this species frequently reaches a meter in length on the Atlantic coast. The material which we have referred to this species is scanty and of small size. Some of our plants may possibly be referred to the var. *fragilis* (Harv.) Kjellman.

Order 6. LAMINARIALES oltmanns

Fronds of large size, solid or hollow, simple or branched, cylindrical to flattened, usually with three distinct regions, viz., (1) a holdfast varying from discoid to clusters of simple or branched hapteres, (2) a stipe cylindrical or more or less flattened and simple to dichotomously or irregularly branched, and (3) a flattened blade or blades, of usually three sets of tissues, inner of colorless, elongated, usually intertwined, hyphal cells, some with enlarged ends ("trumpet hyphae"), intermediate of somewhat vertically elongated or nearly isodiametric cells with scattered chloroplasts (phaeoplasts) passing over into an outer layer of small cells usually deeply colored; mucilage glands, or canals, present in some species; zoosporangia on macroscopic sporophylls, borne in extended sori, accompanied by closely packed unicellular paraphyses having, usually, terminal hyaline appendages; growth in length from a meristematic tissue intercalated between blade and stipe, or, in Chordaceae, just above the holdfast; gametophyte microscopic, usually very much reduced, confervoid, bearing unilocular gametangia; sperms motile, biciliate; eggs non motile, fertilized and germinating in position.

Oltmanns, Morph, und Biol. der Algen (ed. 2), vol. 2, 1922, p. 121.

The discoveries by Sauvageau (1915) and by Kylin (1916, 1918) of the gametophytes of several members of this group inaugurated a change in the whole attitude toward the classification of the Brown Algae and led to interpretations of certain peculiarities of the occurrence of the reproductive bodies in certain groups. Following these indications to their seemingly logical outcome has led us to arrange the Brown Algae as we have, trusting to be justified, at least in large measure, when our knowledge of development within the group shall have been made more exact. The order of the Laminariales, however, is clearly delimited by the intercalary region of growth in the complex plants belonging to it associated with the intermingling of the unilocular zoosporangia with unicellular paraphyses in extensive elevated sori. The question as to the division of the order into families is not so clear as that of its cleavage from other orders. Two families have been recognized and there is great temptation to increase the number. There certainly exists a certain tendency to group genera into some sort of larger divisions, but the difficulty lies in finding sharp lines of cleavage. The best distinctions lie according to the differentiations of the frond arising at the transition place between the blade and the frond and the relation to this and the fertile areas. The alternatives seem to be these: either to retain all the genera under one large and varied family (possibly excepting the Chordaceae) divided into numerous tribes, or to divide them between numerous families of unequal value and of often indistinct cleavage. We have separated the Laminariaceae into five families, one of which Haligeniaceae (including *Haligenia* and *Saccorhiza*) is not represented in our territory.

Key to the Families

1. Stipe absent or not differentiated, paraphyses without hyaline appendages .... 19. **Chordaceae** (p. 591)
1. Stipe distinct, at least when young, paraphyses with hyaline appendages 2
   2. Transition place neither giving rise to splitting nor to outgrowths .... 20. **Laminariaceae** (p. 593)
   2. Transition place not as above 3
3. Splitting arising at transition place or within its influence .... 21. **Lessoniaceae** (p. 621)
3. Outgrowths arising at transition place or within its influence .... 22. **Alariaceae** (p. 633)

Family 19. CHORDACEAE Dumort.

Fronds cylindrical, hollow, interrupted by diaphragms, with a discoid holdfast, growth in length basal (situated just above the holdfast), innermost cells elongated, supporting hyphal filaments united to form the diaphragms; outermost layer a single row of slightly elongated cells with colorless hairs and with or without exserted colored filaments; sori extended, paraphyses destitute of colorless appendages; gametophyte microscopic as in the order.

Dumortier, Comm. Bot., 1822, p. 72 (fide Pfeiffer); Kylin, Stud. über Algenfl. der Schwed. Westküste, 1907, p. 97.

The single genus *Chorda*, clearly a member of the Laminariales, but differing from all the other genera of the order in its hollow cylindrical frond, is taken to represent a distinct family.

40. **Chorda** Stackh.

Fronds arising from a small disk-shaped holdfast, unbranched, cylindrical, solid below, hollow above, the cavity separated by cross-partitions into many chambers, color olive brown, growth intercalary near the base; median tissue of the hollow portion composed of longitudinally elongated cells, hexagonal in cross-section, firmly united, lined with delicate, loose filaments which unite to form the cross-partitions at intervals; the outside of the median tissue is clothed with unicellular paraphyses, hairs and zoosporangia; reproduction asexual by unilocular zoosporangia.

Stackhouse, Physiol. Observ., *in* Ner. Brit., 1797, p. xvi.

The type of the genus is the *Fucus Filum* of Linnaeus (Sp. Pl., 1753, p. 1162). The type locality is unknown.

Chorda Filum (L.) Lamour.

Fronds gregarious, several at times arising from the same confluent base, cylindrical, sometimes spirally twisted, slightly tapering at the base and at the apex, from 3 dm. to 4 m. long, 2–5 mm. diam., lubricous, when young clothed with a dense growth of hyaline or yellowish colored hairs; paraphyses unicellular, densely crowded, clavate, slightly longer than the zoosporangia and nearly obscuring them above; unilocular zoosporangia oblong to ellipsoidal, 30–50μ long, 10–15μ wide; plurilocular gametangia 35–40μ wide.

Growing on stones in the upper sublittoral belt. From Port Clarence, Alaska, to the Straits of Juan de Fuca.

Lamouroux, Essai, 1813, p. 26; Saunders, Alg. Harriman Exp., 1901, p. 424; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 254; Reinke, Atlas, 1889, p. 35, pls. 26, 27, 28. *Fucus Filum* Linnaeus, Sp. Plant., 1753, p. 1162.

There is little to be said under *Chorda* except to note that it is a plant of the colder waters and of which we have seen specimens from our coast collected at Port Clarence, Safety Harbor, near Cape Nome, St. Michaels, and Golofin Bay on the Alaskan coast. It is credited by Postels and Ruprecht (1840, p. 19) to Sitka and Unalaska, by Saunders (1901, p. 424) to Popof Island and Prince William Sound, and by MacMillan (1902, p. 219) to the Straits of Juan de Fuca. The last locality is not verified by any specimens, so far as we know. Such specimens as we have seen do not differ from those of the North Atlantic.

FAMILY 20. LAMINARIACEAE REICHENB.

Fronds simple, composed of holdfast, stipe and blade, at least in the earlier stages, never with true dichotomous branching of the stipe, adventitious or false branching arising in a few cases from the blade, composed of the usual three tissues; mucilage glands and passages present or absent; blades destitute of cryptostomata (or bunches of hairs); sori extended, always on the blade, paraphyses with hyaline appendages.

Reichenbach, Conspect. Reg. Veg., 1828, p. 29 (fide Pfeiffer).

We have adopted the family of the Laminariaceae in restricted sense as including those members of the Laminariales having the principal meristematic region situated at the summit of a more or less well developed stipe, at the base of a flattened blade, and initiating neither splitting nor outgrowths, of or from, either the stipe or the blade. In the simplest genera (e.g., *Laminaria*) the transition place is perfectly plane, but in some genera folds (e.g., *Pleurophycus* and *Cymathaere*), in others ribs (e.g., *Costaria* and *Agarum*) are developed, while in some genera (*Costaria*, *Agarum*, and *Thalassiophyllum*) bullosities and resulting perforations are the final results of its activity. In certain species the center of the blade wears away to the transition place which extends and growing on, produces two false branches each with half a blade attached (*Hedophyllum subsessile* and *Thalassiophyllum*). It has seemed best to group the various genera into tribes according to these various methods of behavior.

Key to the Tribes

1. Blades without perforations, longitudinal ribs or folds, occasionally bullose.... 2
1. Blades with perforations, longitudinal ribs or folds.......... 3
    2. Stipe persistent.......... 1. **Laminarieae** (p. 594)
    2. Stipe early disappearing.......... 4. **Hedophylleae** (p. 616)
3. Blades with longitudinal folds.......... 2. **Cymathaereae** (p. 606)
3. Blades with longitudinal ribs or perforations.......... 3. **Agareae** (p. 609)

TRIBE 1. LAMINARIEAE BORY (LIM. MUT.)

Fronds with well developed stipes and flattened blades; hapteres sometimes elongated and producing new fronds; blades plane, undivided or splitting from above downwards, at times bullose, but without perforations, longitudinal ribs or folds.

Bory de Saint Vincent, *in* Dict. Class., vol. 1, 1822, and vol. 9, 1826, p. 187 (as family); De-Toni, Syll. Alg., vol. 3, 1895, p. 317 (in part); Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 146.

The tribe of the Laminarieae contains the single large genus, *Laminaria*. It may be looked upon as containing the simplest, or, certainly, the least modified of the members of the family and as the type whence divergences have arisen or taken their departúre.

41. **Laminaria** Lamour. (in part)

Fronds differentiated into three distinct parts, a basal holdfast, composed either of a solid disk of more or less branched hapteres, a stipe of greater or less length, and a blade; both the stipe and the blade may or may not have mucilage ducts; blade simple or more or less deeply lacerated into few to many segments, plane or with intramarginal bullae and marginal ruffles; growth intercalary at the base of the blade; reproduction asexual, by zoospores borne in unilocular zoosporangia among unicellular paraphyses in extensive sori nearly covering both surfaces of the blade of the macroscopic plant, and sexual, oogamous, on microscopic plants.

Lamouroux, Essai, 1813, p. 20.

The *Laminaria* of Lamouroux (*loc. cit.*) included plants now referred to several genera and well distributed through the order Laminariales. The first three species, however, are of the genus *Laminaria* as gradually restricted by later authors. The Lamouroux name is antedated by the *Laminarius* of Roussel (1806), by the *Saccharina* of Stackhouse (1809) and the *Phycodendron* of Olafsen and Povelsen (1772). *Laminaria* has, however, received the sanction of the International Botanical Congress of Brussels (1910, *see* Briquet, 1912, p. 76). While most of the species of Laminaria are readily separated into those whose blade is digitate (i.e., split deeply into segments) and those whose blade is entire, there are a few species seemingly presenting both conditions, e.g., *L. cuneifolia* of our coasts.

KEY TO THE SPECIES

1. Blade entire or slightly split at the outer end 2
1. Blade split more or less deeply into several narrow segments 8
    2. Fronds, except when young, arising from creeping "rhizomes" 3
    2. Fronds without creeping "rhizomes" 4
3. Mucilage ducts absent from stipe .... 3. **L. longipes** (p. 597)
3. Mucilage ducts present in both stipe and blade .... 4. **L. Sinclairii** (p. 598)
    4. Holdfast a solid parenchymatous disk .... 6. **L. personata** (p. 599)
    4. Holdfast of branched hapteres 5
5. Blade densely bullate all over .... 5. **L. Farlowii** (p. 599)
5. Bullae in two rows within the margin or scattered 6
    6. Stipe long, complanate, except at base, very dark brown .... 2. **L. complanata** (p. 596)
    6. Stipe short, terete, color yellowish brown 7
7. Mucilage ducts in the blade only .... 1. **L. saccharina** (p. 595)
7. Mucilage ducts in both blade and stipe .... 7. **L. cuneifolia** (p. 600)
    8. Holdfast a solid parenchymatous disk .... 8. **L. ephemera** (p. 603)
    8. Holdfast composed of stout branched hapteres 9
9. Fronds plane, stipe long, up to 1 m. 10
9. Fronds more or less bullate, stipe relatively short .... 7. **L. cuneifolia** (p. 600)
    10. Stipe cylindrical to near apex 11
    10. Stipe compressed from just above holdfast .... 11. **L. platymeris** (p. 605)
11. Mucilage ducts of stipe in a circle just beneath the cortex, stipe slender .... 9. **L. dentigera** (p. 604)
11. Mucilage ducts of stipe deep seated, stipe rigid .... 10. **L. Andersonii** (p. 605)

1. Laminaria saccharina (L.) Lamour.

Holdfast of numerous, branching, more or less rigid hapteres often extending for 5–8 cm. up the stipe which is very variable in length, from 5–50 cm., cylindrical, flattening above into the blade, 6–9 mm. diam., without mucilage ducts; blade undivided, usually coriaceous or membranaceous when growing in quiet waters, plane, undulate, or with two distinct rows of large bullae along the margin, ovate to ovate-lanceolate, often with cuneate base, with mucilage ducts; color rich brown.

Growing on rocks in the upper sublittoral belt. Reported from various localities from the Alaskan peninsula to Coos Bay, central coast of Oregon.

Lamouroux, Essai, 1813, p. 22; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 261; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 149. *Fucus saccharinus* Linnaeus, Sp. Pl., 1753, p. 1161.

All attempts to separate this widespread species of the cooler waters of the northern hemisphere have been unsatisfactory. The type has been assumed to be the plant with mucilage ducts in the blade, but lacking them in the stipe. This seems to be a condition with all the plants we have referred here. We have not met with any forms referrable to *L. Agardhii*, i.e., entirely destitute of mucilage ducts.

On our coast at least two forms of this species may easily be distinguished:

Laminaria saccharina f. linearis J. Ag.

Holdfast composed of an abundance of relatively small branched hapteres extending along the stipe up to 8 cm. above the base, stipe slender and short, blade with cuneate base, 12–18 cm. broad, 2.5–3.5 m., or more, long, with two distinct rows of bullae extending the entire length of the blade just within the margin.

Growing on rocks in localities subjected to the action of the water, in the upper sublittoral belt. From Unga, Alaska, to Puget Sound, Washington.

J. Agardh, De Lamin., 1867, p. 12; Saunders, Alg. Harriman Exp., 1901, p. 429, "forma b."; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 261; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. LXXXVIII.

Laminaria saccharina f. membranacea J. Ag.

Hapteres strong, stipe longer than in the preceding, frond ample, membranaceous, often of delicate consistency, not holding together when lifted from the water, more or less undulate or bullate; large fruiting specimens at Sitka, Alaska, are stiff and rigid, not readily torn.

Growing on rocks, logs, floats, etc., in the upper sublittoral belt. From Alaska southward to Coos Bay, Oregon.

J. Agardh, De Lamin., 1867, p. 13; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 261; Saunders, Alg. Harriman Exp., 1901, p. 429, "forma a." *Laminaria saccharina* Tilden, Amer. Alg. (Exsicc.), no. 240.

2. Laminara complanata (S. and G.) Setchell

Plate 57

Holdfast of few, rigid, slightly branched hapteres; stipe 3–5 dm. long, terete below, much flattened above, varying from 8–12 mm. diam. below, to 20–25 mm. wide and 2–4 mm. thick above, without mucilage ducts; blade 80–100 cm. long, 40–50 cm. wide just above the base, in many specimens short and nearly circular in outline, amply ruffled, with base decidedly cordate and with mucilage ducts large and abundant, just under the surface layer of cells; color dark.

Growing on piles and on rocks in the upper sublittoral and lower littoral belts. Observed in but a single locality, Friday Harbor, San Juan Island, Washington.

Setchell, Kelps of U. S. and Alaska, 1912*a*, p. 149. *Laminaria saccharina* f. *complanata* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 262; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. LXXXVII.

Laminaria complanata, known as yet only from the type locality, seems very distinct from other members of the *saccharina*-group, on account of its rather long and flattened stipe. It does not seem, so far as the material available is concerned, to merge into true *L. saccharina* found in the same locality, even growing on the same piles with it.

3. **Laminaria longipes** Bory

Holdfast at first composed of a few hapteres arising from the basal portion of the stipe, these in turn, becoming rhizome-like and giving off lateral secondary hapteres and lateral erect fronds; stipes terete, smooth below, compressed at the summit, 8–15 cm. long, 4–6 mm. thick, without mucilage ducts; blade plane, undivided, acuminate or rounded at the apex, 10–20 cm. long, 2–4 cm. wide, with large mucilage ducts within the cortex.

Growing on rocks in the Bering Sea (Agattu, Kyska and St. Paul Islands).

Bory, *in* Dict. Class., vol. 9, 1826, p. 189; Kjellman, Om Beringhaf. Algfl., 1889, p. 43; Setchell, Alg. Prib. Isl., 1899, pp. 591, 592, pl. 95, Kelps of the U. S. and Alaska, 1912*a*, p. 150; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 260. *Lessonia repens* Ruprecht, Tange Och., 1851, pp. 232, 350. *Laminaria Ruprechtiana* Le Jolis, Examen, p. 71, or 590. (For explanation of the dates of this publication see Setchell, 1891, p. 214.) *Anthrothamnus? longipes* J. Agardh, De Lamin., 1867, p. 26.

We have followed J. G. Agardh in assigning the northern plant with distinct rhizome-like basal portion to the *Laminaria longipes* Bory, although we have not seen the type specimen. It closely resembles the more southern *L. Sinclairii*, but lacks the mucilage glands of the stipe so well developed in the latter species.

4. **Laminaria Sinclairii** (Harv.) Farlow

Holdfast at first composed of small, branching hapteres, soon sending out numerous extensively creeping rhizomes from which fronds subsequently arise; stipe with small, deep-seated mucilage ducts, cylindrical, 2–3 mm. diam., 2–3 dm. long; blade linear, undivided or slightly lacerated at the free end, plane, glossy, 1.5–3 cm. wide, 4–7 dm. long, with mucilage ducts; color very dark brown, black on drying.

Growing on rocks in the lower littoral and upper sublittoral belts. Abundant from the southern end of Vancouver Island to Pecho, San Luis Obispo County, California.

Farlow, *in* Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 118 (nomen nudum); Setchell, Notes on Kelps, 1896, p. 44; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. VII. *Lessonia Sinclairii* Harvey, *in* Hooker, Flora Antarc., vol. 2, 1846, p. 460. *Laminaria saccharina* Harvey, *in* Hooker and Arnott, Bot. Beechey, 1841, p. 407. *Hafgygia Sinclairii* Areschoug, Obs. Phyc., IV, 1883, p. 6.

The combination *Laminaria Sinclairii* was first used by Farlow as a *nomen nudum* in connection with the plants collected at Santa Cruz, California, by Dr. C. L. Anderson and distributed in Farlow, Anderson and Eaton's Algae Exsiccatae Americae-Borealis, fascicle 3, no. 118, in 1878. The specific name was first used by Harvey in Hooker's Flora Antarctica (*loc. cit.*) in honor of Dr. Sinclair, who first collected the species and sent it to Sir W. J. Hooker in whose herbarium Harvey first saw it. Harvey states on page 87, part 1, of the Nereis Boreali-Americana "The *Lessonia Sinclairii*, from California, mentioned by Dr. Hooker, *Fl. Antarct., vol.* 2, *p.* 460 must for the present remain undescribed. . . . is the *Laminaria saccharina* of *Harvey in* Hook. and Arn. *Bot. Beechey, p.* 407." It was listed by Anderson (1891, p. 220) as "*Laminaria Sinclairii* Farlow and Eaton" and De-Toni (1895, p. 343) adopted this combination. Areschoug (1883) gave the first diagnosis of the species.

Laminaria Sinclairii may readily be distinguished from all other species on our coast, except *L. longipes* Bory, by its relatively long and narrow blade and slender stipe, and by its creeping rhizomes. It is to be distinguished from *L. longipes* of the Bering and Ochotsk seas, which it most closely resembles, by the absence of mucilage ducts in the stipe of that species.

5. **Laminaria Farlowii** Setchell

Plate 56*a*

Holdfast of strong, compact, branching hapteres; stipe short, terete, flattening suddenly into the blade, 4–7 cm. long, 4–6 mm. diam., without mucilage ducts; blade thick, coriaceous, abundantly wrinkled or pitted with rather deep depressions, more or less in longitudinal rows over the whole blade on both sides with scanty large mucilage ducts; color very dark brown.

Growing in the lower littoral and very upper sublittoral belts. Central California to southern California.

Setchell, *in* Anderson, List of Calif. Mar. Alg., 1891, p. 220 (*nomen nudum*), Trans. Conn. Acad., 1893, vol. 9, p. 355 (description), Regeneration among kelps, 1905, pl. 16, fig. 17; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XXXI.

Laminaria Farlowii is not a very abundant or commonly collected species, although in its general region, it is scarce rather than rare. The peculiar corrugated appearance of the blade is difficult to describe, but is a constant and a striking characteristic.

6. **Laminaria personata** S. and G.

Plate 61

Fronds attached by an ample parenchymatous discoid base, yellowish brown in color, 4–6 dm. high; blade plane, broadly cuneate below, 12–20 cm. wide, mucilage ducts in the outer cortex, relatively sparse; stipe 8–12 cm. long, 4–5 mm. diam., terete below, flattening into the blade, without mucilage ducts.

Growing on rocks in the upper sublittoral belt. Alaska [Yakutat Bay, Kukak Bay and Popof Island (Saunders), Sitka (Gardner)].

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 10. *Laminaria solidungula* Saunders, Alg. Harriman Exp., 1901, p. 429?; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 260 (?); Setchell, Kelps of U. S. and Alaska, 1912*a*, p. 150 (?) (none of these of J. G. Agardh).

This species of *Laminaria* is the only one we have seen from Alaskan waters which has a disk-shaped holdfast, and in this respect it resembles *L. ephemera* Setchell, a species extending southward from Puget Sound to central California (Carmel Bay). Only a few specimens were observed at Sitka, and Saunders (*loc. cit.*, p. 429) remarks on the occurrence of his *L. solidungula*: "Occasional in the sublittoral zone'' and he also remarks (*loc. cit.*) that in his plants ''the stipe is thick and abundantly supplied with mucilage canals as are the broad flattened rhizoids.'' The statements, ''thick stipe,'' ''broad flattened rhizoids,'' and ''mucilage canals'' are indications that he must have located and described some other plant. We have been unable to locate a complete specimen of Saunder's plant. The plants from Sitka, upon which we founded *L. personata*, have no mucilage ducts in the stipe, another indication that they are different from those collected by Saunders and are, therefore, different from Agardh's *L. solidungula*.

We have searched carefully for *L. solidungula* in our territory since J. G. Agardh calls attention to Ruprecht's statement (1851, p. 351) that he found a young abnormal specimen of *L. latifolia* Ag. (a form of *L. saccharina*) with a scutate holdfast among his Ochotsk specimens. Kjellman does not mention it among his Bering Sea plants, but Saunders (*loc. cit.*) credits it to Yakutat Bay, Kukak Bay, and Popof Island, Alaska. Possibly both Ruprecht's and Saunders' plants may prove to be the same as our Sitkan specimen. Our Sitkan plant probably belongs to the *Saccharina*-group, although the blade is sometimes broad and deeply split (as in the case of the older plants in our illustration, plate 61).

7. **Laminaria cuneifolia** J. Ag.

Plate 59*a*, *b*, and plate 60

Holdfast of a few, stout, branched hapteres; stipe usually short and flexuose, terete at the base, flattening above into the blade, 6–10 cm. long, 3–4 mm. diam., with moderately large mucilage ducts in a circle near the surface; blade entire or with a few lacerations at apex, usually cuneate at the base, but at times even cordate, becoming linear, very variable in size, about 6–9 dm. long, 7–12 cm. wide, coriaceous, with a row of prominent, transverse bullae within each margin, in some only at the base, in others extending to the apex, with abundant large mucilage ducts; color of the whole plant a very dark brown or nearly black.

Growing in a narrow belt along low-tide line. St. Lawrence Island, Alaska, to Puget Sound, Washington.

J. G. Agardh, De Lamin., 1867, p. 10. *Laminaria bullata* Kjellman, Om Beringh. Algfl., 1889, p. 46, pl. 2, figs. 5–9; Saunders, Alg. Harriman Exp., 1901, p. 428; Setchell and Gardner, Alg. N.W. Amer., 1901, p. 257; Setchell, Kelps of U. S. and Alaska, 1912*a*, p. 151.

There are two series of *Laminarias* in our northern waters present in great variety of form and seemingly overlapping forms which are puzzling as to their proper taxonomic treatment. The one series has passed under the names of forms of *Laminaria bullata* Kjellman and the other under those of forms of *L. Bongardiana* P. and R. The *L. bullata* type (cf. Kjellman, 1889, pl. 2, fig. 5) has a simple individual blade and a series of pronounced bullae within each border. From this simple type, forms with a great variety of lengths of stipe, breadth of blade, more pronounced or less pronounced bullae (even almost, or quite absent) are found. The compression of the stipe also varies greatly in degree. The wider blades become broadly oblong to even cordate at the base and split deeply into a few broad segments. In several of its states it is to be distinguished from very similar forms of the plants, usually grouped under *L. Bongardiana,* by its somewhat less flattened stipe and the presence, or often only indication, of bullae. Both are species possibly better reckoned in the digitate section, yet *L. Bongardiana* (see below under *L. platymeris*) is more properly digitate while *L. cuneifolia* is perhaps more typically of the *saccharina*-group. We hesitate somewhat in referring the *L. bullata* Kjellman series of forms to *L. cuneifolia* J. Ag., but J. G. Agardh certainly included the simpler forms of Kjellman's species under his. Agardh makes no statement as to type, but probably regards the Ochotsk Sea plants from that point of view. The American plants placed by Agardh under his *L. cuneifolia,* viz., one from Esquimault, is the same as the *L. bullata* f. *simplex* S. and G. We can see no way of distinguishing between the two species from the descriptions and consequently unite them, placing the forms we have described under *L. cuneifolia*. The *L. cuneifolia* of Greenland, however, seems to be a different species and is closely related to *L. groenlandica* Rosenvinge.

We are uncertain as to the nature of the Alaskan plant referred by Saunders (1901, p. 429) to *L. cuneifolia,* since he says that the blade is "thin, papyraceous, light olive green and very brittle in drying, quite regularly wavy on the margin" and have not included it in our synonymy.

Laminaria cuneifolia f. **angusta** S. and G. comb. nov.

Holdfast of distinct branched hapteres; stipe short, 1–2 cm. long, terete or slightly flattened above, with mucilage ducts closely crowded in a circle just beneath the periphery, elongated radially in section view, surrounded by conspicuous secreting cells; blade undivided, 15–45 cm. long, 3–5 cm. wide, cuneate at the base, usually more or less falcate, with a well defined row of bullae within each margin; mucilage ducts in the blade large, about one-third of the way between the surface and the distinctly marked off, wide medulla; color very dark brown, turning black on drying.

Growing abundantly on rocks in the upper sublittoral belt. Reported at Cape Flattery and along the west coast of Whidbey Island, Washington, and doubtless at other localities in the lower Puget Sound region and farther north.

Setchell and Gardner, Alg. N.W. Amer., 1903, p. 257; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. LXXXV (both *sub L. bullata*).

Laminaria cuneifolia f. **subsimplex** S. and G. comb. nov.

Hapteres well developed; stipe short and stout, 4–8 cm. long, 4–6 mm. diam., terete below, somewhat compressed above, with mucilage ducts forming a circle just beneath the periphery; blade thick and somewhat coriaceous, 50–150 cm. long, 10–15 cm. wide, plane in some specimens, particularly the younger ones, with a distinct row of bullae extending for some distance above the base within each margin, entire or split from a half to a third of the distance to the base into two, or at most a few, broad segments, with large mucilage ducts situated about halfway between the surface and the distinctly marked off medulla; color very dark in old specimens.

On rocks in the upper sublittoral belt. Common in the lower Puget Sound region.

Setchell and Gardner, Alg. N.W. Amer., 1903, p. 257 (*sub L. bullata*). *Laminaria bullata* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XXIX.

Laminaria cuneifolia f. amplissima S. and G. comb. nov.

Stipe 2–4 cm. long, soon much flattened into the blade, with mucilage ducts in a discontinuous circle just within the periphery; blade up to nearly 3 m. long, 1 m. wide, but usually smaller, broadly cuneate to cordate at the base, rounded above, split into few segments, the rows of bullae large and fairly distinct, particularly at the base when the plants are young, at maturity the whole blade strongly bullate; mucilage ducts conspicuous and plentiful, associated with groups of secreting cells one-half to one-third the way between the surface and the distinct medulla; color very dark brown, black when dry.

Growing on piles, floats, and rocks in the upper sublittoral belt in quiet water. Sitka, Alaska, to Puget Sound and Cape Flattery, Washington.

Setchell and Gardner, Alg. N.W. Amer., 1903, p. 258; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. LXXXIV (both *sub L. bullata*).

8. **Laminaria ephemera** Setchell

Plate 58

Holdfast strictly discoid, firmly attached to rocks; stipe terete, slender, 2–4 mm. diam., 6–10 cm. long, devoid of mucilage ducts; blade broadly rounded to narrowly cuneate at the base, linear, entire or split more or less deeply into a few linear lobes or segments, 5–8 cm. wide, 3–4 dm. long, about 1 mm. thick, without mucilage ducts; sori arranged in several longitudinal bands; color light brown; annual; fruiting in May.

Growing in the upper sublittoral belt. Known from only four localities, Cape Flattery and Tacoma, Washington, Port Renfrew on the southwest coast of Vancouver Island, British Columbia, and Carmel Bay, California.

Setchell, Notes on Algae I, 1901, p. 121, Kelps of U. S. and Alaska, 1912*a*, p. 150. *Renfrewia parvula* Griggs, Postelsia, 1906, pp. 247–274, pls. 16–19; Tilden, Amer. Alg. (Exsicc.), no. 609.

This is one of the few seemingly strictly annual species of the genus *Laminaria* and the only one on our coast. It shares this distinction with comparatively few species either in the family or in the entire order. In the family Laminariaceae, the only suspected annuals of our coast are *Costaria costata*, *Cymathaere triplicata* and *Agarum fimbriatum*. The annual character and the discoid holdfast clearly distinguish this species.

9. **Laminaria dentigera** Kjellm.

Holdfast composed of a dense mass of rigid hapteres; stipe 30–35 cm. long, smooth, flexuose, thickest at the base, slightly attenuated upward, somewhat compressed at the apex, mucilage ducts large, densely crowded in a circle just beneath the surface; blade sublanceolate, simple cuneate at the base, thick, smooth, dark brown or almost black, shining, dissected nearly to the base with narrow or wide linear lobes with lacerated margins.

Growing in the sublittoral belt. Aleutian Islands to the Bering Strait.

Kjellman, Om Beringh. Algfl., 1889, p. 45, pl. 2, figs. 10–14; Setchell, Kelps of U. S. and Alaska, 1912*a*, p. 151. *Laminaria dentigera* f. *brevipes* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 259.

Laminaria dentigera, while seemingly distinct in appearance from any of the truly digitate species, is somewhat difficult to diagnose with certainty. The rather stout, nearly cylindrical, or often more or less compressed, stipe, the sharply cuneate base of the blade and the usually numerous and narrow segments of the blade with lacerate margins as if irregularly dentate, distinguish the typical plants. As is frequent among the Laminariaceae, there are long-stiped and short-stiped forms with other variations tending to obscure the limits of the species. The form, previously described by us as var. *brevipes* (Setchell and Gardner, 1903, p. 259) is probably close to Kjellman's type while var. *longipes* S. and G. (*loc. cit.*) is in our present opinion, to be separated on account of its decidedly flattened stipe. We now refer the latter to *L. platymeris* de la Pyl. In spite of these, however, *Laminaria dentigera* seems clearly distinct from the forms usually reckoned under *L. Bongardiana* P. and R. (*L. platymeris* De la Pyl.) with the normal form of which, according to Kjellman, Areschoug confused it. It is to be distinguished from *L. Andersonii* Farlow in having the circle of mucilage glands of the stipe situated among the outer tissues. The type of *L. dentigera* came from Bering Island, on the Asiatic side of the Bering Sea.

10. **Laminaria Andersonii** Farlow

Fronds perennial; holdfast spreading out at the very base of the stipe, composed of numerous strong, overlapping branched hapteres; stipe large and very strong and elastic, terete, tapering upward and flattening into the blade, 1–1.5 cm. diam., 5–8 dm. long, smooth and glossy, with concentric layers and numerous deep-seated mucilage ducts; blade coriaceous, thick, smooth, divided often nearly to the base into several narrow segments, 15–25 cm. wide, 5–8 dm. (up to 10 dm.) long; color rich dark brown.

Growing in the upper sublittoral belt. Sitka, Alaska, to central California.

Farlow, *in* Anderson, List Calif. Mar. Alg., 1891, p. 220; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 255; Setchell, Regeneration among kelps, 1905, p. 145, pl. 17, figs. 19–25, Kelps of U. S. and Alaska, 1912*a*, p. 151; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. IV. *Hafgygia "Andersoni"* (Farlow) Areschoug, Observ. Phyc., IV, 1883, p. 3.

This seems to be a perfectly distinct species, with typically digitate blade, stout, cylindrical, erect and rigid stipe, the latter having deep-seated mucilage ducts. Its color, when living, is light brown.

11. **Laminaria platymeris** De la Pyl.

Holdfast forming a more or less globose mass of strong, irregularly branched hapteres; stipe thick, long or short, terete at the base, beginning to flatten a short distance above the base, often becoming widely complanate at the apex; blade plane, from cuneate to deeply cordate at the base, free from transverse bullae, more or less lacerated into segments of different lengths and widths, mucilage ducts in both stipe and blade.

Ranging from Bering Sea to the Strait of Juan de Fuca.

De la Pylaie, Flore de Terre-Neuve, 1829, p. 52; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 151. *Laminaria platytoba* De la Pylaie, Ann. Sci. Nat., vol. 4, 1825, p. 178, pl. 9, fig. I (*nomen nudum?*). *Laminaria Bongardiana* Postels and Ruprecht, Illus. Alg., 1840, p. 10, pls. 13, 14 (in part); Kjellman, Om Beringh. Algfl., 1889, pp. 43, 44 (excl. syn. *Hafgygia Bongardiana* Areschoug, et varr.). *Laminaria taeniata* Postels and Ruprecht, Illus. Alg., 1840, p.

10, pl. 38, fig. *f*. *Laminaria nigripes* J. G. Agardh, Spetsb. Alg., Till. 1868, p. 29. *Laminaria atrofulva* J. G. Agardh, Groenl. Alg., 1872, p. 16. *Laminaria fissilis* J. G. Agardh, De Lamin., 1867, p. 18.

After trying in vain to find definite lines of cleavage between the Arctic species, *L. nigripes* J. Ag., and *L. atrofulva* and the North Atlantic *L. platymeris* De la Pyl., all three digitate species, with mucilage ducts in the flattened stipes, Setchell (1912*a*, p. 151) decided to unite them. In a similar fashion he found it impossible to separate satisfactorily *Laminaria fissilis* J. Ag. and *L. Bongardiana* P. and R. of the North Pacific. He found also that the two groups of North Atlantic (Arctic) and North Pacific had no definite characteristics to segregate one from the other. He consequently, combined them all under the oldest tenable name, viz., *L. platymeris* De la Pyl.

Each of the components of this general group shows form variations as to length of stipe, thickness of stipe, degree of flattening or compression of stipe, and length, breadth, shape of base, and degree of splitting of blade. The following sets of form names may illustrate this variation: f. *taeniata,* f. *oblonga,* f. *elliptica,* and f. *reniformis* as to shape and base of blade; f. *brevipes* and f. *longipes* as to varying length of stipe; f. *complanata,* f. *compressa,* and f. *subteres,* as to compression or flattening of the stipe. Most forms may be better designated by combinations of the foregoing names than by any single one of them.

TRIBE 2. CYMATHAEREAE S. AND G.

Members of the Laminariaceae (in sensu restrict) having the blades provided with one or more longitudinal folds.

Key to the Genera

1. Fold single, broad, median..42. **Pleurophycus** (p. 606)
1. Folds several, narrow..43. **Cymathaere** (p. 608)

42. **Pleurophycus** Setchell and Saunders

Holdfast of numerous branching hapteres; stipe simple; blade long, undivided, with a single median, longitudinal, rather broad, shallow fold and with broad, at times ruffled, margins; sori narrow on both surfaces of the median fold; mucilage ducts absent from both bladder and stipe.

Setchell and Saunders MS., *in* Setchell, Notes on Algae I, 1901, p. 123, *in* Saunders, Alg. Harriman Exp., 1901, p. 427 (description).

Pleurophycus is a monotypic genus as at present known, and was discovered in 1898 on the west coast of Whidbey Island, Washington, where it grows in abundance in the upper sublittoral belt. A little later (1899) Saunders found it cast ashore at Yakutat Bay, Alaska. At Neah Bay, Washington, and on the west coast of Vancouver Island, it grows in abundance. Being so large and having such distinct character, it is rather remarkable that it escaped the notice of collectors for so long. Technically it is nearest in structure to *Cymathaere* from which it differs much in general appearance.

Pleurophycus Gardneri Setchell and Saunders

Plate 80*a*

Holdfast of numerous whorls of rigid, branched hapteres; stipe 30–50 cm. long, solid, in mature specimens terete at base, gradually flattened above into the relatively thin, meristematic, transition region; blade of flabby, elastic consistency, not perforated, undivided, but more or less eroded at the outer end, with single, median, longitudinal, broad, shallow fold, with broad, undulate margins, and with delicate wrinkles along either side of the fold, rounded or cuneate at the base, margin entire; blade 6–9 dm. long, 12–20 cm. (up to 40 cm.) broad; fold 2–4 cm. (up to 15 cm.) broad; color dark olive green.

Growing on rocks in the upper sublittoral belt. Yakutat Bay, Alaska, to Coos Bay, Oregon.

Setchell and Saunders, MS., *in* Setchell, Notes on Algae I, 1901, p. 123, *in* Saunders, Alg. Harriman Exp., 1901, p. 427, pl. 52 (description); Setchell and Gardner, Alg. N.W. Amer., 1903, p. 264; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc), no. XC; Tilden, Amer. Alg. (Exsicc.), no. 346.

So far as is known at present, this member of the Laminariaceae, seemingly very closely related to *Laminaria*, fruits but once and then dies, quite different in this respect from many species of *Laminaria* which are perennial and regenerate the blade several times. Its present known southern limit of distribution is the mouth of Coos Bay, on the coast of Oregon. It possibly extends many miles farther south, even to the coast of California.

43. **Cymathaere** J. Ag.

Holdfast discoid or with inconspicuous, rudimentary, simple hapteres; stipe short, flattened, persistent; blade long, narrow, wider at the base and tapering upward, longitudinally grooved, or loosely folded, folds deep at the base becoming nearly plane above; mucilage ducts abundant and large in both stipe and blade; sori broad, on both surfaces, at the base of the blade, paraphyses unicellular with well developed hyaline appendage (not as in Griggs, Ohio Naturalist, vol. 7, 1907, p. 92, as to absence of either mucilage ducts or hyaline tips to the paraphyses).

J. G. Agardh, De Lamin., 1867, p. 29.

The genus *Cymathaere* resembles *Pleurophycus* in having longitudinal grooves or folds. It is also peculiar in having a discoid holdfast, although this is not a primitive structure as Griggs (1907) supposes. Griggs is, also, in error in denying mucilage ducts and hyaline tips to the paraphyses on *C. triplicata*, the only known species.

Cymathaere triplicata (Post. and Rupr.) J. Ag.

Holdfast discoid, 6–15 mm. broad; stipe short and stout, 5–25 cm. long, cylindrical below, flattened above; blade undivided, narrowly linear, tapering upward, with acuminate apex and rounded or cuneate, rarely cordate base, 1.5–4 m. long, 8–18 cm. wide, thick and coriaceous at the base, thinner above, possessing three characteristic longitudinal folds extending throughout the length of the blade; sori broad, occupying the basal portion only; paraphyses linear with hyaline appendages; color yellowish brown.

Growing on rocks in the upper sublittoral belt. From Bering Sea to Puget Sound.

J. G. Agardh, De Lamin., 1867, p. 30; Saunders, Alg. Harriman Exp., 1901, p. 430; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 264; Griggs, *Cymathere,* 1907, pp. 89–96, pl. 7; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XXXIII *a, b;* Tilden, Amer. Alg. (Exsicc.), no. 343; *Laminaria triplicata* Postels and Ruprecht, Illus. Alg., 1840, p. 10, pl. 10.

The type and only species of *Cymathaere* resembles in appearance, color, texture, etc., *Costaria costata* more nearly than any other alga. In pressed specimens, the longitudinal folds are often obscured or even obliterated. Such specimens are partly responsible for the report of *Laminaria dermatodea* on our northwest coast. Griggs (1907) looks upon this species as of a more simple type than can be adopted by other students of the plant.

TRIBE 3. AGAREAE KUETZ. (LIM. MUT.)

Members of the Laminariaceae having blades, either longitudinally ribbed or perforated, or both.

Kuetzing, Phyc. Gen., 1843, p. 347; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 153.

Key to the Genera

1. Adult fronds simple; blades bilaterally symmetrical.. 2
1. Adult fronds branched; blades not bilaterally symmetrical..
....45. **Thalassiophyllum** (p. 613)
    2. Rib single; perforations numerous and constant..........46. **Agarum** (p. 614)
    2. Ribs several; perforations frequent, but never constant..
....44. **Costaria** (p. 609)

44. **Costaria** Grev.

Holdfast of branched hapteres; stipe variable in length usually flattening above; blade with longitudinal percurrent ribs, each projecting on one side only and alternating on the two surfaces, bullate and not rarely perforate, mucilage ducts absent from both stipe and blade; sori broad, distributed over most of the blade.

Greville, Alg. Brit., 1830, p. xxxix.

The genus *Costaria* was founded by Greville (*loc. cit.*) to receive a single species, *C. Turneri* Grev., dedicated to Dawson Turner, who had previously (1819, p. 72, pl. 226) described and figured it as *Fucus costatus*. Greville also quotes as a synonym the *Laminaria costata* of Agardh (1820, p. 109 and 1824, p. 269).

The members of this genus, as at present known, are confined to the waters of the Pacific Ocean, and largely on the North American coast. They are closely related to the species of *Agarum*, but differ in number, breadth, and structure of ribs, as well as in constancy of perforations.

Costaria costata (Turn.) Saunders

Plate 56*b*, and plate 79*a*

Holdfast of extensive, widespreading, dichotomously branched hapteres; stipe very variable in length and thickness, from slender forms 3 mm. diam. and 5 cm. long, up to forms 1.5 cm. diam. at the base, and 65 cm. long, with numerous, fine, parallel, longitudinal grooves, flattened at the top; blade also variable in size and form, from narrowly lanceolate with cuneate base, to ovate with marked cordate base, 1–3 dm. wide, 5–25 dm. long, coarsely bullate, with five, prominent, parallel, longitudinal ribs alternately projecting only on one side of the blade, leaving a depression on the opposite side; color dark brown, soon changing to green on drying.

Growing on rocks, wood, and other large algae in the lower littoral and upper sublittoral belts. Common along the whole Pacific coast from the Bering Sea to San Pedro, California.

Saunders, *in* Bot. Gaz., 1895, vol. 20, p. 57; Setchell, Kelps of U. S. and Alaska, 1912*a*, p. 154. *Costaria turneri* Greville, Alg. Brit., 1830, p. xxxix; Postels and Ruprecht, Illus. Alg. 1840, p. 12, pl. 24; Saunders, Alg. Harriman Exp., 1901, p. 431; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 265; Collins, Mar. Alg. Vancouver Island, 1913, p. 109; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), nos. 631 and XXXV. *Costaria Turneri* var. *pertusa* Collins, Holden and Setchell, *loc. cit.*, no. XXXIV. *Costaria Mertensii* J. G. Agardh, Sp. Alg., vol. 1, 1848, p. 140; Tilden, Amer. Alg. (Exsicc.), no. 238. *Fucus costatus* Turner, Fuci, 1819, pl. 226.

Much diversity of opinion has existed among phycologists as to the number of distinct species of *Costaria* that should be recognized. Fortunately but few species have been proposed. The earlier descriptions of these, however, have been inadequate, probably on account of insufficient data, to enable one to mark their limits with much degree of certainty. Four species and one variety were recognized by De-Toni (1895, p. 361) as follows: *C. Turneri* Grev. and its var. *pertusa* Harv., *C. Mertensii* J. Ag., *C. quadrinervia* Rupr. and *C. reticulata?* Saunders, all of which have been reported within our territory. The last mentioned is now known to be a young stage of *Dictyoneuron californicum* Rupr. *C. quadrinervia* has not again been reported, so far as we know, since its discovery, and we do not feel that the description sufficiently distinguishes it to warrant retaining it as a distinct species.

Our problem lies in the distribution of the bulk of our plants between "*C. Turneri*" and "*C. Mertensii*," one or both, and in the proper combination to use by which to designate them. *Costaria Turneri* was first proposed by Greville in 1830, when he established the genus, in the following language: "Fucus membranacea, integra, linearis, multi-costata. Fructus ignotus." No additional diagnosis was given for the species. The diagnosis is wholly inadequate to distinguish the species, were it not for the fact that he cites *Fucus costatus* Turner (Hist. Fuc., 1819, pl. 226), and *Laminaria costata* Agardh (Syst., 1824, p. 269), who in turn cites Turner's plant as a synonym. Turner proposed *F. costatus* in 1819, thus antedating Agardh's *L. costata*, first used in 1820 (Sp., vol. 1, p. 109). Turner's description and figure were based upon material collected "On the west coast of South America" by Menzies, and is so complete as to leave no doubt that his plant was a true species of *Costaria* as now recognized. As diagnosed, his species was "a foot and a half or more long, nearly linear, about two inches wide." He states that he had but a single specimen and that was pressed very flat, so he relied largely upon the description and figure of Menzies for his information. We are thus left very much in doubt as to whether Menzies' knowledge was of a normal medium-sized plant, or, as it seems to us more likely, of a young or a dwarf specimen. We have, on the California coast, plants which answer very well to the description of "*F. costata*" except as to size. They are wider and longer, three to six inches wide and three to six feet long, although Saunders (1895, p. 57) reports fruiting plants from Pacific Grove, California, which are two inches wide and two feet long. We feel fairly certain until we can obtain further knowledge of South American plants, that the citation of South America is erroneous and that our long, narrow forms are of the type species. Observing the Vienna Code, therefore, they should be listed as *Costaria costata* (Turner) Saunders.

Costaria Mertensii of J. G. Agardh (1848, p. 140) as diagnosed differs in no essential particulars from the diagnosis of *C. Turneri* Postels and Ruprecht (1840, p. 12, pl. 24) which Agardh quotes as a synonym. Whether or not *C. Turneri* Post. and Rupr. is the same as *Fucus costatus* Turner, which Postels and Ruprecht quote as a synonym, *C. Mertensii* J. Ag. has no legitimate right to supplant *C. Turneri* Post. and Rupr., and we are thus disregarding it in our account.

We have made no attempt to correlate anatomical differences with the gross morphological characters of the various forms of the genus which we have studied. Such studies as we have made of a rather extensive array of material from different habitats and localities, have all been confined to the general shape and size of the plant as a whole, and in this we have found a great range of variation. As to the hapteres, *Fucus costatus* Turner is said to have numerous, slender, unbranched hapteres. We have come across no forms except those in the juvenile stage that have this character. Ours are all many times dichotomously branched in unmutilated specimens. The thickness of the hapteres seems to depend upon the habitat. Those growing in quiet waters are usually longer and more slender than those growing in exposed situations. Regarding the *stipe,* it is to be noted that there are extreme variations. In Turner's description, the stipe is only an inch long and "of the size of a crow's quill." On two occasions, seven years apart, one of us (Gardner) has studied colonies of living plants growing in quiet water at Oak Bay, Victoria, British Columbia, and at Roche Harbor, San Juan Island, Washington, whose rigid stipes were up to six and a half decimeters long and ten centimeters wide at the flattened top. In all cases, they are covered with finer or coarser longitudinal grooves. Between these two extremes there are innumerable gradations in length and thickness. The *blades,* as we have studied them, range in width from about five to seven centimeters in *C. Turneri* var. *pertusa* (cf. Collins, Holden and Setchell, *loc. cit.*, no. XXXIV) to forms mentioned above at Oak Bay and Roche Harbor, with blades up to sixty-five centimeters wide and only one to two times as long. Some of the forms of medium width, growing in the Puget Sound region, are up to three meters long. The *bullations* are finer or coarser, deeper or shallower, but not in any way correlated with other characters. The bases are narrowly to broadly cuneate, passing over into slightly cordate and finally auriculate-cordate. The consistency of the blade seems to be correlated with the exposure. They are more or less thick and rigid in the locations exposed to the heaviest surf, and thinner and flabby in quiet water. With our present knowledge, we do not feel able to recognize more than one exceedingly variable species, and we are not able even to state the limits of forms.

45. **Thalassiophyllum** Post. and Rupr.

Holdfast of stout, dichotomously branched hapteres; primitive stipe short, not elongating but thickening, soon buried among the stout hapteres; blade soon eroded to the base and developing two lateral scrolls which unroll as they develop from thickened margins and form fan-shaped, spirally twisted, closely and regularly perforated, partial blades; numerous secondary stipes or branches, arising along the thickened margins, bearing small blades; no mucilage ducts in either the stipe or blade; sori in irregular dark brown areas; plants perennial.

Postels and Ruprecht, Illus. Alg., 1840, p. 11.

There are two peculiarities of the genus *Thalassiophyllum*, viz., the one-sided fan-shaped blades unrolling from a one-sided scroll, borne on what seems to be a branched, heavy, solid stipe. From the development (cf. Setchell, 1905*a*, p. 123, pl. 13, figs. 6–13) it appears that the early stages resemble those of *Agarum* in being bilaterally symmetrical, with basal margins inrolled. By the disintegration of the central portion of the blade, the basal margins only are left with their scrolls. One margin ceases to develop, as does the short primitive stipe. The other basal margin thickens, elongates, and becomes stipe-like, bearing its one-sided blade. The branches (false) arise (cf. Rosenthal, 1890, Flora, vol. 73, pp. 140, 141, pl. 8, figs. 33, 34) by adventitious outgrowths from the developing scroll-like base of the blade. The branching of *Thalassiophyllum* is a pseudo-branching and of a pseudo stipe not to be confounded with that of the Lessoniaceae or in *Egregia* of the Alariaceae.

Thalassiophyllum Clathrus (Gmel.) Post. and Rupr.

Plate 72

Plants 12–15 dm. high, rigid; holdfast and stipe as in the genus; blade thick and coriaceous, with the numerous, large elliptical perforations with roughened margins radially arranged; color dark brown to deep olive green, much darker toward the basal portions.

Growing on rocks in the sublittoral belt. Bering Sea to the Straits of Juan de Fuca (the last mentioned locality fide MacMillan, 1902, p. 219).

Postels and Ruprecht, Illus. Alg., 1840, p. 11, pls. 18–19; Setchell, Alg. Prib. Isl., 1899, p. 592, Post-emb. Stages, 1905*a*, p. 123, pl. 13, figs. 6–13, Kelps of U. S. and Alaska, 1912*a*, pp. 155, 156; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 266; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XXXVI. *Fucus Clathrus* Gmelin, Hist. Fuc., 1768, p. 211, pl. 33.

The juvenile blade disintegrates in the center, back to the stipe, after which two meristems are established at the base and along the margin of the remaining two partial blades. For a time these continue to develop together but sooner or later one takes the ascendancy and becomes erect while the other usually degenerates sooner or later. As the blade continues to grow, it rolls and thickens along the margin, leaving behind a false stipe, which branches here and there, the branches developing numerous small blades.

46. **Agarum** (Bory) Post. and Rupr.

Holdfast composed of small branched hapteres; stipe comparatively small, cylindrical or flattened, at times fimbriated; blade relatively thin, with narrow to broad percurrent midrib and perforated alae; sori broad.

Bory, *in* Dict. class., vol. 9, 1826, p. 193.

The genus *Agarum* was founded by Bory (*loc. cit.*). He enumerated five species, as follows: *A. quinquecostatum*, *A. cribrosum*, *A. esculentum*, *A. Delisei*, and *A. Pylaii*, all but one of which have since been distributed between two other genera, the first one to *Costaria*, the last three to *Alaria*, thus indicating that he had a much broader generic concept than can be accepted by later algologists. Thus *Agarum cribrosum*, though imperfectly described specifically by Bory, is the type of the genus as reconstituted by Postels and Ruprecht (1840, p. 11). They enumerated five species, as follows: *A. Gmelini*, *A. Turneri*, *A. pertusum*, *A. platyneurum*, and *A. brassicaeforme*, all of which were reported within our territory with the exception of *A. Turneri*.

Key to the Species

1. Stipe cylindrical, not fimbriate; blade with two basal scrolls..1. **A. cribrosum** (p. 615)
1. Stipe flattened, with fimbriate margins; blade with rounded or cordate base..2. **A. fimbriatum** (p. 616)

1. Agarum cribrosum Bory

Plate 63

Holdfast consisting of numerous branched hapteres, slender and diffuse in young specimens, thicker and more compact in older exposed specimens; stipe cylindrical, 3–30 cm. long, 5–8 mm. diam.; blade with median percurrent midrib 1.5–3 cm. wide, rather rigid, membranaceous, plane, 5–9 dm. long, 2–5 dm. wide; mature specimens broadly ovate, cordate at base, margin smooth, unfolding at the base from a scroll on either side of the midrib, profusely perforated; perforations smooth, circular to very irregular in outline and up to 2 cm. in diam.; color dark brown, changing to olive green on drying; sori generally distributed over the blade.

Growing on rocks in the sublittoral belt. Apparently very generally distributed from the Bering Sea to Sitka, Alaska, and recently reported as far south as San Juan Island, Washington.

Bory, *in* Dict. class., vol. 9, 1826, p. 193 (in part); Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 155; Muenscher, Key to Phaeophyceae, 1917, p. 260, fig. 12.

Fucus cribrosus Mertens, *in* Linnaea, vol. 4, 1829, p. 52. *Agarum Gmelini* Post. and Rupr., Illus. Alg., 1840, p. 11, pls. 20, 21; Saunders, Alg. Harriman Exp., 1901, p. 430, pl. 61. *Agarum Turneri* Post. and Rupr., Illus., 1840, p. 12, pl. 22; Saunders, Alg. Harriman Exp., 1901, p. 431. *Agarum pertusum* Post. and Rupr., Illus., 1840, p. 12, pl. 23. *Fucus Agarum* Turner, Fuci, vol. 2, 1809, p. 10, pl. 75.

The earliest name for this plant was *Fucus Agarum* Turner, but since the generic name *Agarum* was limited by Postels and Ruprecht to this and related species, this specific name became untenable and they chose *Turneri*. By the laws of priority, however, the earlier specific name *cribrosum* must be considered as the one to be adopted. Postels and Ruprecht attempted to distinguish five species of which three had broad flattened midribs and two had narrow prominent midribs, but our experience, which includes a study of a great variety of *Agarums* from both the Atlantic and the Pacific coasts of North America, leads us to feel that there is no distinct cleavage as to constancy of broader or narrower midrib and as to coarser or finer perforations, all gradations appearing on both coasts. The unrolling of the blade from two small cone-like scrolls distinguishes *Agarum cribrosum* as a true *Agarum*.

2. **Agarum fimbriatum** Harv.

Plate 71

Holdfast of branched hapteres, profuse and slender in specimens growing on wood in sheltered localities, larger and denser in old specimens growing in situations exposed to the action of the water; stipe flat, 2–6 cm. long, 4–7 mm. wide, beset with numerous, often branched, fimbriae on the margins, particularly near the blade; blade thin and bullate, nearly circular to narrowly elliptical in outline, 2–8 dm. long, 1.5–2.5 dm. wide, base rounded or slightly cordate, margin crisp and fimbriate, midrib fairly broad, complanate, perforations few and irregular in outline; color light brown.

Growing in the sublittoral belt from 60 fathoms up to low water mark on stones, other algae, or on piles, woodwork, etc. Abundant in the quiet water of the lower Puget Sound region, particularly Island County, Washington. Rare on the California coast but found floating as far south as San Pedro.

Harvey, Coll. Alg. N.W. Amer., 1862, p. 166; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 266; Setchell, Kelps of U. S. and Alaska, 1912*a*, p. 155; Muenscher, Key to Phaeophyceae, 1917, p. 262, fig. 13; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XCI; Tilden, Amer. Alg. (Exsicc.), no. 345.

We have been able to examine hundreds of specimens of this species from Puget Sound and to note its characters. The lack of distinct scrolls at the base of the blade and the thin extremely flattened stipe giving off, more or less abundantly fimbriate, haptere-like outgrowths, are characters distinguishing this species from *Agarum cribrosum* most satisfactorily. Outside of a few floating specimens, possibly from deep water, found in southern California, *A. fimbriatum* is narrowly confined to the region of the inner Straits of Juan de Fuca and to the shores of Island County, Washington.

The type locality is Esquimalt, near Victoria, British Columbia, where it was dredged in 4–10 fathoms of water.

Tribe 4. HEDOPHYLLEAE Setchell

Stipes present only in very young plants, later disappearing or remaining short and obscure; blade plane (or irregularly bullate), soon becoming sessile and usually more or less decumbent, thickened and emitting hapteres either scattered or in whorls; meridional region usually wearing away, leaving the thickened (and sometimes auriculate) basal margins separated from one another, to grow on into simple, or, in turn, dichotomously falsely branched fronds.

Members of the Laminariaceae with plane blades and with false branching of pseudostipes formed from the thickened lower margins of the fronds.

Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 151.

Key to the Genera

1. Pseudoblades without auricles..47. **Hedophyllum** (p. 617)
1. Pseudoblades with auricles..48. **Arthrothamnus** (p. 619)

47. **Hedophyllum** Setchell

Holdfast of branched hapteres; stipe distinct at first, later disappearing in some species; blade short, broad and plane, at first often becoming bullate, not auriculate at the base, later giving rise to branched hapteres from the lower margin, either scattered or whorled; sori basal, irregular in outline.

Setchell, Notes on Algae, I, 1901, p. 121.

Key to the Species

1. Stipe very short, soon vanishing; blade sessile, often much bullate..1. **H. sessile** (p. 617)
1. Stipe longer, flat, persistent, blade subsessile..2. **H. subsessile** (p. 618)

1. **Hedophyllum sessile** (Ag.) Setchell

Plate 73

Stipe of young plant very short and much flattened, soon entirely disappearing; blade at first ovate, entire, soon splitting deeply even to the base, and becoming decidedly cucullate, in age becoming ample, much plicated and absolutely attached, sessile, not greatly thickened at the base, giving rise to hapteres along the sessile margin, 30–50 cm. (up to 15 dm.) long, and 8 dm. wide; surface of blade either perfectly smooth or with irregular bullate swellings scattered over the whole blade or only the basal portion, with numerous mucilage ducts surrounded by small secreting cells; sorus extensive, basal, irregular in outline.

Growing on rocks in the middle and lower littoral and in the upper sublittoral belts. Ranging from Yakutat Bay, Alaska, to Point Sur, California.

Setchell, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. VIII, Notes on Algae, I, Zoe, 1901, p. 121; Saunders, Alg. Harriman Exp., 1901, p. 429, pl. 51; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 262; Setchell, Post-emb. Stages, 1905, pp. 119–123, pl. 12, Kelps of the U. S. and Alaska, 1912*a*, p. 152. *Laminaria sessilis* Agardh, Syst. Alg., 1824, p. 270; Tilden, Amer. Alg. (Exsicc.), no. 344. *Laminaria apoda* Harvey, Notice of a collection of algae, 1862, p. 167.

Hedophyllum sessile is the type of the genus. It is the *Laminaria sessilis* of Agardh (*loc. cit.*), said to have come from "Mari Australi." The type specimen of *L. sessilis* is in the herbarium of J. G. Agardh under number 1730. Also in the same herbarium under number 1731 is a plant marked "*Laminaria apoda* Harv., Esquimalt." This was probably contributed by Harvey.

Both of these specimens have been carefully examined by one of us (Setchell) and found to be our plant, *H. sessile.* It was next collected by Dr. David Lyall in the "Fuca Straits" and later classified as *Laminaria apoda* by Harvey (*loc. cit.*). There are six specimens in the herbarium of Harvey at Dublin, probably of this collection, which have been examined by one of us (Setchell) and found to be good *H. sessile.*

The size of the plant and the amount of bullations depend largely upon the habitat in which they grow. On exposed coasts, e.g., at Fort Ross, California, they are short, scarcely over three decimeters long and practically the whole blade is much bullated. At Neah Bay, Washington, in a sheltered location, where they grow in great profusion at and below extreme low water level, the blade frequently becomes fifteen decimeters long and eight decimeters wide, folding back and forth as it widens and becoming attached at the base. The blades may be entirely smooth or only the lower parts bullate.

2. **Hedophyllum subsessile** (Aresch.) Setchell

Young fronds provided with a normal holdfast, attached by a few branched hapteres; stipe short, stout, somewhat flattened; blade of the young plant at first narrow and simple, later becoming broader than long and divided, with a cordate base and marginal rows of bullae; at maturity the base becomes deeply cordate or even reniform, the basal margins are much thickened and give rise to hapteres which attach the thickened bases to the substratum; the central portion of the blade dies away clear to the base, leaving two separated, partial blades, each at the extremity of a thickened basal margin which resembles very closely a running rootstock; blade 60–75 cm. long, segments very variable in width, somewhat rolled at the base, but not auriculate; mucilage ducts present in both blade and stipe.

Growing on rocks in exposed localities in the middle littoral belt. Known in Bering Sea and possibly extends for some distance south along the coast of Alaska.

Setchell, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XXVII, Notes on Algae, I, Zoe, 1901, p. 122; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 263, pl. 20; Saunders, Alg. Harriman Exp., 1901, p. 430. *Arthrothamnus Bongardianus* J. G. Agardh, De Lam., 1867, p. 28 (in part). *Hafgygia Bongardiana* f. *subsessilis* Areschoug, Obs. Phyc., part 4, 1883, p. 5.

This very curious plant has been described and illustrated by us in our Algae of Northwestern America. It is intermediate between the simpler decumbent *Hedophyllum sessile* and such a decumbent species as *Arthrothamnus bifidus* (Gmel.) Ruprecht. *Hedophyllum spirale* Yendo (1903) is an erect species, even more closely related to the erect species of *Arthrothamnus*, difficult to place with precision. Yendo's later account (Notes on algae new to Japan II, 1914, pp. 269–273, with fig.) seems to us to have confused several different plants as well as distinctly different views on relationships. This is particularly true as regards Postels and Ruprecht's *Laminaria Bongardiana* and is due, we think, to the fact that Yendo had access to so little material for comparison. The plates of Postels and Ruprecht (1840, pls. 13, 14) show clearly a digitate *Laminaria*, even plate 14 being quite possible of this interpretation. Very possibly plants of *Hedophyllum subsessile* or of *H. spirale* were mixed in the material, yet the conception of the species is largely that of a digitate *Laminaria* and one that we have referred under *L. platymeris*. The *Hedophyllum subsessile* of Setchell is very different from *H. spirale* of Yendo, the latter approximating *Arthrothamnus*.

48. **Arthrothamnus** Rupr.

Original true stipe short, simple, flattened, attached by short stout hapteres; original blade at first simple, smooth, flat, soon thickening along the lower margin next to the stipe, and becoming more or less cucullate; the two thickened margins become the meristems, the original blade disintegrates to the top of the stipe, the thickening elongating margins become secondary stipes, develop spirally and each produces a secondary blade at its summit, the process perfecting dichotomous branching; the secondary stipes become more or less decumbent and produce numerous hapteres along the lower margin; the blades produce fruit, disintegrate and bifurcate as before, the process being repeated many times till a complex organism is built up; sori unknown.

Ruprecht, Bemerkungen, 1848, p. 67 (11).

The type of the genus is *A. kurilensis* Rupr. from the island of "Urup" in the Kurile group. At the same time that Ruprecht proposed the genus he also proposed a second species, viz., *A. radicans*, which is the *Fucus bifidus* of Gmelin (1768, p. 201, pl. 29, fig. 2) which Ruprecht later 1851, p. 350) so recognized. The observations on the development of *Arthrothamnus* by Yendo (1903) have thrown much light on the systematic position of this previously little known genus. It is obvious that it has close resemblances in development to *Thalassiophyllum* and *Hedophyllum* in the method of formation of the secondary stipe and to the members of the sub-family Lessonieae in the splitting of the transition region. Yendo's later discussion of *Arthrothamnus* (1914) is less clear than the earlier, but serves to emphasize certain points.

Arthrothamnus bifidus (Gmel.) J. Ag.

Secondary or false stipes spirally twisted, marked with scars of successive eroded blades, decumbent, attached by numerous hapteres, ascending at the apices, developing into a scroll bearing the terminal blades; mucilage glands in the blades just beneath the cortex; blade membranaceous, linear, relatively long and acuminate.

Aleutian Islands, Alaska.

J. G. Agardh, De Lam., 1867, p. 28; Setchell and Gardner, Alg. N. W. Amer., 1903, p. 267; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 152. *Arthrothamnus radicans* Ruprecht, Algenst., 1848, p. 68. *Laminaria bifida* Agardh, Sp., vol. 1, 1820, p. 122; Postels and Ruprecht, Illus. Alg., 1840, p. 10, pl. 15. *Fucus bifidus* Gmelin, Hist. Fuc., 1768, p. 201, pl. 29, fig. 2.

We are including this rather singular species of algae in our account on the authority of Areschoug (1884, part 5, p. 14), who reports it from the Aleutian Islands. Being quite abundant just across on the Asiatic coast, it may justly be expected to occur somewhere among the islands of the Alaskan peninsula.

FAMILY 21. LESSONIACEAE FAM. NOV.

Fronds more or less compound, composed of holdfast, branching stipe and few to numerous blades; structure as in Laminariaceae; mucilage ducts present or absent; blades destitute of cryptostomata or tufts of hairs; paraphyses unicellular, with hyaline appendages.

We have included under the family Lessoniaceae all those members of the Laminariales in which a distinct division of stipe and frond occurs by a splitting (rather than disintegration, e.g., schizogenetic rather than lysigenetic) process in the principal region of growth, i.e., at the transition place. With one exception (*Lessoniopsis*), there are no outgrowths arising at the transition place as in the Alariaceae.

Key to the Tribes

1. Sori on distinct sporophylls arising as outgrowths (alarioid) at the transition-place............3. **Lessoniopseae** (p. 631)
1. Sori on the ordinary blades............ 2
   2. Stipe regularly dichotomous ....1. **Lessonieae** (p. 621)
   2. Stipe scorpioid sympodial............2. **Macrocysteae** (p. 626)

TRIBE 1. LESSONIEAE SETCHELL

Members of the family of the Lessoniaceae with regularly dichotomous stipes, but without specialized sporophylls.

Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 157.

Key to the Genera

1. Stipe flattened, solid, blade reticulately ribbed........49. **Dictyoneurum** (p. 621)
1. Stipe swollen, hollow; blade plane or longitudinally grooved............ 2
   2. Main stipe swollen at summit into a pneumatocyst............50. **Nereocystis** (p. 623)
   2. Main stipe cylindrical to the apex............51. **Postelsia** (p. 624)

49. Dictyoneurum Rupr.

Original stipe very short, attached by branched hapteres, at first erect, later becoming decumbent, much flattened and thin, developing hapteres along the margins and later dying and disappearing as the anterior portion advances, meristem at the advancing end of the flattened prostrate stipe becoming erect and splitting dichotomously, finally dividing the blade longitudinally into two equal parts; original blade and often the mature later blades with distinct "midrib" and reticulate alae, later the "midrib" disappearing more or less and the blade becoming reticulated with coarse ribs; sori on both sides of blade, irregular, broad.

Ruprecht, Neue Pflanzen, 1852, p. 80, pl. 7.

Dictyoneurum is one of several monotypic genera confined to the west coast of North America. It was discovered by Wosnessenski in the vicinity of Fort Ross, California, and specimens were contributed by him to Ruprecht. The reticulate character of the blade marks it as distinct from all other genera. In its method of the dichotomous splitting of the blade, beginning at the transition meristematic region between the stipe and the blade, it closely resembles *Lessonia*.

Dictyoneurum californicum Rupr.

Plate 70

Holdfast and stipe as in the genus; transition or growing region at the juncture of the stipe and blade; no mucilage ducts; blade rigid and somewhat brittle, margins smooth or with scattered short spine-like projections, variable in width with age, up to 18 cm. wide, 4–6 dm. long, increasing in number by dichotomous splitting in the transition point, constantly eroding at the outer free end; the stipe portion of the transition region constantly becoming prostrate after longitudinal splitting, developing hapteres along the margin, and by wearing away at the rear end the plants are multiplied vegetatively; color yellowish brown; perennial.

Growing on rocks in the lower littoral and upper sublittoral belts. From Vancouver Island to Pecho, San Luis Obispo County, California.

Ruprecht, Neue Pflanzen, 1852, p. 80, pl. 7; Setchell, Notes on Kelps, 1896, pp. 46–48, pl. 1; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 267; Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 115; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XI; Tilden, Amer. Alg. (Exsicc.), no. 519. *Costaria reticulata* Saunders, Bot. Gaz., vol. 20, 1895, p. 58, pl. 7.

Costaria reticulata Saunders (*loc. cit.*) was founded upon material collected at Pacific Grove, California. His excellent illustration of the species leaves no doubt that it is the *Dictyoneurum* of Ruprecht. Saunders' illustration, unlike that of Ruprecht, is of a broad mature blade, probably of the first or original blade and stipe of a young plant, while the large illustrations of Ruprecht (*loc. cit.*) are of older plants whose blades have recently split and which have no "midribs." Superficially, in the wrinkled bullate character, the blade of *Dictyoneurum* resembles that of a *Costaria*, but the tissue composing the so-called "nerves" of the former is different and distinct from the other tissues of the blade, whereas in *Costaria* the tissues are uniform among the bullae, between the five longitudinal costae. The so-called "midrib" represents only a very slight modification of the blade. The histological characters are the same as the remainder of the blade. The part between two parallel longitudinal nerves is usually smooth and free from cross nerves and is only slightly thickened at the margins. The stipe in *Dictyoneurum* is erect only in the juvenile stage, soon becoming prostrate and attached by secondary hapteres, only the short terminal portion remaining erect. That of *Costaria* always remains erect. *Dictyoneurum* is perennial, lasting as long as it can maintain attachment, and new blades are constantly being formed. *Costaria* never fruits more than once.

50. **Nereocystis** Post. and Rupr.

Holdfast of a dense, interwoven mass of strong branched hapteres; stipe much elongated, slender, solid and cylindrical from the base through the most of its length, enlarging above into a thick hollow tube, contracting suddenly at the outer end just below the large, terminal, spherical pneumatocyst, which bears at its summit a row of short dichotomous branches, on the ends of which are the long, narrow, thin blades which bear the sori.

Postels and Ruprecht, Illus. Alg., 1840, p. 9, pl. 39, figs. 24–30.

Nereocystis differs so greatly in aspect from any species of *Lessonia* and even more so from the single species of *Dictyoneurum* that the resemblances are more in need of emphasis, in order to justify association in the same tribe of the same family. In *Nereocystis* the first segment of stipe is so long, so swollen, and the pneumatocyst so large, while the branches (above the pneumatocyst) are so abbreviated and condensed, that the *Lessonia* relationship is obscured, but becomes plain on careful analysis. While *Nereocystis* differs so greatly in aspect from other members of the Lessonieae, it resembles in the modification of the stipe, at least, *Pelagophycus*, of the tribe Macrocysteae, so nearly that one must realize the significance of the unilateral branching of the stipe in the latter to feel justified in separating the two. *Postelsia*, however, is closely related to *Nereocystis*, the difference between the main types of the type species of the two genera, apart from dimensions, consisting largely in the development of a globular pneumatocyst in *Nereocystis* and the lack of such a terminal globular inflation on the main stipe of *Postelsia*. The blades are much more differentiated in the latter genus.

Nereocystis Luetkeana (Mert.) Post. and Rupr.

Stipe very strong and elastic, 20–25 m. long, 1–1.5 cm. thick below, the hollow portion, or pneumatocyst, 3–4 m. long, 15–17 cm. broad; sporophylls 25–40 in number, 3–4.5 m. long, 6–15 cm. broad; sori in large, irregular, promiscuously distributed areas on both sides of the sporophylls.

Growing on rocks and epiphytic in water 5–25 m. in depth. Extending from the Shumagin Islands, Alaska, to Santa Barbara, California.

Postels and Ruprecht, Illus. Alg., 1840, p. 9, pls. 8, 9; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 268; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 158; Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 116; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. X; Tilden, Amer. Alg. (Exsicc.), no. 237. *Nereocystis priapus* (Gmel.) Saunders, Alg. Harriman Exp., 1901, p. 431. *Fucus Luetkeanus* Mertens fil, *in* Linnaea, 1829, p. 48.

The "Bull Kelp," as it is frequently called, is an annual plant, grows in beds of greater or less extent, rising from even 10–12 fathoms of water, particularly extensive in the Puget Sound region and is an available source of potash salts and other substances. It is one of our largest and most striking seaweeds. We are extremely disinclined to adopt the binomial *Nereocystis Priapus*, although by the process of exclusion its application to our plant may seem to be extremely plausible. The *Ulva Priapus* Gmelin (1786, p. 231, pl. 31, fig. 2) was neither well described nor convincingly illustrated. Its locality is in doubt. Probably it is either *Nereocystis* or *Pelagophycus*, and more probably the former than the latter. We have neither seen nor heard anything of the type specimen.

51. **Postelsia** Rupr.

Holdfast of stout branched hapteres; stipe large, cylindrical and hollow, bearing a group of pendent blades on short, solid dichotomous branches at its summit.

Ruprecht, Neue Pflanzen, 1852, p. 19 (75).

Postelsia is a unique, monotypic genus of algae, confined as at present known to the temperate waters of the west coast of North America. Its relation to *Nereocystis* has just been discussed. The date of publication depends upon the date of issue of the separate papers which have 1852 on the title page, thus seeming to antedate Areschoug's genus *Virginia*.

Postelsia palmaeformis Rupr.

Plate 69

Holdfast of stout, blunt, branched hapteres; stipe stout, smooth and glossy, elastic though rigid, cylindrical, tapering slightly upward, hollow, 4–6 dm. high, 1.5–3 cm. diam., bearing at its tip numerous solid, cylindrical, dichotomous branches; blades terminating the small branches, falcate, 100–150 on a plant, 15–24 cm. long, produced by longitudinal splitting in the transition region at their bases, with deep, parallel, longitudinal grooves on either side, in which the sori are developed; color a rich olive brown.

Growing only on rocks exposed to the heavy action of the waves. Extending from the southern end of Vancouver Island to Lion Rock, San Luis Obispo, California.

Ruprecht, Neue Pflanzen, 1852, p. 19 (75), pls. 6 and 8; MacMillan, Kelps of Juan de Fuca, 1902, pp. 213 and 217; Setchell and Gardner, Alg. N.W. Amer, 1903, p. 268; Setchell, Kelps of U. S. and Alaska, 1912*a*, p. 158; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XXXVIII and no. 131; Tilden, Amer. Alg., no. 341; Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor.. no. 113. *Virginia Palma-Maris* Areschoug, Oefvers. Kongl. Vet.-Akad. Förhandl., 1853, p. 147, Flora, 1855, p. 652. *Postelsia californica* Guignard, App. Mucif. Lam., 1892, p. 41.

This plant, in many ways remarkable, was first brought to the attention of phycologists by Wosnessenski, who found it growing on the exposed shore of a small island at the entrance to Bodega Bay, California. It was known to the Indians of that region as Kakgunuchale, according to Ruprecht. It is everywhere known today as the Sea Palm, owing to the close resemblance of more or less extensive clusters of these singularly beautiful plants to miniature groves of palms as seen in the distance along ocean shores.

It has accustomed itself to growing only on rocks exposed to the very heaviest action of the waves. It mainly inhabits the middle of the littoral belt, but in certain localities in which the waves are accustomed to beating high, they may grow at or even above the general high-tide level. They are annual plants.

Postelsia palmaeformis was first published by Ruprecht (*loc. cit.*), who gave a very excellent illustration of the three specimens collected by Wosnessenski. This paper was published separately in 1852 and afterwards in Memoirs Imp. Acad. St. Petersburg in 1855 (ser. 6, vol. 7, p. 75, pl. 6). Pfeiffer (Nom. Bot., vol. 2, p. 823) quotes this as the original publication, thus considering *Virginia Palma-Maris* of Areschoug (*loc. cit.*) as antedating Ruprecht's *Postelsia palmaeformis*. The *Postelsia californica* of Guignard (*loc. cit.*) undoubtedly refers to *Postelsia palmaeformis,* since he lists several other kelps of the California coast along with this species.

TRIBE 2. MACROCYSTEAE KUETZING (LIM. MUT.)

Plants of the family Lessoniaceae having, in large part, unilateral splitting, thus producing a scorpioid sympodial stipe.

Kuetzing, Phyc. Gen., 1843, p. 348; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 158.

The Macrocysteae have regularly dichotomous splitting in the first few divisions, but after that the splitting is unilateral.

Key to the Genera

1. Stipes solid .... 52. **Macrocystis** (p. 626)
1. Main stipe hollow .... 53. **Pelagophycus** (p. 629)

52. **Macrocystis** Ag.

Holdfast of mature plants consisting of a large entangled mass of dichotomously branched hapteres or of creeping flattened rhizomes giving off lateral hapteres as well as erect fronds; stipe in the juvenile plant forking 1–3 times dichotomously, forming several main stipes, later the branching is unilateral; blade at first splitting equally, but soon the terminal bladderless falcate blade splitting unequally; meristematic transition region at the juncture of the stipe and falcate blade; the mature blades undivided bearing a bladder at their base and the sori on both sides; perennial.

Agardh, Sp. I, 1820, p. 46.

The species of *Macrocystis* are not well marked off from one another but the genus, with its unilateral splitting and its long cylindrical stipe, unbranched above the basal dichotomies, and its large and complicated holdfasts or overlapping massive "rhizomes," is distinct from any other.

Concerning the position of the sori in members of this genus, Skottsberg (1907, pp. 104–108) and Howe (Mar. Alg. Peru, 1914, pp. 62, 63, 65, 66) have reviewed the literature and the facts most thoroughly. The sori, in our species, seem confined to the basal leaves, and specimens are not commonly collected. The sori do not seem to be confined to grooves in the leaves (cf. Hoffman, 1911, p. 155) as Smith and Whitting (1895, p. 84, pl. 20) found them, as did also Skottsberg (*loc. cit.*).

The sporelings of *Macrocystis* have been observed by R. P. Brandt (1923, pp. 4–7, fig. 2), who did not succeed, however, in clearly elucidating the complete life-history of the gametophyte. Brandt also deals with the polymorphy, especially as regards the shape of the bladders, due to more quiet or rougher waters.

Key to the Species

1. Fronds arising from masses of branched hapteres ....1. **M. pyrifera** (p. 627)
1. Fronds arising from stout creeping rhizomes....................2. **M. integrifolia** (p. 628)

1. Macrocystis pyrifera (L.) Ag.

Plates 64 and 65

Holdfast very large, often becoming nearly a meter in diameter in the typical deep sea form; stipe at first dichotomously branched, establishing 2–8 growing points; the main stipes become 30–50 m. long, bearing at their summits the young differentiating blades and along the greater part of their length, at regular intervals, the mature lateral blades, each with a pyriform bladder at its base, which is in turn supported by a short cylindrical stipe; blades rigid, coarsely rugose, 3–5 dm. long, 5–9 cm. wide, with spinulose margins.

Growing on rocks usually in 20–30 m. of water. It extends from Sitka, Alaska, to Magdalena Bay in Lower California, but is a plant of the outer coasts, exposed to wave action.

Agardh, Sp. I, 1820, p. 47; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 158; Postels and Ruprecht, Illus. Alg., 1840, p. 9, pl. 6; Saunders, Alg. Harriman Exp., 1901, p. 431, pl. 60; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 270; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XXXIX; Tilden, Amer. Alg. (Exsicc.), no. 518. *Fucus pyriferus* Linnaeus, Mantissa, II, p. 311; Turner, Hist. Fuc., vol. 2, 1809, p. 103, pl. 110.

We have not attempted to segregate varieties or forms of this species, since we have not been able to determine any exact lines of cleavage. The varying shape of the bladders from globular to extremely elongated, the varying breadth, length, dentation, wrinkling, etc., of the leaves seem possibly matters of age and character of habitat. There are also some indications of the possibility that this species is only the deep water condition of the next. The exact northern and southern limits of this species have not been satisfactorily determined. W. C. Crandall (Fert. res. U. S., 1912, p. 210) has seen "beds as far south as Cedros Island," off the coast of Mexico, and states that "according to local fishermen these beds extend to Magdalena Bay." The northern limit, as growing near Sitka, rests especially upon the report of Edward C. Johnston (Fert. res. U. S., 1912, p. 215).

Our *Macrocystis* of the north Pacific seems to grow in warmer water than that of the Antarctic and south Pacific. While the southern hemisphere form grows in the comparatively warmer waters of Peru it also grows about Cape Horn in waters of extreme coolness. In our Alaska waters, it seems to stop short at Sitka and does not go farther west and north into the coldest waters of our region, Sitka being decidedly under the isothere of 10° C. but just about on the isocryme of 0° C. The coldest locality for *Macrocystis* seems to be South Georgia, between the isocryme of somewhat below 0° C. and the isothere of 5° C.

2. **Macrocystis integrifolia** Bory

Plate 62

Fronds relatively slender, composed of a flattened, almost ligulate, prostrate, creeping, rhizome-like portion, 2–3.5 cm. wide, profusely and for the most part dichotomously branched, attached closely and firmly to rocks by numerous, strong hapteres arising along its two margins and giving rise to numerous free erect portions, relatively slender, 5–8 m. long, bearing the vesicles with blades at their distal ends; vesicles subspherical to broadly pyriform; blades denticulate along the whole margin, 2.5–3.5 dm. long, 3.5–5 cm. wide, acuminate at both ends.

Growing on rocks at slightly below extreme low water mark. Central California.

Bory, *in* Dict. class. d'hist. nat., vol. 10, 1826, p. 9.

At several localities along the coast of central California, notably at Monterey Bay and Carmel Bay, for many years we have observed quantities of a species of *Macrocystis* attached to boulders and rock ledges at and just below low-tide level which, according to our judgment, is entirely distinct from the abundant and widely distributed *M. pyrifera* (Turner) Ag. We have thought that possibly it might represent only stranded individuals of that species. The fundamental difference between the two species as represented on our coast is the character of the attaching portion—"rhizome" and hapteres. In the deep sea species, there is no rhizome and the mass of hapteres developed often becomes several decimeters in thickness and up to a meter in diameter, while in the shore species the conspicuous "rhizome" is flat and adheres closely to the rock, dying and decaying at the rear as it advances and spreads out in all directions. We have had an excellent opportunity to study what might be considered a natural experiment upon the effect of changing the deep sea species to the habitat of the shore species at San Pedro, where a government breakwater was extended out from the shore a long distance in the vicinity of a large "kelp bed" of *Macrocystis pyrifera*. Thousands of plants attach themselves to the rocks along low-tide level and persist until they are torn loose. In not a single instance has the nature of the holdfast been changed. It thus seems perfectly definite that the shore species is a distinct entity, as well as the deep sea species. We have never seen any specimens of either species which would seem to represent transition stages between the two.

53. **Pelagophycus** Aresch.

Holdfast of several whorls of strong, dichotomously branched hapteres diminishing in size toward their termini; stipe solid at the base, hollow above, constricted at the summit just below the large spherical bladder, again becoming smaller and solid for a few centimeters beyond the bladder at its summit, dividing once dichotomously, each branch again dividing unilaterally 4–6 times and each branch bearing a single large terminal blade.

Areschoug, *in* Botaniska Notiser, 1881, p. 49; Observ. Phycol., part 5, 1884, p. 6.

Pelagophycus is one of the large, conspicuous, monotypic kelp genera confined to a relatively small area on the Pacific coast of North America. Its resemblance to *Nereocystis* is striking so far as the main stipe up to the first dichotomy is concerned. Above the first, or occasionally, the second dichotomy, however, the unilateral splitting and sympodial character of the stipe clearly places the genus with the Macrocysteae.

Pelagophycus porra (Leman) Setchell

Holdfast composed of whorls of dichotomously and later fasiculately branched hapteres, the whole mass about 1.5 dm. diam.; stipe solid, terete and slender below, increasing slightly in diameter upward for 6–7 m., merging abruptly into a swollen, hollow portion, the apophysis, about 80 cm. long, which is deeply constricted just below the terminal bladder or pneumatocyst; pneumatocyst spherical, 12–20 cm. diam., filled with gas, giving rise on its summit to 2 solid branches, 1.3–1.6 m. long, decidedly flattened, each bearing about 5 short lateral branches on the distal side; the main and the lateral branches terminate in blades which are 4–5.5 m. long, 20–45 cm. wide, with cuneate base, borders loosely ruffled, more or less beset with small, spine-like projections, coarsely rugose, easily torn; sori scattered in irregularly shaped areas.

Growing in open waters, 10–15 fathoms, mostly attached to rocks. From the vicinity of Point Conception, California, to some unknown locality on the coast of Lower California (Mexico).

Setchell, *Nereocystis* and *Pelagophycus, in* Bot. Gazette, vol. 45, 1908, pp. 129–134, The Elk Kelp, *in* Erythea, vol. 4, 1896*a*, pp. 179–184, pl. 7, Kelps of the U. S. and Alaska, 1912*a*, p. 159; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. CIX. *Nereocystis gigantea* Areschoug, *in* Bot. Not., 1876, p. 71. *Pelagophycus giganteus* Areschoug, *in* Bot. Not., 1881, p. 49. *Laminaria porra* Leman, *in* Dict. Sci. Nat., vol. 25, 1822, p. 189.

Pelagophycus porra is quite limited in its distribution as noted above. It has been known to the civilized world in a general way since the days of the early Spanish navigators to the west coast of North America. Although it is a plant which is normally anchored relatively near the shore, it may become detached and, coming into an ocean current, may float for many miles out to sea, remaining alive for many months. The early navigators, on approaching the shores of Mexico and California, were constantly on the lookout for this floating seaweed, the presence of which was looked upon by them as an unfailing sign of their near approach to land. Porra was one of the names by which it was known, but the term also applied to both *Macrocystis* and *Nereocystis* as well (cf. Setchell, 1908, for a complete account of the early literature bearing on this alga). At present it is generally known as Elk-kelp and is one of the kelps made use of in large quantities during the recent war as a source of potash, etc.

Leman (*loc. cit.*) was the first to publish a critical diagnosis of the species under the combination, *Laminaria porra*. Nothing was done with it in a botanical way until 1876, when Areschoug redescribed it from material collected by Dr. G. Eisen, at Santa Catalina, California, placing it with *Nereocystis* as *N. gigantea*. Later (1881) he created the genus *Pelagophycus* to receive the same species where it remained until the combination employed here was made (cf. Setchell, *loc. cit.*).

TRIBE 3. LESSONIOPSEAE SETCHELL

Members of the Lessoniaceae having specialized sporophylls arising as outgrowths on the outer margins of the transition place where splitting is about to occur.

Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 160.

The tribe of the Lessoniopseae might perhaps be placed with equal propriety either under Lessoniaceae or under Alariaceae, since the sole genus, monotypic, has the characters of each of these families. The plant, however, has the habit of a *Lessonia* and this influences us strongly to place it nearer to *Lessonia* than to *Alaria*.

54. **Lessoniopsis** Reinke

Frond differentiated into holdfast, stipe, blade, and sporophylls; holdfast consists of a dense mass of short, thick, dichotomously branched hapteres; stipe short, cartilaginous, very dense and rigid, arborescent, more or less deeply furrowed, merging into hapteres below, irregular in outline, profusely dichotomously branched above, branching taking place by splitting in the meristematic region, terminating in long narrowly linear blades with distinct percurrent midrib and stipitate base; the meristematic transition region at the base of each blade giving rise to sporophylls in pairs, 1–3 pairs each season.

Reinke, Studien zur Entwick. Lam., 1903, pp. 25–28.

Lessoniopsis is one of the many monotypic genera of kelps thus far known exclusively on the west coast of North America. It was established by Reinke to receive *Lessonia littoralis* Farlow and Setchell. Although among the relatively recent discoveries, its morphology, anatomy and life-history, except as to the embryonal stages, have been quite thoroughly made known.

In its method of development of the sporophylls, its affinities are close to *Pterygophora*. It resembles *Lessonia* in its method of dichotomous branching of the blade and the consequent production of new blades.

Lessoniopsis littoralis (Farlow and Setchell) Reinke

Plates 67 and 68

Frond up to 2 m. high; stipe up to 2 dm. thick at the base, very dense and cartilaginous; blade 7–12 mm. wide, up to 8 dm. long, with percurrent midrib 1–2 mm. wide, up to 800 in number on a single plant, splitting longitudinally at the transition region; sporophylls always wider than the blade, but generally considerably shorter, broadly ovate below, somewhat narrowed and rounded at the apex, arising in pairs on the edges of the flattened transition region; sori on both sides covering most of the sporophyll; fruiting in summer and then eroding from the apex; color dark olive green; mucilage ducts absent from both stipe and blade.

Growing on large boulders and rock ledges exposed to the action of the heaviest surf. Ranging from Sitka, Alaska, to Point Carmel, California.

Reinke, Studien zur Entwick. Lam., 1903, pp. 25–28, fig. 8; Griggs, Sporophylls of *Lessoniopsis*, Ohio Nat., 1909*a*, vol. 9, no. 4, p. 437, Juvenile kelps, 1909, p. 9; MacMillan, Observations on *Lessonia*, Bot. Gaz., vol. 30, 1900, p. 318; Setchell and Gardner, Alg. N.W. Amer., 1903, pp. 267, 268. *Lessonia littoralis* Farlow and Setchell, *in* Tilden, Amer. Alg. (Exsicc.), no. 342; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XXXVII. *Lessonia fuscescens*(?) Farlow, Mar. Alg. U. S., 1875, p. 355 (not of Bory). *Lessonia nigrescens* Farlow, Mar. Alg. U. S., 1876, p. 707 (?); Setchell, Class. and Geog. Dist. Lam., 1893, p. 357 (neither *L. nigrescens* Bory).

This species was first brought to the attention of phycologists by Mr. E. Hall who sent specimens of it which he found on the coast of Oregon to Farlow, who (1875, p. 355) doubtfully referred it to *Lessonia fuscescens.* Still later, Farlow collected living material near Monterey, California, and recognizing it as a new species of *Lessonia* he gave it the manuscript name, *L. littoralis.* Tilden distributed the species from Vancouver Island, in 1900, as no. 342 in American Algae and gave the first diagnosis, accrediting the name to Farlow and Setchell. A complete account of the plant was given in the same year by MacMillan. Reinke (*loc. cit.*) was the first to recognize the fundamental distinction between this species and those of the genus *Lessonia* proper, viz., that all of the terminal blades with midribs are sterile and that the other blades which are free from midribs are in reality the sporophylls. The sporophylls are lateral in origin, and in this respect are like those of the genus *Pterygophora*, and continue to develop in the transition region in pairs year after year as the meristem moves forward until the plant is dislodged and dies. Griggs (1909) was the first to properly describe the origin of the sporophylls.

The branching is strictly dichotomous and is accomplished by the splitting of the blades longitudinally through the midrib, the splitting beginning at the transition region and progressing to the outer end. A new ala develops on each half blade as the splitting proceeds.

Lessoniopsis littoralis and *Postelsia palmaeformis* are the most typical examples of cumatophyte species of our algal flora. No surf seems to be too rigorous to hinder their optimum development. The former usually occupies a belt lower down than the latter. Apparently it is unable to withstand the desiccation incident to long exposure to the air.

FAMILY 22. ALARIACEAE FAM. NOV.

Fronds simple or irregularly branched, with terminal blades and lateral outgrowths, the latter arising at the transition places; terminal blade with or without a midrib or central thickened area, plane or rugose, with or without cryptostomata, or tufts of hairs; otherwise as in the order.

The family of the Alariaceae is intended to include all the genera whose species possess sporophylls, either kinetic or potential, arising as outgrowths of either stipe or blade and arising at the transition place, with the exception of the genus *Lessoniopsis,* described above.

Key to the Tribes

1. Mature outgrowths confined to the stipe .... 1. **Alarieae** (p. 633)
1. Mature outgrowths not as above 2
   2. Mature outgrowths confined to the blade .... 2. **Ecklonieae** (p. 645)
   2. Mature outgrowths on both stipe and blade .... 3. **Egregieae** (p. 647)

TRIBE 1. ALARIEAE SETCHELL

Members of the Alariaceae with sporophylls only on the stipe.

Setchell, Kelps of the U. S. and Alaska, 1912*a,* p. 160.

The Alarieae are confined to the northern hemisphere, occurring in the Arctic, the north Atlantic, and the north Pacific oceans. The outgrowths at the transition place are arranged on the stipe and are usually highly specialized sporophylls, bearing sori, maturing and disintegrating.

Key to the Genera

1. Midrib distinct; sporophylls definitely limited in growth .... 56. **Alaria** (p. 635)
1. Midrib indistinct; sporophylls more or less indefinite in growth .... 55. **Pterygophora** (p. 634)

55. **Pterygophora** Rupr.

Holdfast of stout, branched hapteres; stipe simple, solid, more or less woody, containing mucilage ducts; blade terminal, linear, without distinct midrib but with central portion thickened; sporophylls lateral on both sides of the upper part of the stipe at the transition region, long, and of continued growth; sori on both sides of sporophylls and on the terminal blade; perennial, the stipe increasing in length and in diameter through several years.

Ruprecht, Bemerkungen, 1848, pp. 8 (64) and 14 (70) (nomen), Neue Pflanzen, 1852, p. 17 (73) (description).

Pterygophora was first proposed by Ruprecht in 1848, as above mentioned, in connection with a study of the structure of the stipes of some of the large Melanophyceae. A diagnosis of the whole plant was deferred until 1852. No other species than the one then proposed as the type, viz., *P. californica,* has been discovered since, and this one seems to be in a state of specific equilibrium, as it varies but slightly throughout its entire range of distribution. It was discovered by Wosnessenski in the vicinity of Fort Ross, California, in 1840. It is less specialized than *Alaria*.

Pterygophora californica Rupr.

Plate 74

Stipe terete below, flattened and somewhat constricted above at the transition region, with distinct concentric rings shown in cross-section, 8–12 dm. (up to 2 m.) long, 2.5–4 cm. (up to 7 cm.) diam., giving rise successively to elongated, blade-like sporophylls, pinnately arranged in the transition region; blade with mucilage ducts and with a slightly thickened median, longitudinal band, forming a false midrib, linear, 6–9 dm. long, 6–10 cm. wide, fruiting annually then dying back and regenerating; sporophylls of the same general shape as the blade, but smaller, stipitate, without median thickening, 12–18 maturing in a season, then disintegrating, leaving only a scar on the stipe, new ones meanwhile developing above; sori occupying the basal half or more of each sporophyll on both sides.

Growing on rocks and on other large algae in the upper sublittoral belt, largely on exposed coasts. From the southern end of Vancouver Island to Lower California.

Ruprecht, Neue Pflanzen, 1852, p. 17 (73), pl. 5; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 271; MacMillan, Observations on *Pterygophora*, 1902*a*, p. 723, pls. 57–62; Muenscher, Key to the Phaeophyceae, 1917, p. 280, fig. 45; Frye, The Age of *Pterygophora californica*, 1918, pp. 65–71, pl. 17; Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 114; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. CVIII; Tilden, Amer. Alg. (Exsicc.), no. 520.

Pterygophora californica is a perennial. No accurate data, obtained from experimental evidence, has yet appeared to indicate the age of this sturdy species of algae. Frye (*loc. cit.*) has summarized the opinions of various writers on the subject and has given the results of his own observations on plants in the vicinity of Blakeley Island and at Cape Flattery, Washington. His results are based upon the number of scars on the stipe, produced by the disintegration of sporophylls, and upon the number of rings in the stipe. Thirteen years is the oldest estimated age of any plant which he has discovered.

56. **Alaria** Grev.

Holdfast comparatively small, of more or less slender branched hapteres from near the base of the stipe, forming a turbinate compact mass; stipe comparatively small and usually short, solid, unbranched, with or without mucilage ducts; blade terminal, considerably elongated, entire, thin, with a pronounced longitudinal, percurrent, centrally located midrib, usually showing tufts of hairs (cryptostomata); sporophylls from both sides of the stipe, of limited growth, developing in the transition region; sori usually covering nearly the whole of both surfaces of the sporophylls; perennial.

Greville, Alg. Brit. Syn., 1830, p. xxxix and p. 25.

Greville remarks (*loc. cit.*) concerning the establishment of the genus as follows: ''The individuals which constitute this genus I have removed from an assemblage published by Bory de St. Vincent under the name of *Agarum*.'' The individuals to which Greville refers, as enumerated in the Synopsis, were *Agarum esculentum*, *A. Delisei* and *A. Pylaii*. As the type of his new genus he selected the first which is the *Fucus esculentus* of Turner (1809, pl. 117), this being the only species of the three mentioned by Bory which occurs within the British waters, the other inhabiting ''Terre-Neuve.'' The Vienna Congress has conserved the generic name *Alaria* Grev. (1830) as against *Musaefolia* Stackhouse (1809) and *Orgyia* Stackhouse (1816).

No genus of the Laminariaceae, not even excepting the genus *Laminaria*, is so confusing as to specific segregation within its limits as *Alaria*. Ruprecht, J. G. Agardh, Kjellman, Setchell, and Yendo have struggled with it and assisted both in clearing some species and confusing others. The arrangement of our species by Setchell (1912*a*) and the monograph of the genus by Yendo (1919) are followed in their essentials in our account. We cannot, however, follow Yendo in all his distinctions since our experience leads us to assign somewhat different degrees of importance to certain of the characters which he stresses. We are not able to apply the distinction into "Holosoria" and "Metasoria" with such precision even as Yendo (1919, pp. 24–26) indicates as possible.

Key to the Species

1. Midrib solid throughout 2
1. Midrib fistulose at intervals .... 9. **A. fistulosa** (p. 644)
    2. Sporophylls short 3
    2. Sporophylls long 7
3. Sporophylls narrow 4
3. Sporophylls broad 5
    4. Blade long and broad above .... 2. **A. praelonga** (p. 637)
    4. Blade short and narrow .... 1. **A. nana** (p. 636)
5. Stipe long, very much flattened .... 3. **A. tenuifolia** (p. 638)
5. Stipe short, cylindrical 6
    6. Midrib broad .... 4. **A. marginata** (p. 640)
    6. Midrib narrow .... 5. **A. Pylaii** (p. 641)
7. Sporophylls narrow 8
7. Sporophylls broad .... 8. **A. valida** (p. 643)
    8. Cross-section of midrib elliptical .... 6. **A. dolichorhachis** (p. 642)
    8. Cross-section of midrib oblong .... 7. **A. lanceolata** (p. 642)

1. **Alaria nana** Schrader

Plants anchored by firm strong hapteres; stipe 4.5–7 cm. long, robust, 5–8 mm. diam., terete; rhachis 2–4 cm. long, slightly compressed, passing gradually into the midrib; blade usually widest near the base tapering rather abruptly below and gradually above, with some specimens nearly linear, 40–60 cm. long, 3–8 cm. wide; midrib prominent, 4–6 mm. wide, nearly rectangular in cross-section; sporophylls 25–50 in number, linear to slightly elliptical, 6–12 cm. long, 8–15 mm. wide, rounded at the outer end, tapering rather abruptly at the base to a distinct short stipe, sori covering both entire surfaces.

Growing on rocks in the upper part of the littoral belt, in localities exposed to the action of the heavy surf, in company with *Postelsia palmaeformis* and *Lessoniopsis littoralis*, Port Renfrew, Vancouver Island, British Columbia.

Schrader, Observations on *Alaria nana*, 1903, p. 157, pls. 23–27; Yendo, Monogr., 1919, p. 118, pl. 13, figs. 1–3. *Alaria praelonga* f. *nana*, Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1292. *Alaria marginata* f. *nana* Collins, Mar. Alg. Vancouver Isl., 1913, p. 110.

The above locality is the only one in which this species is certainly known to occur. There are plants, however, growing on the central California coast in similar habitats which seem to be closely related to, if not identical with, the Port Renfrew plant. Specimens have been distributed from Golden Gate, San Francisco, in Collins, Holden and Setchell, Phyc. Bor.-Amer., no. 1292, under *A. praelonga* f. *nana*. Yendo (1919, p. 118, et seq.) considers this a distinct species on account of the shape of the sporophylls. We are still of the opinion, in which Kjellman agreed, that it is very closely related to *A. praelonga*.

2. **Alaria praelonga** Kjellm.

Stipe 5–8 cm. long, terete; rhachis 3–5 cm. long, larger than the stipe, somewhat flattened, passing almost directly into the blade, muriculate; blade up to 4 m. long, 7–10 cm. wide, with narrowly cuneate base, plane, smooth, shining, rigid, dark brown color; costa more or less prominent, narrow, in cross-section slightly enlarged at the ends or elliptic-linear, passing abruptly into the blade; sporophylls numerous, fasciculate, distinctly petiolate, oblong-lanceolate to linear-lanceolate, 8–10 cm. long, 1–2 cm. wide, plane, rigid; sori covering nearly the entire surface.

Growing in the lower littoral belt. From St. Paul Island, Bering Sea, Alaska.

Kjellman, Om Beringh. Algfl., 1889, p. 38, Tab. 4, figs. 1–4.

Alaria praelonga Kjellman is a much misunderstood species and seemingly needlessly so. Relying upon Kjellman's opinion (in litt.), we have classified under this name such diverse species as *A. marginata* Post. and Rupr. and *A. lanceolata* Kjellm. The type, both as represented by the type specimen and by Kjellman's figure, is a plant with a short stipe, short narrow sporophylls, a long, moderately broad blade, very long and narrowly attenuated at the base. The figure of Yendo (1919, pl. 4) seems to have broader as well as longer sporophylls than the type, with the sporophylls broader at the base. We have only a single imperfect plant which, in the light of Kjellman's figures and type specimen, we venture to refer finally to this species.

It was collected on St. Paul Island of the Pribiloff Group. Yendo has (1919, p. 88) with justice said that "it is to be questioned as to how Setchell comprehended *A. praelonga* Kjellm." Setchell, finally, has restricted his view to a plant closely resembling Kjellman's figure and type specimen, both young plants.

3. **Alaria tenuifolia** Setchell

Stipe 16–60 cm. in length, cylindrical or nearly so only at the very base, much flattened above, slender and flexible; rhachis more or less elongated, flattened, with the sporophylls at first remote in young plants, later crowded; blade 10–15 dm. long, 10–35 cm. wide, broadly to narrowly cuneate at the base, very thin, collapsing when withdrawn from the water, with plentiful cryptostomata of small size; midrib narrow to fairly broad, oblong in cross-section; sporophylls from narrowly to broadly lanceolate and cuneate at the base, varying to broadly ovate or oblong and distinctly cordate at the base, sessile or with more or less pronounced stipes.

Not uncommon, from the Bering Sea to Puget Sound, Washington.

Setchell, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XLV, Kelps of the U. S. and Alaska, 1912*a*, p. 162, Critical notes on the Laminariaceae, 1908*a*, p. 12; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 272. *Alaria Pylaii* Yendo, Monogr., 1919, p. 97, pl. 7 (at least in last part, but not *Agarum Pylaii* Bory.).

Two well-marked forms have been noted as follows:

Alaria tenuifolia f. **typica** Setchell

Stipe of moderate length, 10–15 cm. long; blade comparatively narrow, 8–15 cm. in width and cuneate at the base; midrib not noticeably broad; sporophylls narrowly to broadly lanceolate with cuneate base and short stalks.

On rocks and stone at low water mark. Amaknak Island, Bay of Unalaska, Alaska.

Setchell, *in* Setchell and Gardner, Alg. of N.W. Amer., 1903, pp. 273–274, pl. 22.

Alaria tenuifolia f. **amplior** S. and G.

Stipe varying from 10–90 cm. in length, usually stouter than in the last and usually as much flattened; blade ample, 20–35 cm. wide, 10–15 dm. long, base generally distinctly cordate; sporophylls broadly ovate to oblong and cordate, each with a conspicuous stalk, frequently very large, 45 cm. long, 25 cm. wide, sorus more or less orbicular and covering only the basal third or fourth.

Attached to piles and boulders near low water mark. Esquimalt, B. C., and Roche Harbor, San Juan Island, Washington.

Setchell and Gardner, Alg. of N.W. Amer., 1903, p. 274.

Yendo (1919, p. 98) has referred this species to *A. Pylaii* Grev. and he may be right although J. G. Agardh's plant, so far as his adult type specimen (cf. Yendo, 1919, pl. 8, fig. 1) is concerned, resembles our f. *longipes* more nearly than f. *typica*, which is the type of *A. tenuifolia*. J. G. Agardh's *Alaria Pylaii* has been the basis of all discussion of this species and is assumed by Yendo to be the true *A. Pylaii*. It is not the *Agarum Pylaii* Bory, however, nor in any wise resembling it, but is possibly the *Laminaria remotifolia* De la Pyl. (*L. Despreauxii* of J. G. Agardh's herbarium is a different and distinct species. W. A. S.) We have for some time been leaning toward the opinion that the f. *longipes* with the truncate base to the blade might be distinct from the typical form of *A. tenuifolia*. It is certainly a very distinct form (or perhaps rather variety) if this characteristic is constant (as it is in all our specimens). It is important to note that J. G. Agardh's plant (no. 2088 of his herbarium), representing his and the prevalent idea of *Alaria Pylaii*, is labeled "*Al. Despreauxii* Bory. *L. Pylaii* de la Pyl, viz., Bory (*musaefolia* v. *remotifolia* Del.), Groenland, Sukkertoppen, S. Berggren," and that this is the plant figured by Yendo (1919, pl. 8, fig. 1). A plant in J. G. Agardh's herbarium (no. 2090), assigned also by him to *Alaria Pylaii*, but very different from that just discussed, is labeled "*Laminaria musaefolia* Bory, Terre Neuve, Mr. Despreaux, 1828. ded. Guillermin." This plant is entirely different from the *Alaria Pylaii* J. Ag., as understood, as well as entirely different from the *Agarum Pylaii* Bory and probably also different from the *Laminaria musaefolia* De la Pyl.

These various considerations lead us to retain the name *Alaria tenuifolia* for our plant and to retain both forms, *typica* and *longipes*, under it for the present at least. What we consider to be the true *Alaria Pylaii* (Bory) Grev. will be discussed below.

4. **Alaria marginata** Post. and Rupr.

Plate 66

Stipe moderately short, 2–5 cm. long, 3–5 mm. diam., nearly terete; rhachis flattened, up to two times as thick as the stipe, merging gradually into the midrib; blade 2.5–3 m. long, 15–20 cm. wide, nearly linear, somewhat tapering above with abruptly cuneate base, producing numerous cryptostomata with abundant exserted hairs; midrib variable in width, from 5 mm. in some individuals up to 22 mm. in others, merging abruptly into the blade; sporophylls ovate, lanceolate or elliptical, rounded above, 10–20 cm. long, 2–3 cm. wide, coriaceous, rigid, usually plane, 24–40 in number, sori in some individuals covering both sides completely except a narrow margin, in others only the basal half or third.

Growing on exposed rocks or in sheltered coves in the middle and lower littoral belts. Fairly abundant along the central California coast, possibly also in Puget Sound.

Postels and Ruprecht, Illus. Alg., 1840, p. 11; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 162, Notes on Kelps, 1896, p. 41, Critical Notes on Laminariaceae, 1908*a*, p. 9; Yendo, Monogr., 1919, p. 93, pl. 6, figs. 1–4. *A. curtipes* Saunders, A New Species of *Alaria*, Minn. Bot. Studies, 1901*a*, p. 561, pl. 33; Tilden, American Algae (Exsicc.), no. 521 (at least in part). *Alaria cordata* Tilden, Amer. Alg. (Exsicc.), no. 241 (*fide* Yendo). *A. lanceolata* (?) Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), 1901, no. XLIV (not of Kjellman).

The first notice of this species of *Alaria* appeared in 1840, in the above mentioned publication of Postels and Ruprecht. Later Ruprecht (Tange, 1851, p. 355) referred to *A. marginata* as being rare, and known to him only from Fort Ross on the California coast. One of us (Setchell) has examined a good specimen of *Alaria* in the Herb. Acad. Sci. Petrograd, labeled *A. marginata* ''Unalaska—Wosnessenski,'' which is like our California species which we have placed under *A. marginata* Post. and Rupr. No later discovery of this species has been made in the original locality, Unalaska, although careful search has been made for it by one of us (Setchell), and it seems quite probable that the Wosnessenski plant may have come from Fort Ross, California. Hence we take this plant as the type of *A. marginata* Post. and Rupr. and Fort Ross as the type locality, and place all of the California plants, except *A. nana* Schrader, under that name at present. At first we were inclined to place the broad Californian plant under *A. praelonga* Kjellman, being led thereto partially by the opinion of Kjellman, who stated in a letter that one of our plants greatly resembled his *Alaria praelonga* but differed in the shape of the blade. The blade in our plants is, at times, much nearer in shape to that of *A. praelonga* than are the sporophylls.

Alaria marginata Post. and Rupr., as shown by the type, has a short stipe, crowded with broad but rather short sporophylls, and a long broad blade, long attenuate at the base. The midrib seems to vary from narrow to very broad.

5. **Alaria Pylaii** (Bory) Grev.

Stipe 2–4 cm. long, terete; rhachis flattened, about twice the diameter of the stipe, passing directly into the midrib; blade short and broad, with broadly cuneate or truncate-cordate base, 2.5–3.5 dm. long, 1–2 dm. wide, thin, membranaceous; midrib 5–8 mm. wide; sporophylls 16–24 in number, 8–10 cm. long, 2–4 cm. wide, obovate, with slender pedicels.

Growing on stones in the upper sublittoral belt, in the vicinity of Prince William Sound and Kadiak Islands, Alaska.

Greville, Alg. Brit. Syn., 1830, p. xxxix; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 272; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 162. *Agarum Pylaii* Bory, *in* Dict. class. d'hist. nat., vol. 9, 1826, p. 194. (Neither *Alaria Pylaii* J. Ag. nor *A. Pylaii* Yendo.)

The type locality of this species is Newfoundland and the type specimen is in the Herbarium of the Museum of Paris, and is labeled, *Laminaria Pylaii*. It was collected by De la Pylaie in 1817. The specimen is evidently an old one, more or less battered, and has somewhat broader sporophylls than the measurements given above, otherwise our specimens from Orca agree fairly well with the type and until more data can be obtained from field study we are placing our plants somewhat doubtfully under this species.

The type of *Agarum Pylaii* Bory in Herb. Bory shows a plant with a short stipe, thickly placed, short but broad sporophylls, and a broad blade, broad to even cordate at the base. Our specimens agree sufficiently to be considered a geographical variety of this species.

6. **Alaria dolichorhachis** Kjellm.

Stipe 2–7 cm. long, terete; rhachis 8–20 cm. long, merging abruptly into the costa; blade short and narrow, 3–7 dm. up to 1 m. long, 4–7 cm. wide, often splitting to the midrib into narrow segments, even wearing completely away, lanceolate, with narrowly cuneate base, undulate; midrib little prominent, 6–10 mm. wide, elliptical in cross-section; sporophylls 30–50 in adult plants, narrowly linear to spatulate, more or less undulate, or spirally twisted, 14–25 cm. long, 6–9 mm. wide.

Growing on rocks in the upper sublittoral belt. Known only from a single locality on our coast. Collected by Charles H. Townsend in the service of the U. S. Fish Commission at Agattu Island, Alaska, 1894.

Kjellman, Algae Arctic Sea, 1883, pp. 217–220, pls. 20, 21, 25, figs. 11–18; Setchell and Gardner, Alg. N.W. Amer., 1913, p. 272; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 162. *Alaria crispa* Kjellman, Om Beringh. Algfl., 1889, p. 37, pl. 3, figs. 5–7; Yendo, Monogr., 1919, p. 89, pl. 5. *Alaria taeniata* Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 162 (not Kjellm.) (not *A. dolichorhachis* Collins, Holden and Setchell, Phyc. Bor.-Amer., 1901, no. XLI).

We have only one collection (of several plants, however), which have the exceedingly long and narrow sporophylls demanded by Kjellman's figure (*loc. cit.*). Kjellman's type, however, does not show these as does his figure and looks more like Kjellman's *A. crispa.* We are retaining our plants under *A. dolichorhachis,* to which species Kjellman thought them closely related yet from which he thought they ought to be separated.

7. **Alaria lanceolata** Kjellm.

Stipe short, 3–6 cm. long, subterete; rhachis short, compressed, thicker than the stipe; blade lanceolate, short and narrow, up to 1.5 m. long, 10 cm. wide, decurrent, somewhat undulate and plicate, often much worn away; midrib 4–8 mm. wide, oblong in cross-section; sporophylls 30–40, linear or linear-lanceolate, cuneate at base, rounded or spatulate apex, short stipitate; sori covering the basal portion.

Growing on rocks in the littoral and sublittoral belts. The type locality is Bering Island in the Bering Sea. Kjellman reports it growing in the sublittoral belt, but one of us (Setchell) has observed it growing in abundance high up in the littoral belt at Amaknak Island, Alaska.

Kjellman, Om Beringh. Algfl., 1889, p. 39, pl. 5, fig. 1–3; Saunders, Alg. Harriman Exp., 1901, p. 426, pl. 53(?); Setchell and Gardner, Alg. N.W. Amer., 1903, p. 275; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 162; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XLIV. *Alaria laticosta* Saunders, Alg. Harriman Exp., 1901, p. 425, pl. 55 (not of Kjellm.). *Alaria dolichorhachis* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XLI.

The *Alaria lanceolata* of Kjellman, judging from his illustration and a photograph of his type, seems to be a plant with short stipe, crowded long and narrow sporophylls, with the blade fairly broad and narrowed to a moderately broad cuneate base. On the authority of Kjellman, we remove to this species the specimens distributed as *A. dolichorhachis* under no. XLI of the Phycotheca Boreali-Americana. The only difference noted by Kjellman in the case of these plants is that the blade is not so dark as in his type specimens. We also feel inclined to refer here the plant figured by Saunders (*loc. cit.*) as *Alaria laticosta*, which has, however, a much broader midrib. Yendo refers Saunders' plant to *A. macroptera* (Rupr.) Yendo, but the figures of that species as given by Yendo show a plant with different sporophylls (too broad) and with the base of the blade long and narrowly attenuated. The *Alaria lanceolata* Saunders (*loc. cit.*) has shorter sporophylls than is characteristic for this species.

8. **Alaria valida** Kjellman and Setchell

Stipe short, 1–5 cm. long, cylindrical, at first slender, but at length stout and showing rings of growth, reaching a diameter of 13 mm., showing also a well developed cork layer; rhachis at first short, becoming very much elongated, up to 15–20 cm., somewhat flattened, obtuse on the edges, stout like the stipe; blade up to 3–4 m. long, 15–25 cm. wide, tapering very gradually to the base, midrib 16–22 mm. wide, little prominent and abruptly narrowing toward each end in cross-section; sporophylls linear lanceolate, 15–30 cm. long, 3–6 cm. wide, with margins undulate and all except the narrow margins and a small portion of the tip occupied by the sorus.

In the sublittoral belt. From Unga, Alaska, to Puget Sound, Washington.

Kjellman and Setchell, *in* Setchell and Gardner, Alg., N. W. Amer., 1903, p. 278, pl. 21. *Alaria grandifolia* J. Ag., Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. CV (not J. Ag.).

Alaria valida f. longipes S. & G.

Stipe long, 8–20 cm. in length, not including any of the rhachis; otherwise as in the type.

With the typical form on the west coast of Whidbey Island, Washington.

Setchell and Gardner, Alg. N.W. Amer., 1903, p. 279.

Alaria valida seems to be a distinct species, as was suggested by Kjellman. This is also the opinion of Yendo (1919, p. 118). At one time Setchell (1908*a*, p. 11) was inclined to unite it with *A. grandifolia* J. Ag., but that species has the blade broadly cuneate, almost oblong at the base. Yendo (1919, pp. 116, 118) states that Tilden's no. 521 (a specimen collected by De Alton Saunders on the shores of Monterey Bay and presumably determined by him) is *Alaria valida* Kjellm. and Setch. The specimen in our copy is *Alaria marginata*, as we understand it, and we have not seen anything referable to *A. valida* on the California coast.

9. Alaria fistulosa Post. and Rupr.

Holdfast of numerous, irregularly branched hapteres; stipe 20–25 cm. long, 8–12 mm. diam., without mucilage ducts, terete below, much flattened in the transition region, where the numerous sporophylls are developed, passing imperceptibly into the blade, perennial; blade up to 25 m. long and up to 9 dm. broad, cuneate at the base, with well defined midrib 2–3 cm. broad, which is hollow and inflated at irregular intervals, the inflations being distinctly separate; mucilage ducts abundant; color very dark olive brown; cryptostomata absent.

Growing often in great profusion on rock ledges and boulders in the upper sublittoral belt. From Augustine Bay, Dall Island, to the Bering Sea in our waters and extending to the Kurile Islands and Japan on the Asiatic coast.

Postels and Ruprecht, Illus. Alg., 1840, p. 11, pl. 16; Saunders, Alg. Harriman Exp., 1901, p. 246, pl. 57; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 275; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 163; Kibbe, Structure of *Alaria fistulosa*, 1915, pp. 43–57, pls. 7–9; Yendo, Monogr. *Alaria*, 1919, p. 76, pl. 1.

Two forms have been segregated:

Alaria fistulosa f. stenophylla Setchell

Blade narrow, 10–25 m. long, usually not over 30 cm. wide; midrib narrow; sporophylls usually short and more or less decidedly obovate.

Growing in belts just off shore and in isolated groups in quiet waters, 5–10 fathoms. Ranging from the latitude of the Pribilof Islands in the Bering Sea to southeastern Alaska.

Setchell, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XLIII; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 276.

Alaria fistulosa f. platyphylla Setchell

Blade usually 6–9 dm. wide, up to 25 m. long, with broad, much inflated midrib; sporophylls numerous, up to 200, long and narrow, 30–50 cm. long, 3–6 cm. wide.

Growing in deep water, usually found floating or cast ashore. Same range as preceding.

Setchell, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XLII; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 277.

The fistulose midrib distinguishes this large, or at least long species, which varies much in breadth of blade and size and number of sporophylls. The two forms described above are fairly easy to segregate but are probably ecological. This kelp grows in deep water and forms beds in fairly deep water, its northern area comparable with that of *Nereocystis,* with which it may be associated.

TRIBE 2. ECKLONIEAE SETCHELL

Members of the Alariaceae having the outgrowths from the transition place maturing on the blade; simple, or once or twice furcate through wearing away of the central portion of the blade.

Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 163.

The genus *Ecklonia* is not represented on our coast, but *Eisenia,* whose early stages are like those of *Ecklonia,* occurs on the coast of southern California and in Japan. *Ecklonia* is represented in the Southern Hemisphere (Australia, New Zealand, Cape Good Hope, and even up to the Canary Islands, as well as in Japan).

57. **Eisenia** Aresch.

Holdfast of dichotomously branched hapteres; stipe elongating and persistent, bifurcate above, the two false branches being the thickened lower margins of the original and subsequently eroded blade. A small partial blade persists at the outer extremity of each false stipe throughout the life of the plant, giving rise to numerous sporophylls along the lower outer margin; perennial.

Areschoug, *in* Bot. Not., 1876, no. 3, p. 69, Observ. Phycol., part 5, 1884, p. 7.

Eisenia is a distinct genus of two known species; one, *E. arborea*, the type of the species, inhabiting the waters of southern California, and the other, *E. bicyclis* (Kjellm.) Setchell, inhabiting the Japanese waters.

Eisenia arborea Aresch.

Hapteres arising from very close to the base of the stipe, much branched, the terminal branchlets fine and contorted; stipe nearly terete at the base, much flattened above, up to 1 m. long, tough and rigid, containing mucilage ducts; blade in young plants entire, somewhat ovate, soon giving rise to short outgrowths, the pinnules, in the transition region, later eroding from the apex to the transition or meristematic region, which now becomes divided longitudinally establishing two meristems; these two now moving forward, giving rise to the two twisted stipe-like portions, each bearing a short terminal thickened blade, in turn bearing numerous pinnules or sporophylls along the lower outer margins; a third meristem remaining active at the summit of the true stipe and elongating; each blade bearing 30–50 sporophylls; the sori in large irregularly shaped areas.

Growing on rocks in the upper sublittoral and lower littoral belts. Southern California, south of Redondo.

Areschoug, *in* Bot. Not., 1878, no. 3, p. 69, Observ. Phycol., part 5, 1884, p. 7; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 164; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. IX. *Ecklonia radiata* Areschoug, 1884, p. 13, in part (not *Fucus radiatus* Turner).

The plants reported by Saunders from Puget Sound, Washington, and Wrangell, Alaska, proved to be large specimens of *Laminaria Andersonia* with blades worn away. Areschoug reports it "in sinu propre San Francisco" on the authority of Dr. G. Eisen, in honor of whom the genus was named, but the type locality (fide Dr. Eisen) is Santa Catalina Island. Areschoug also reports it from Santa Cruz, California, on the authority of Dr. C. L. Anderson, who has told us that his plant was found floating. We have no knowledge which seems to us to be authentic of its occurrence, growing in position, north of Redondo, California. We have no data as to its southern limit of distribution, but we presume that it extends to some distance south along the coast of Lower California.

TRIBE 3. EGREGIEAE SETCHELL

Members of the Alariaceae having irregular branching and outgrowth of sporophylls on both stipe and blade.

Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 164.

There is a single genus of this tribe, with two species, both confined to the western coast of North America.

58. **Egregia** Aresch.

Holdfast a very densely compact mass of repeatedly branched hapteres; stipe irregularly branched near the base, terete below, each branch soon becoming ligulate forming a rhachis and bearing outgrowths on each margin nearly throughout its length; some outgrowths metamorphosing into conspicuous stipitate bladders, some becoming ligulate and sterile, and some remaining small and bearing sori of zoosporangia on both surfaces.

Areschoug, *in* Bot. Not., 1878, no. 3, p. 66, Observ. Phycol., part 5, 1884, p. 3.

The genus *Egregia* was established by Areschoug (*loc. cit.*) to receive the *Fucus Menziesii* of Turner. Menzies collected it at "Nootka, Trinidad and Monterey."

Key to the Species

1. Sterile, lateral outgrowths linear spatulate .... 1. **E. Menziesii** (p. 647)
1. Sterile, lateral outgrowths ligulate .... 2. **E. laevigata** (p. 648)

Egregia Menziesii (Turn.) Aresch.

Compact mass of hapteres arising close to the base of the stipe, by repeated branching, often growing up around the base of the stipe; stipe smooth, nearly terete at the base for 8–15 cm., branched several times, soon becoming ligulate, forming a rhachis; rhachis

5–8 m. long, 2.5–3.5 cm. broad, densely covered on both sides with short blunt tubercles, and along each margin with outgrowths bearing the ellipsoidal bladders and smooth ovate or spatulate sporophylls among the sterile leaflike structures; blade in the young specimens coarsely rugose, conspicuous, but soon lost.

Growing in the upper sublittoral and lower littoral belts. From the southern end of Vancouver Island to Point Conception, California.

Areschoug, *in* Bot. Not., 1878, no. 3, p. 66; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 271; Setchell, Kelps of the U. S. and Alaska, 1912*a*, p. 164; Muenscher, Key to the Phaeophyceae, 1917, p. 274; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), nos. 1741 and XCII; Tilden, Amer. Alg. (Exsicc.), no. 236. *Macrocystis Menziesii* Agardh, Sp. Alg., 1820, p. 49. *Macrocystis obtusa* Harvey, Botany Beechey's Voyage, 1833, p. 163 (cf. Harvey, 1852, p. 62). *Phyllospora Menziesii* Ruprecht, Neue Pflanzen, 1852, p. 70, pl. 4. *Fucus Menziesii* Turner, Hist. Fuc., 1808, p. 58, pl. 27.

This plant is often very long, with several branches arising mostly near the base as outgrowths which, unlike those of the sporophyll type, have lateral blades, transition places, and lateral outgrowths in turn, developing like the main stipe and rhachis. The bladders are frequent but develop in no exact order.

Egregia laevigata Setchell

Holdfast and stipe much as in *E. Menziesii*, but the true stipe and the rhachis smooth on both sides, the marginal outgrowths very variable in different individuals and at different ages of the same individual, some profusely dissected and filiform, even capillary, others large, linear and entire, up to 15 cm. long; the bladders varying in shape from spherical to very narrowly ellipsoidal.

Growing on rocks in the lower littoral and upper sublittoral belts. Extending from the vicinity of Point Conception, California, to some unknown locality on the west coast of Lower California, at least as far down as Ensenada.

Setchell, Notes on Kelps, 1896, p. 44, Kelps of the U. S. and Alaska, 1912*a*, p. 164; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), nos. 420 and XII; Tilden, Amer. Alg. (Exsicc.), no. 340. *Egregia menziesii* Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 111.

Egregia laevigata f. borealis Setchell

Form with entire sporophylls and with blade and ligulate portions roughened slightly with pointed papillae.

Growing in the upper sublittoral belt. Carmel Bay, California.

Setchell, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XL.

This plant, which in its well developed form with capillary dissected leaflets, is known as the "Feather Boa," is usually readily to be distinguished from its sister species. Toward its northern limit, it is not common, occurring as f. *borealis* along with *E. Menziesii* and presenting forms with few to fairly numerous papillate roughenings, appearing as if of possible hybrid origin.

SERIES 2. APLANOSPOREAE SER. NOV.

Fronds of moderate size, filamentous and monosiphonous (Choristocarpaceae) or polysiphonous (Tilopteridaceae) or complanate (Dictyotaceae); reproduction by both sexual and asexual methods; sexual reproduction isogamous? or heterogamous; non-sexual reproduction brought about by the formation of aplanospores, one or more, usually four, in a sporangium and, in some genera, by biciliate zoospores; alternation of generations known in some species (e.g., *Dictyota dichotoma* in which reduction takes place at the time of aplanospore formation).

The Aplanosporeae consists of two orders, viz., the Tilopteridales and the Dictyotales. The series is characterized by certain of the members of both orders bearing non-motile, non-sexual spores which may be single (Tilopteridales) although possessing (in some cases at least) four nuclei at maturity or may be formed in fours from a single mother cell (Dictyotales). The Tilopteridales resemble the Ectocarpales in vegetative structure and may have unilocular zoosporangia giving rise to biciliated zoospores. There are no representatives of this order on our coasts.

Order 7. DICTYOTALES Kjellm.

Fronds of moderate size, complanate, attached by a more or less extensively stupose base, with the hairs often extending for some distance up the fronds; reproduction both asexual and sexual; the non-sexual spores (aplanospores) usually borne in groups of four, but rarely more, in transformed surface cells projecting singly or in groups beyond the surface; the gametes heterogamous, the female, borne singly in a gametangium, large and non-motile, the male, borne many in a plurilocular gametangium, small and motile by a single (?) lateral flagellum; the male and female gametangia usually in dense sori, and always projecting beyond the surface; hairs numerous, in groups; paraphyses present in some forms.

Kjellman, *in* Engler und Prantl., Die natürl. Pflanzenfam., 1 Teil, 2 Abt., 1896, p. 291.

The order Dictyotales is a distinct, well marked group, but with uncertain affinities. The possession of a brown pigment in addition to chlorophyll is a prominent character of the Melanophyceae. The development of aplanospores in groups of four (tetraspores) is a character common in the Rhodophyceae. The male gamete with but a single cilium is not present elsewhere in either group. The brown pigment and heterogamous method of reproduction seem sufficient to relate them to the Melanophyceae and probably closely to the Fucales, where we are placing the group. It has no zoosporangia or zoospores represented in any of its members.

Family 23. DICTYOTACEAE Harvey (lim. mut.)

Characters of the order which contains only the single family.

Harvey, Ner. Bor.-Amer., vol. 1, 1852, p. 99.

Harvey included all the complex Melanophyceae "whose spores are superficial and disposed in definite lines or sori." The Dictyotaceous genera as now understood were included, but also some others such as *Punctaria*, *Soranthera*, *Stilophora*, *Dictyosiphon*, *Asperococcus*, and *Hydroclathrus*. Harvey, himself, realized that in external habit and even in internal structure, the plants he referred to his order, as he termed it, exhibited "considerable variety." He also stated that "the fructification exhibits considerable diversity of aspect."

KEY TO THE GENERA

1. Growth in length by division of an apical cell..........................59. **Dictyota** (p. 651)
1. Growth in length by the division of many marginal cells.. 2
   2. Frond with a distinct midrib.......................................60. **Neurocarpus** (p. 655)
   2. Frond without a midrib.. 3
3. Reproductive organs on both sides of the frond... 5
3. Reproductive organs on only one side of the frond.. 4
   4. The terminal margin inrolled...64. **Padina** (p. 661)
   4. The terminal margin not inrolled..........................62. **Chlanidophora** (p. 658)
5. Sori usually in more or less distinct concentric lines partially embedded in the frond, even at maturity.............................. ....61. **Taonia** (p. 656)
5. Sori seldom concentric, entirely superficial at maturity..........63. **Zonaria** (p. 659)

59. **Dictyota** Lamour.

Frond plane, membranaceous, ecostate, dichotomous below, somewhat irregularly cleft and flabellate above, arising from a stupose base, and consisting of two layers of cells, an inner layer of large, colorless, longitudinally elongated, prismatic cells, and a cortex of small, assimilating cells, arranged longitudinally in rows; reproduction sexual, by antheridia developed in small groups producing antherozoids with a single terminal cilium, and by oogonia in groups, each oogonium producing a single egg which is extruded and fertilized in the water; and asexual by aplanospores, 4 in a sporangium, cruciately divided, developed from the surface cells, scattered, sparse.

Lamouroux, Nouv. Bull. Soc. Philom., vol. 1, 1809 (May), p. 331, and *in* Desv., Jour. de Bot., vol. 2, 1809*a*, p. 38.

The older genus *Dictyota* was distinct among the Dictyotaceae whose fronds, arising from a single apical cell, were flattened or compressed and more or less dichotomously branched. The latest divisions of J. G. Agardh, while attractive and representing certain tendencies toward increase in complexity, yet present certain difficulties in the line of cleavage. *Dilophus*, for example, presents species in typical form with two or four layers of cells throughout the older portions of the frond, but what is to be done with those species which are two-layered only on the extreme margins, those which are two-layered more widely on the margins, and those which are only one-layered occasionally? All of our species are of the first or second types and we feel better satisfied to refer them all to the genus *Dictyota*. Concerning the other segregate of J. G. Agardh (1894) from the *Dictyota* of earlier accounts, we are in no position to speak.

KEY TO THE SPECIES

1. Margin of the frond profusely toothed and crenulate ....5. **D. crenulata** (p. 655)
1. Margin of the frond smooth 2
    2. Fronds large, 1.5–2.5 dm. long, 250–500μ thick, axils rounded 5
    2. Fronds smaller, up to 15 cm. long, axils more or less acute 3
3. Fronds 7–9 cm. long, 135–160μ thick, axils wide ....4. **D. Vivesii** (p. 654)
3. Fronds 8–15 cm. long, 80–135μ thick, axils narrow, acute 4
    4. Oogonia single ....6. **D. hesperia** (p. 655)
    4. Oogonia collected into sori ....3. **D. Johnstonii** (p. 653)
5. Fronds dark brown, coriaceous, tips rounded ....1. **D. Binghamiae** (p. 652)
5. Fronds pale yellowish brown, delicate, tips truncate ....2. **D. flabellata** (p. 652)

1. **Dictyota Binghamiae** J. Ag.

Plate 34, figs. 1, 2

Fronds 10–18 cm. (up to 25 cm.) high, with stupose base of fine brown hairs, closely appressed, extending for some distance up the frond, coriaceous below, up to 500μ thick, thin and membranaceous above, branches strict, angles rounded, terminal lobes rounded; color dark below, brown above.

Growing in pools in the middle and lower littoral belts. Southern California and northern Lower California (Ensenada).

J. G. Agardh, Anal. Alg. Cont. I, 1894, p. 72; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1392. *Dictyota Kunthii* Farlow, Rept. U. S. Fish Comm., for 1875, 1876, p. 705; Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 93. *Glossophora Kunthii* Collins, Holden and Setchell, *loc. cit.*, no. 85.

This is a large and broad, coarse species with even margins and rounded axils. In color it is usually darker brown than the next species, somewhat thicker and more coriaceous, more truly dichotomous above, and with the upper lobes longer and more rounded.

2. **Dictyota flabellata** (Collins) S. and G.

Plate 34, fig. 3; plate 35, fig. 7, and plate 36, figs. 13–17

Fronds plane, membranaceous, slightly stupose at the base, dichotomous, or in mature plants certain segments growing faster than others, presenting the appearance of being a flexuose rhachis with alternate branching, 1–2 dm. high; segments cuneate, widening upward to each forking, terminal lobes and sinuses rounded; width variable, 2 mm. to 2 cm. wide; color yellowish brown, darker toward the base; medulla consisting of a single layer of nearly cuboidal, colorless cells, except along the thickened margins of the old fronds where it is double; cortex of a single layer of colored cells, except in older, thickened margins where there are two layers, arranged in longitudinal parallel series; oogonia, antheridia, and tetrasporangia all growing on different individuals; oogonia scattered in small sori; antheridia and tetrasporangia in oval or oblong sori; reproductive cells on both surfaces of the frond.

Growing on boulders in the lower littoral belt. Southern California.

Setchell and Gardner, Phyc. Cont. VII, 1924, p. 12. *Dilophus flabellatus* Collins, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 834. *Glossophora Kunthii* Tilden, Amer. Alg. (Exsicc.), no. 334. *Dictyota dichotoma* Tilden, Amer. Alg., no. 335 (not Lamour.).

This seems to be a distinct species, thus far confined to southern California, but with unattached specimens collected at Monterey, California, and Tracyton, Washington, probably sporadic or transported to the latter. The species has the least doubling of the marginal cells of any in our territory and is closely related to *D. Binghamiae.* It is thinner, lighter colored, more pseudodichotomous, with the uppermost almost pinnately arranged lobes short and bent. It is not difficult to separate the two species when in company, either living or in herbarium specimens, but we do find it difficult to express definitely the exact points of distinction between them.

3. **Dictyota Johnstonii** S. and G.

Fronds 12–16 cm. high, 5–8 mm. wide, 125–135μ thick, composed of a single layer of large medullary cells surrounded by a single surface layer of small cells except in the lower part, along the margin the medullary and surface cells becoming doubled, slightly stupose at the base, pinnate, dichotomously branched, angles acute to somewhat rounded, branches strict, margins smooth, color dark brown, black on drying; oogonia aggregated into elliptical or elongated areas, 115–125μ long, 80–90μ wide; tetrasporangia and antheridia unknown.

Growing on rocks in the upper sublittoral belt. San Marcos Island, Gulf of California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 730, pl. 18, figs. 54–56, and plate 39.

Dictyota Johnstonii appears to belong to the subgenus or section of the genus, *Strigocarpus* J. Agardh (Anal. Algol. Cont. I, 1894,

p. 73) and related to *D. pinnatifida* Kuetzing (Tab. Phyc., vol. 9, 1859, p. 16, pl. 39, fig. 1), to *D. Pappeana* Kuetzing (*loc. cit.*, pl. 38, fig. 2), and to *D. liturata* Kuetzing (*loc. cit.*, fig. 1). The cross-section in the central and lower parts of the frond has a structure similar to that shown by Okamura (1913, p. 33, pl. 109, figs. 3, 7) for *D. marginata*. In *D. Johnstonii* the margins are thickened by divisions of the cells of both the medulla and the surface, while in *D. marginata* increase in thickness is brought about by division of the medullary cells only.

4. **Dictyota Vivesii** Howe

Fronds densely caespitose, stupose at the base, 7–9 cm. high, 135–160μ thick (240μ at the base), collapsed and thin on drying, somewhat regularly 3–6 times dichotomous below, the branches then rather closely 3 or 4 times subflabellately or subpinnately dichotomous, sinuses mostly rather acute, margins entire or slightly undulate; main segments oblong or obcuneate, 3–8 mm. broad, diminishing in length and width upward, terminal segments 1–2 mm. wide; cortical cells nearly uniform in size, 19–65μ long, 11–27μ wide, interior cells much larger and very thin-walled; aplanospores forming small, scattered, inconspicuous sori.

Collected by Señor G. V. Vives at La Paz, Lower California, in February, 1911.

Howe, Phyc. Stud. V, 1911, p. 497, pl. 27.

Dictyota Vivesii seems to be a near relative to *D. Bartayresiana* Lamour. from the West Indies. According to Howe (1911, p. 498): "It is more caespitose in habit of growth than *D. Bartayresiana,* more stupose at the base, less regularly dichotomous towards the apices, rather broader in its broadest parts and more conspicuously dwindling in width as the ultimate segments are approached, the axils (the upper at least) are more acute and the segments less patent or divaricate, the apices are less acute, and both the cortical and the interior cells are for the most part narrower and the cortical cells overlaying the septa and lumina of the interior cells show scarcely any of that differentiation in form and translucency that led J. Agardh to describe *B. Bartayresiana* as 'fenestrate.' "

5. **Dictyota crenulata** J. Ag.

Frond attached by a stupose base, decompositely dichotomous, with wide sinuses; segments linear, margins crenulate-dentate, narrow below, tongue-shaped above, areolae rectangular; sori sparingly scattered over the whole surface of the segments.

Reported from St. Augustin, on the west coast of Mexico, and from La Paz, on the peninsula of Lower California.

J. Agardh, Nya Alg., 1847, p. 7; Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 730, pl. 18, figs. 50, 51. *Dictyota Bartayresiana* var. *denticulata* Kuetzing, Tab. Phyc., 1859, p. 8 (as to synonym only).

The type locality for *Dictyota crenulata* is St. Augustin, Mexico. We referred a plant to this species (*loc. cit.*) collected at La Paz, which, although sparse, seems to belong to J. G. Agardh's species from St. Augustin.

6. **Dictyota hesperia** S. and G.

Fronds linear, repeatedly branched, 8–10 cm. high, 2–4 mm. wide, 80–120μ thick, more or less finely stupose at the base, dichotomously, or at times subdistichously branched, antheridia and oogonia distributed over both surfaces on the same frond, oogonia single and antheridia in small, circular groups; tetrasporangia single or in small, irregular groups.

Growing on rocks in the lower littoral and upper sublittoral belts. San Marcos Island, Gulf of California.

Setchell and Gardner, Mar. Alg. Gulf. Calif., 1924, p. 731, pl. 18, figs. 52, 53.

Dictyota hesperia seems to belong to the subgenus or section of the group designated as *Pleiadophora* by J. G. Agardh (1894, p. 69) with close affinity with *D. sandvicensis* Sond.

60. **Neurocarpus** Web. and Mohr

Fronds smooth, fairly firm, with distinct, percurrent midrib, repeatedly dichotomo-flabellate, attached by a stupose base, composed of two distinct tissues, a medulla of cuboidal to angular cells, many layers deep at the midrib, diminishing to few at the margin, and a single layer of small, color bearing cells on the surface; aplanospores arranged in sori along either side of the midrib; oogonia and antheridia scattered.

Weber and Mohr, Beiträge zur Naturkunde, vol. 1, 1805, p. 300; Howe, Mar. Alg. Peru, 1914, p. 69. *Dictyopteris* Lamouroux, Observ. Phys., 1809, p. 332. *Halyseris* Agardh, Sp. Alg., vol. 1, 1820, p. 141.

We have adopted the opinion of Howe as regards the proper designation of this genus which is readily recognized among the genera of our coast by its percurrent midrib, although our species has somewhat the superficial aspect of a *Zonaria.*

Neurocarpus zonarioides (Farlow) Howe

Plate 34, fig. 4; plate 35, fig. 11; plate 36, fig. 21; plate 38, fig. 39, and plate 95

Fronds arising from a stupose base, 8–24 cm. high, densely and irregularly dichotomous, ultimate dichotomies short, with prominent, percurrent midrib, tomentose below, and laminae without lateral veins, much incised and lacerate above, soon disappearing below; color when young, yellowish brown, dingy brown or almost black on drying; ultimate segments often subflabellate, short, somewhat divergent, with obtuse or slightly retuse tips; aplanosporangia numerous, arranged in sori parallel to the midrib on both sides of the frond, 75–100μ diam.

Growing on rocks in the lower littoral and upper sublittoral belts. Known only from southern California and northern Lower California (Ensenada).

M. A. Howe, Mar. Alg. Peru, 1914, p. 69; Setchell and Gardner, Mar. Alg. Gulf of Calif., 1924, p. 728. *Dictyopteris zonarioides* Farlow, *in* Erythea, vol. 7, 1899, p. 73; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 581. *Haliseris polypodioides* McClatchie, Seedless plants of southern Calif., 1897, p. 354.

Farlow and Howe have made plain the characteristics of this species. Its nearest rlative seems to be *N. Cokeri* Howe of the Peruvian coast. For exact information, Howe's comparison (*loc. cit.*) should be consulted.

61. **Taonia** J. Ag.

Fronds plane, ecostate, attached by a more or less stupose base, flabellate, the cuneate segments more or less deeply divided and dissected into narrow laciniae, composed of two distinct tissues, a medulla of several layers (usually 4) of larger colorless cells, surrounded by a single layer of cuboidal, color bearing cells, arranged mostly in longitudinal series; aplanospores scattered or arranged vaguely in concentric zones, usually abundant; oogonia and antheridia on different individuals.

J. G. Agardh, Sp. Alg., vol. 1, 1848, p. 101.

The genus was founded by J. G. Agardh on *Ulva Atomaria* Woodward (Linn. Trans., vol. 3, 1797, p. 53). *U. Atomaria* was discovered by Mr. Lilly Wigg on the beach at Yarmouth, England. Since its discovery, it has been associated with at least the following genera: *Dictyota,* three different species, *Zonaria Atomaria, Padina,* two species, *Stypopodium Atomaria* and *Ulva serrata.* While the genus *Taonia* is to be distinguished from *Zonaria* by its usually more delicate tissues, its absolute lack of a midrib (*Zonaria* being subcostate), and by a greater tendency to have its reproductive bodies in concentric lines, nevertheless there are difficulties in exactly diagnosing it. In all the species of *Zonaria,* the reproductive bodies are, at least at maturity, superficial, while in the species of *Taonia,* they are partially embedded in the frond.

Taonia Lennebackerae Farlow

Plate 35, figs. 9, 10, and plate 96

Fronds arising from a slightly stupose base, 1–2 dm. (up to 3 dm.) high, variable in width; segments mostly broadly cuneate from near the base of the fronds, unevenly divided at the outer end into several lobes, often deeply lacerated; color when young olive, dark brown in older specimens; cells of the interior 3–4 layers, angles considerably rounded, slightly elongated longitudinally; cells of the cortex mostly arranged in longitudinal rows, 1.5–3 times as long as broad; reproductive cells mostly scattered promiscuously and profusely on both sides of the frond, at times vaguely in concentric lines.

Growing on rocks in the upper subittoral belt. Southern California.

Farlow, *in* Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 160 (*nomen nudum*); J. G. Agardh, Anal. Alg. Cont. I, 1894, p. 30 (description); Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 327; Tilden, Amer. Alg. (Exsicc.), no. 337.

The type locality of this species is Santa Barbara, California. The type specimens were contributed by Miss Lennebacker, of Santa Barbara. The California species seems more delicate than the European, with never a sign of a stupose base and with the fruit dots usually scattered, although at times in undulate and indistinct concentric lines. According to J. G. Agardh, the cortical cells are shorter than in other species of the genus (1.5–3 times longer as contrasted with 3–4 times longer in surface view). Our plant is certainly less characteristic than the European *T. Atomaria* (Good. et Wood.) J. Agardh, as to concentric lines of sori while, in habit, it seems to differ decidedly from *T. australasica* (Kuetz.) J. Agardh, if we may rely on Kuetzing's figure (1859, pl. 48, fig. 2, quoted by J. G. Agardh with a query).

62. **Chlanidophora** J. Ag.

Fronds multifid decompound, terminal segments plane, flabellately dichotomous, subcostate below, lateral laciniae acuminate often ending in a terminal cell; external cells rectangular in surface view regularly placed, those of each surface (in transverse section) adherent in turn and corresponding in position, forming a distromatic frond (there being no internal cells); fertile cells superficial, sparse, obovate globose; antheridia situated on the same individuals, forming oblong-linear superficial sori, parallel to the length of the fronds, of a double series of cells, finally quaternate.

J. G. Agardh, Anal. Alg. Cont. I, 1894, p. 16 (*Chlanidote* in Key, *loc. cit.*, p. 6). *Chlanidote* De-Toni, Syll. Alg., vol. 3, 1895, p. 238.

We have paraphrased the generic description of J. G. Agardh, but give below under our species the characters of our plant, which may possibly be of a distinct genus. We have no specimens of *Chlanidophora microphylla* (Harv.) J. Agardh for examination and, consequently, must rely on the descriptions and on Harvey's (Ner. Austr., vol. 4, 1862, pl. 195) and Kuetzing's (Tab. Phyc., vol. 9, 1859, pl. 69, fig. III, *a–d*) figures. In structure, the Australian plant is very close to ours, yet ours seems to be more an aggregation of somewhat loosely cohering filaments, while the type of the genus seems possibly more tightly cohering and parenchymatous. We have altogether too imperfect a knowledge of the reproductive bodies in the case of either species for a close comparison. Harvey's plant was sterile. Kuetzing's plant was probably sterile. The description and figures of J. G. Agardh are confusing.

Chlanidophora abyssicola S. and G.

Plate 50, figs. 1–7

Fronds 2–3 cm. high, composed at maturity of numerous broadly flabellate segments; false stipe slender, in part polystromatic, composed of the original narrow blade covered on both sides by numerous, slender, closely appressed, multicellular hairs spreading out at the base on the substratum, serving as attaching organs; cells dividing horizontally 1–3 cells back of the margin, making the main body of the frond distromatic; marginal layer of 1–3 cells monostromatic; cells, in surface view, quadrangular, 16–24μ long, 10–12μ broad, marginal cells 30–50μ long, containing numerous, small, spherical chromatophores; sporangia pyriform to ellipsoidal, 32–38μ long, 28–32μ broad; aplanospores (?) 4–5μ diam., numerous; paraphyses clavate, 4–7 cells long.

Growing attached to shells of mollusks in 10–15 fathoms. Griffin Bay, San Juan Island, Washington.

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 11.

63. **Zonaria** Ag. (lim. mut.)

Fronds in part decumbent or wholly erect, decidedly stupose at the base, ecostate at first, the margins soon wearing away in the lower part, thus becoming stipitate and subcostate by thickening, flabellately divided; growth in length by means of numerous cells at the terminal edge; fronds composed of two tissues, a medullary layer of several cells, and a single cortical layer, arranged more or less in longitudinal rows, containing many chromatophores; antheridia and aplanospores unknown; oogonia on one or both sides of the thallus, borne in small sori, among paraphyses.

C. A. Agardh, Syn. Alg. Scand., 1817, p. xx (lim. mut.); J. G. Agardh, *in* Linnaea, vol. 15, 1841, p. 444, Bidrag till Alg. Syst., I, 1873, p. 45; Anal. Alg. Cont. I, 1894, p. 12.

We have taken the genus *Zonaria* in the broader sense and including certain of the segregated genera of J. G. Agardh, such as his *Gymnosorus*, *Homoeostrichus*, and *Stypopodium*. This is the sense in which Howe has used it in the Bahama Algae (1920, p. 594). While *Homoeostrichus* has certain very distinct species, there seems to be less distinct cleavage for certain others. Our single species seems clearly of *Zonaria* in this broader sense.

Nieuwland (1917, pp. 51, 52) has proposed the name *Villania* instead of *Zonaria* (J. G. Agardh, 1872, p. 45) because of a most convincingly evident misprint of "*Zonaria*" for "*Zornia*." Such an attempted application even of the principle: "once a synonym always a synonym" seems a "*reductio ad absurdum*" and especially when applied by one seemingly in absolute ignorance of the genus affected, other than as an abstract entity. *Zonaria*, however, dates back to

1801 (Draparnaud, Discours sur les moeurs des plantes, fide Steudel) and was apparently applied to a Discomycete. Roussel also used the name for a fungus in 1806 (fide Steudel). C. A. Agardh (1817, p. xx) first used the name for a genus of algae of far wider extent than that in which it is used at present. J. G. Agardh has variously applied the name, his final and rather too narrow limitation having been published in 1894.

Zonaria Farlowii S. and G.

Plate 34, fig. 5; plate 36, fig. 20; plate 43, fig. 63, and plate 97

Fronds 8–12 cm. long, profusely and more or less flabellately branched, terminal lobes flabellate, alae at times split into numerous, narrow and pointed segments, lower part forming a much thickened stipe, becoming decidedly stupose; marginal growing cells very large, densely filled with cell contents; medulla composed of 6–9 layers of cells parallelopiped in shape, having scattered chromatophores; aplanospores borne in sori, irregular in shape and size, scattered promiscuously on both sides of the frond, formed under the cuticle among numerous, multicellular paraphyses, growth of aplanospores and paraphyses finally rupturing the cuticle allowing the escape of the spores; paraphyses clavate, composed of 5–7 cells; hairs borne in small, independent groups or arranged in transverse bands.

Growing on rocks in the upper sublittoral belt, and in pools in the lower littoral belt. Southern California (Santa Barbara to San Diego).

Setchell and Gardner, Phyc. Cont., VII, 1924, p. 11. *Zonaria Tournefortii* Farlow, *in* Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., 1878, no. 91; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 86; Tilden, Amer. Alg. (Exsicc.), no. 336 (not *Fucus Tournefortii* Lamouroux). *Zonaria flava* Harvey, Ner. Bor.-Amer., part 3, Suppl., 1858, p. 123 (not *Fucus flavus* Clem.).

The *Zonaria* abundant on the southern coast of California is near to *Z. Tournefortii* (Lamour.) Farlow (i.e., *Fucus Tournefortii* Lamour.) or *Z. flava* (Clem.) Agardh of Europe, but that is a coarser plant than ours with larger cells, and (judging from Kuetzing's figures, 1859, pl. 65, I, fig. *b*) the sori lack paraphyses as do those of *Z. Turneriana* J. Agardh of Australia (fide specim. auth.). It is a more slender species than *Z. zonalis* (Lamour.) Howe (*Stypopodium lobatum* (Ag.) Kuetzing). *Z. Sinclairii* (Harv.) J. Agardh is narrow and of *Homoeo-*

strichus structure. *Z. Diesingiana* J. Agardh is more prostrate and coarser. The Japanese plant illustrated under this name by Okamura (1907, pl. 4, figs. 1–10) has paraphyses with peculiar swollen terminal cells. *Zonaria interrupta* (Lamour.) J. Agardh, from the Cape of Good Hope, has very narrow divisions and has paraphyses with short, swollen cells above, as in ours, but the terminal segment of each division of the frond is peculiarly truncate and enlarged above (cf. *Phycopteris cuneata* Kuetz., Tab. Phyc., vol. 9, 1859, pl. 67, fig. II). The structure of the frond is also very different, as may be seen from Kuetzing's figure quoted above.

64. **Padina** Adans.

Fronds plane, ecostate, flabellate, entire or branched, differentiated into two kinds of tissues, a single surface layer on either side consisting of color bearing rectangular cells, and a central tissue, medulla, of several layers of somewhat elongated cells with few chromatophores; growth in length by divisions of many marginal cells; margin scrolled, or inrolled; reproduction sexual, heterogamous, and asexual by aplanospores; the reproductive organs at times developed in transverse zones on the upper parts of the fronds and the antheridia in longitudinal sori, on the same frond as the oogonia.

Adanson, Fam. II, 1763, p. 13 (fide De-Toni).

The "Peacock's-Tail" algae are well-known tropical species whose specific limits require careful study and consideration. The genus is readily distinguished by its involved meristematic margin and by its having the sori only on one side (the upper) of the frond.

Padina Durvillaei Bory

Plate 93

Fronds 10–22 cm. high, membranaceous to decidedly coriaceous, highly stupose for considerable distance above the base, repeatedly and irregularly branched by splitting of the blade more or less deeply, the lobes laciniate to reniform-flabellate; thickness of frond varying from 18 cells, at the base, to 1 cell, at the broad inrolled margin, for the most part 8–12 cells thick; the flabellate portion of the frond marked distinctly by numerous, narrow, concentric bands of hairs; color dark brown, dark green to almost black on drying; sori of oogonia and aplanosporangia distributed unevenly over both sides of the frond with a slight tendency to concentric zonation; antheridia unknown; oogonia 140–200μ long, 70–90μ broad, wall 10–12μ thick; aplanosporangia about the same size, but with much thinner walls.

Growing in the lower littoral and upper sublittoral belts. Widely distributed in the Gulf of California, and as far north as Magdalena Bay, Lower California.

Bory, Dict. class. hist. nat., vol. 12, 1827, p. 591; Voy. Coquille, Bot. Crypt., 1828, p. 147, Atlas, 1826, pl. 21, fig. 1; Howe, Phyc. Stud. V, 1911, p. 497; Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 729.

There may be other species represented on our coast, but all of the specimens in our hands seem to belong to the same coarse, thick, dark colored species which passes under the foregoing name.

Series 3. CYCLOSPOREAE Aresch.

Thallus at maturity never unicellular nor monosiphonous, simple or branched, varying in size from a few centimeters to several meters long, usually saxicolous but rarely epiphytic or floating, composed of highly differentiated and complex tissues, always solid, provided in part with specialized cavities, the vesicles, filled with gas which serves to buoy the plant; multiplication in a few (e.g., *Sargassum*) by fragmentation; growth terminal; reproduction sexual only, the oogonia, or unilocular female gametangia, and antheridia, or unilocular male gametangia, being located within the thallus, or frond, in specially developed cavities (the conceptacles) scattered over the whole surface of the frond or limited to specialized terminal or subterminal parts (the receptacles); the female gametes non-motile, the male gametes motile by two laterally placed cilia of unequal length and possessing a small, red "eye spot"; fertilization is effected after both gametes have escaped into the water; branched paraphyses associated with the reproductive organs and often extruding through the osteole of the conceptacle.

Areschoug, Phyc. Scand., 1846, p. 28 Repr.

The members which now constitute this series are diverse and heterogeneous, both as to structure and form. Scarcely any two authors have agreed from the beginning up to the present time as to their grouping into orders, families, etc. The various genera, now regularly assigned to the series, are, in general, in close agreement regarding the method of reproduction. The gametangia (oogonia and antheridia) are both unilocular and are borne on the same or on separate individuals in specialized cavities among the so-called paraphyses. The reproduction is heterogamous and fertilization takes place after the escape of the gametes. The female gametes (eggs) are non-motile, and the male gametes (antherozoids) are motile by two laterally placed cilia of unequal length. The inequality in size of the gametes is very marked, the female having been estimated in some cases to be thirty thousand times as large as the male.

Areschoug (*loc. cit.*) used the name as an order under the subclass Fucaceae, as he interpreted that group, and included four genera, viz., *Halidrys* Lyngb., *Halicoccus* Aresch., *Fucus* L., and *Himanthalia* as occurring in the region covered by his account.

Order 8. FUCALES Oltmanns

Fronds extremely variable in size, from a few centimeters to several meters long, but usually slender, complanate, cylindrical, subcylindrical or tumid and constricted at regular intervals, branched, the branches either pinnate in two ranks in one plane (Fucaceae) or arising on all sides of the main axis (Sargassaceae); attached by a well developed, solid, usually disk-shaped holdfast, perennial, fruiting annually and then the specialized fruiting parts disintegrating; receptacles limited to the terminal or subterminal parts of the fronds, the oogonia producing 1, 2, 4, or 8 non-motile gametes (eggs).

Oltmanns, Morph. u. Biol. der Algen, vol. 2, 1922, p. 186.

Key to the Families

1. Frond differentiated into axial and lateral members........25. **Sargassaceae** (p. 704)
1. Fronds flattened without differentiation into axil and lateral members..24. **Fucaceae** (p. 663)

Family 24. FUCACEAE Lamour. (lim. mut.)

Members of the order Fucales with flattened fronds not differentiated into axial and lateral members.

Lamour., Essai, 1813, p. 8, in part.

Key to the Genera

1. Fronds with distinct percurrent midrib........................ 2
1. Fronds without midrib........................ 3
  2. Oogonium producing 8 viable gametes (eggs)..................65. **Fucus** (p. 664)
  2. Oogonium producing 1 viable gamete (egg)........68. **Hesperophycus** (p. 703)
3. Oogonium producing 2 viable gametes (eggs)........................66. **Pelvetia** (p. 700)
3. Oogonium producing 1 viable gamete (egg)........................67. **Pelvetiopsis** (p. 702)

65. **Fucus** (L.) Dec'ne and Thuret

Fronds attached by a solid disk-shaped holdfast, complanate, with more or less distinct percurrent midrib and alae of variable widths, branching beginning 2–5 cm. from the base, dichotomous or subsecund, stipe formed by thickening of the midrib and wearing away of the alae; reproduction sexual, by antheridia and oogonia borne among hyaline, more or less branched, sterile filaments, the paraphyses, within cavities, the conceptacles, limited to the terminal, metamorphosed, more or less swollen portions of the branches, the receptacles; oogonium producing eight oospheres, or eggs, which escape together in a translucent utricle which soon disintegrates and frees the eggs; antheridium produces 64 antherozoids, each with a "red eye spot" and two laterally affixed cilia of unequal length; fertilization effected after the eggs escape from the membrane; plants synoicous or dioicous.

Decaisne and Thuret, Rech. sur Anthèrid., 1845, p. 13; Linnaeus, Gen. Plant., 1737, p. 326 (*lim. mut.*).

For a discussion of the genus *Fucus*, see Gardner (1922).

Key to the Species

1. Fronds with abundant caecostomata .... 1. **F. furcatus** (p. 664)
1. Fronds with few or no caecostomata 2
   2. Cryptostomata absent .... 5. **F. nitens** (p. 699)
   2. Cryptostomata present, usually abundant 3
3. Fronds membranaceous .... 2. **F. membranaceus** (p. 673)
3. Fronds coriaceous 4
   4. Cryptostomata few, fronds usually narrow .... 3. **F. edentatus** (p. 678)
   4. Cryptostomata more or less abundant, fronds wider .... 4. **F. evanescens** (p. 681)

1. **Fucus furcatus** Ag.

Fronds usually rigid, often arborescent, more or less cartilaginous, for the most part decidedly mucilaginous, regularly dichotomous, olive green to yellowish; segments usually relatively long, slightly cuneate to linear, in some cases decidedly crisped, midrib prominent and percurrent and often yellowish, caecostomata usually abundant; receptacles for the most part complanate, sometimes tumid, often decidedly yellowish.

Growing in the middle and lower littoral belts. From Sitka, Alaska, to Oil Port, San Luis Obispo County, California.

Agardh, Sp. Alg., 1820, p. 97; Icon. Ined., fasc. 2, 1821, pl. 14, Syst., 1824, p. 279; J. Agardh, Sp. Alg., 1848, vol. 1, p. 209. Gardner, Genus *Fucus*, 1922, p. 16, pl. 1, fig. 1 (copy of original of Agardh).

KEY TO THE FORMS

1. Caecostomata very numerous, 250–450 per square centimeter........................ 2
1. Caecostomata less than 250 per square centimeter........................ 4
   2. Fronds cartilaginous, much crisped and twisted........5. f. **contortus** (p. 668)
   2. Fronds tough, coriaceous, plane or nearly so........................ 3
3. Fronds much branched, 10–18 mm. wide, 20–30 cm. high....1. f. **typicus** (p. 665)
3. Fronds loose, 10–18 mm. wide, 30–50 cm. high....................3. f. **elongatus** (p. 667)
3. Fronds much branched, 15–30 mm. wide, up to 90 cm. high........................ ....2. f. **luxurians** (p. 666)
   4. Receptacles cornute, wholly or in part........................ 5
   4. Receptacles not cornute........................ 6
5. Segments linear, 5–6 mm. wide........................10. f. **cornutus** (p. 671)
5. Segments cuneate, 18–24 mm. wide........................9. f. **nigricans** (p. 671)
   6. Young receptacles decidedly reflexed........................7. f. **reflexus** (p. 669)
   6. Young receptacles not reflexed........................ 7
7. Fronds 8–12 cm. high........................11. f. **abbreviatus** (p. 672)
7. Fronds over 12 cm. high........................ 8
   8. Fronds 4–12 mm. wide........................ 9
   8. Fronds over 12 mm. wide........................10
9. Fronds 4–7 mm. wide, receptacles acute........................13. f. **angustus** (p. 673)
9. Fronds 8–12 mm. wide, receptacles blunt........................12. f. **linearis** (p. 672)
   10. Segments increasing in width upward........................8. f. **latifrons** (p. 670)
   10. Segments diminishing in width upward........................11
11. Receptacles covering 3–4 terminal segments, linear..................4. f. **rigidus** (p. 668)
11. Receptacles covering 1–2 terminal segments, very variable in shape........................ ....6. f. **variabilis** (p. 669)

1. **Fucus furcatus** f. **typicus** Gardner

Fronds somewhat caulescent, moderately cartilaginous, 20–30 cm. high, regularly dichotomous, dark olive green, black on drying, segments plane, linear to cuneate, 10–18 mm. wide, midrib distinct, percurrent, caecostomata 250–300 per sq. cm., small, inconspicuous, cryptostomata absent or very sparse; receptacles complanate, mostly broadly linear, 4–6 cm. long, mostly bifid, apices acute; conceptacles very numerous and relatively small.

Growing on boulders and rock ledges in the middle of the littoral belt. From the Strait of Juan de Fuca to central California.

Gardner, Genus *Fucus,* 1922, p. 16, pls. 2, 3. *Fucus evanescens* f. *typicus,* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1338. *Fucus inflatus* f. *edentatus,* Setchell and Gardner, Alg. N.W. Amer., 1903, p. 280.

The *Fucus furcatus* of Tilden's American Algae, no. 234, as to the specimen distributed in Professor Setchell's copy, is not typical of this species as found on the California coast. The specimen is only a small portion of a plant. It is mature, considerably worn and battered, and has comparatively few caecostomata. The distribution is probably to be referred to f. *typicus,* but it is desirable to consult other specimens of the distribution before deciding definitely.

This form is abundant on the California coast, but less common toward the north, being supplanted by numerous other forms. It reaches its optimum growth in localities where the surf is only moderately active. In such situations it attains its greatest height, not infrequently specimens attaining a height of 4.5 dm., but when on boulders exposed to a heavy surf, it remains much shorter, is more arborescent, the alae wearing away up to the last segment. The illustration on Gardner's plate 3 is of the former state, and that on plate 2 is from an exposed situation at Fort Ross, California, presumably the type locality for the species.

2. **Fucus furcatus f. luxurians** Gardner

Plate 99

Fronds cartilaginous, distinctly caulescent, the alae wearing away, the much thickened midrib becoming the flattened stipe, regularly dichotomous, 4–5 dm. (up to 9 dm.) high, dark olive green to olive brown, midrib and receptacles yellowish, holdfast large and firm; segments varying from broadly cuneate to nearly linear, frequently splitting obliquely to the midrib, 1.5–3 cm. wide, terminal often wider and rounded, caecostomata very numerous, 300–350 per sq. cm., cryptostomata scattered, bearing fascicles of long exserted paraphyses. Receptacles definitely delimited, 4–6 cm. long, complanate or decidedly tumid, bi- tri-furcate, apices blunt or acuminate; conceptacles very numerous.

Growing on boulders and rock ledges in the middle of the littoral belt. Northern and central California.

Gardner, Genus *Fucus*, 1922, p. 22, pl. 10.

Plate 99 represents a plant of this form in mature fruit, producing receptacles for the first time. The receptacles in this specimen are all complanate, a condition which prevails very commonly, but in certain localities the receptacles are tumid and mucilaginous.

Forma *luxurians* is closely related to forma *typicus.* The two forms often grow intermingled, but may readily be distinguished by differences in size and color, forma *luxurians* being the more robust, and of a lighter brownish or yellowish color in the upper parts, particularly the receptacles. The southern limit of the form, as of all forms of

Fucus, so far as is at present known, is Oil Port, San Luis Obispo County, California. The northern limit has not yet been determined, but it probably extends as far north as Cape Flattery, Washington, where there is an intermingling of several forms whose limits have not yet been determined.

3. **Fucus furcatus** f. **elongatus** Gardner

Fronds sparsely branched, distinctly arborescent, somewhat foliaceous, 3–5 dm. high, regularly dichotomous, angles wide and rounded, dark olive green, dark olive brown on drying; segments long, 10–18 mm. wide, cuneate, terminal segment often ovate, rounded, growing point slightly depressed, midrib narrow but distinct, frequently yellowish above, alae wearing away below, remaining on 4–5 segments from the apices, caecostomata variable but usually abundant, up to 450 per sq. cm., cryptostomata few, scattered, bearing fascicles of long, exserted paraphyses; receptacles dark brown to yellowish, either complanate or much inflated, distinctly delimited, simple, emarginate or bifid, blunt or acute, 3–5 cm. long; conceptacles not prominent or abundant.

Growing on boulders in the lower littoral belt in localities exposed to the surf. South end of San Juan Island, Washington, and Sunset Beach, near the mouth of Coos Bay, Oregon.

Gardner, Genus *Fucus*, 1922, p. 21, pl. 9.

This form is intermediate, in several of its characters, between *F. furcatus* f. *typicus* and *F. furcatus* f. *luxurians*. On drying it is smoother than either of the above mentioned forms, the caecostomata not standing out so prominently.

Gardner, no. 1973 (Herb. Univ. Calif., no. 132743, and in Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. CX, sub *F. evanescens* f. *macrocephalus* Kjellm.) is typical of forma *elongatus* in color, character of branching, having mostly wide and usually rounded angles, character of segments and receptacles, but varies from the type in having very few caecostomata. It is certainly quite different from Kjellman's *F. evanescens* f. *macrocephalus* in all of its important characters.

4. **Fucus furcatus f. rigidus** Gardner

Plate 100

Fronds robust, rigid, cartilaginous, 30–45 cm. high, dichotomous or subsecund, dark olive green, black on drying, midrib and receptacles olive green below, olive brown and yellowish above, angles mostly rounded; segments linear or slightly cuneate, strict, 1.5–3 cm. wide, apices truncate, midrib prominent, caecostomata, 60–100 per sq. cm.; receptacles not definitely delimited, complanate, linear, apices acuminate, bi- tri-furcate, 10–20 mm. wide, 5–8 cm. long; conceptacles large, covering a cuneate area extending down the midrib from the receptacle.

Growing on boulders in the lower littoral belt. Port Townsend and the west coast of Whidbey Island, Washington.

Gardner, Genus *Fucus,* 1922, p. 24, pl. 13.

According to our conception of this form, its phylogenetic position is between forma *latifrons* and forma *luxurians.* From the former it differs in having a more rigid cartilaginous structure, in having narrower and more strict segments, and in having longer and narrower receptacles. From the latter it differs in having more strict and more nearly linear segments and longer and narrower receptacles.

5. **Fucus furcatus f. contortus** Gardner

Fronds 20–30 cm. high, caulescent below, foliaceous above, robust, cartilaginous, much contorted, dichotomous or subdichotomous, olive green below, yellowish above, dark olive brown on drying; segments cuneate below, margins crisped, linear above, reduced in width above each forking, 2–2.5 cm. wide, apices rounded, growing depression slight, midrib prominent, caecostomata 250–300 per sq. cm., minutely papillate on drying; receptacles complanate, 4–7 cm. long, not distinctly delimited.

Growing in quiet water on boulders in the lower littoral belt. Near Bellingham, Washington.

Gardner, Genus *Fucus,* 1922, p. 25, pl. 15.

This form seems to be quite distinct from all others. Its color, its rigid, cartilaginous consistency, its relatively wide fronds, its large number of caecostomata, its contorted and crisped habit of growth are characters not found combined in any other known form. The plants were found growing in great profusion, in good vegetative condition in midsummer. The fruiting season apparently is in the winter, as only a few well developed receptacles could be found.

6. **Fucus furcatus** f. **variabilis** Gardner

Fronds caulescent, foliaceous above, 25–40 cm. high, subcartilaginous, dichotomous or in part subsecund, dark olive green to olive brown, black on drying, midrib and receptacles yellowish; segments linear to moderately cuneate, 2–3.5 cm. wide, usually reduced in width above each forking, midrib well developed, percurrent, caecostomata varying from few up to 75 per sq. cm.; receptacles very variable in shape and size, definitely delimited, swollen and mucilaginous or complanate, simple and blunt or bi- tri-furcate and acuminate.

Growing on rock ledges in quiet bays in the middle of the littoral belt. Sitka, Alaska.

Gardner, Genus *Fucus*, 1922, p. 26, pls. 16, 17.

A close relationship seems to exist between this form of *F. furcatus* and *F. evanescens* f. *magnificus*. The color, caecostomata characters, and the rigid, more or less cartilaginous consistency of the fronds are characters that belong to the *furcatus* group. The width of segments and particularly the fruiting habit (see under *F. evanescens* f. *magnificus*) are very similar to those of that form. The caecostomata vary much in number. In some specimens they are practically absent, while in others there may be seventy-five or perhaps more to the square centimeter. They are mostly large, deep-seated, and inconspicuous on drying, except by transmitted light. Specimens with but a few caecostomata usually have a few small cryptostomata.

7. **Fucus furcatus** f. **reflexus** Gardner

Fronds foliaceous, subcartilaginous, 30–45 cm. high, regularly dichotomous, dark olive green to dark olive brown, angles mostly very broad and rounded; segments cuneate below, terminal often obovoid, 8–25 mm. wide, apices rounded, growing point only slightly depressed, midrib narrow but distinct, slightly evanescent above, caecostomata very variable in number, 50–150 per sq. cm.; receptacles distinctly delimited, substipitate, complanate, ellipsoidal, entire or bifid, wide-spreading; conceptacles small and numerous.

Growing on boulders in the lower littoral belt. Point Defiance, Tacoma, Washington.

Gardner, Genus *Fucus*, 1922, p. 23, pls. 11, 11*a*, and 12.

The consistency of this form is somewhat like that of the *evanescens* group, the tissues being more delicate and soft than those of the typical *furcatus* forms. It is placed in the *furcatus* group on account of the color, dark olive green to dark olive brown, and the presence of caecostomata in abundance.

Many of the terminal segments are very broadly ovate, almost stipitate, on account of the narrowing of the bases, producing broad rounded angles between the segments. The growing points differ from those of all other forms observed on our coast, the apices of the segments being rounded and smooth, but with slight inconspicuous slits to indicate the position of the growing point.

The receptacles, particularly when young, have the pronounced and distinguishing character of spreading very widely from each other at their bases, in some instances standing at right angles, or even more, to each other. Many segments have the character of reducing their width at each forking, the terminal segments forming the stipe-like portion bearing the much wider receptacles.

8. **Fucus furcatus** f. **latifrons** Gardner

Plate 101

Fronds decidedly foliaceous, contorted, comparatively thin, 25–35 cm. long, dark olive brown below, light brown above, black on drying, dichotomous, angles mostly acute; segments cuneate, terminal segments mostly rounded, 2–3.5 cm. wide, midrib prominent below, decidedly reduced above, caecostomata 40–80 per sq. cm.; receptacles not definitely delimited, complanate, bi- tri-furcate, mostly acute; conceptacles large, frequently extending down the midrib, covering a cuneate area of the segment.

Growing on rocks in the middle and lower littoral belts. Channel Rocks, near Fort Ward, west of Seattle, Washington.

Gardner, Genus *Fucus*, 1922, p. 25, pl. 14. *Fucus evanescens* f. *pergrandis*, Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. CXI.

In width of fronds, this form of *F. furcatus* overlaps or merges into forms of *F. evanescens*, e.g., forma *magnificus*. It is here placed under *furcatus* on account of the dark olive green color, more or less cartilaginous consistency, and particularly on account of the abundance of caecostomata.

It is closely related to *F. furcatus* f. *rigidus*, but the fronds are more foliaceous, the receptacles are wider and shorter and the caecostomata are less abundant.

9. **Fucus furcatus f. nigricans** Gardner

Fronds comparatively fragile, thin membranaceous, 35–45 cm. high, regularly dichotomous, dark olive green, black on drying, angles broad and slightly rounded; segments cuneate below, linear above, reduced to a midrib 4–5 segments back of the apices, widest 3–4 back of the apices, reduced in width at each forking, widest 18–24 mm., midrib narrow but distinct, percurrent, alae thin, caecostomata 70–80 per sq. cm., small, obscure; receptacles 2.5–3.5 cm. long, complanate or inflated, single or bifid, definitely delimited, apices mostly acute and mostly reflexed.

Growing on boulders and rock ledges in the middle of the littoral belt. Cattle Point, south end of San Juan Island, Washington.

Gardner, Genus *Fucus*, 1922, p. 21, pl. 8.

In the cornute habit, forma *nigricans* is closely akin to forma *cornutus*, but differs from it in the following characters; thinner fronds which are more cartilaginous, darker color, black on drying, in having widely divergent segments and in having an abundance of caecostomata.

10. **Fucus furcatus f. cornutus** Gardner

Fronds subcoriaceous, 20–30 cm. high, regularly dichotomous, dark olive green to dark olive brown, black on drying; segments divergent, linear, or very slightly cuneate in the narrower specimens, varying to decidedly cuneate in the wider specimens, 5–8 mm. wide, apices acuminate, truncate, midrib well developed, prominent, very slightly evanescent above, alae narrow, caecostomata very sparse, 10–20 per sq. cm., small; receptacles distinctly delimited, very variable, complanate or inflated, usually much wider than the segments, simple or bifurcate, 2–4 cm. long, blunt to acuminate, apices mostly laterally reflexed; conceptacles not numerous, inconspicuous.

Growing on rocks in the middle and lower littoral belts. From Yakutat Bay, Alaska, to Victoria, British Columbia.

Gardner, Genus *Fucus*, 1922, p. 20, pl. 7. *Fucus evanescens* f. *cornutus* Saunders, Alg. Harriman Exp., 1901, p. 432, pl. 62, fig. 2; Collins, Mar. Alg. Vancouver Isl., 1913, p. 111; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 927.

The narrow fronds with prominent midribs and the very dark color make this form close to certain narrow forms of *edentatus*, but the absence of cryptostomata and the small caecostomata relate it to the *furcatus* group. It has the least number of caecostomata of all the forms with which we are familiar, certain specimens being nearly free from them. In this character the form approaches very closely to the *edentatus* group.

11. **Fucus furcatus** f. **abbreviatus** Gardner

Plate 98

Fronds cartilaginous, rigid, rough, 8–12 cm. high, regularly dichotomous, varying from olive green to olive brown or light yellowish; segments cuneate to linear, 8–16 mm. wide, apices truncate, midrib narrow but distinct, caecostomata comparatively large, prominent on drying, 60–80 per sq. cm.; receptacles distinctly delimited, much wider than the segments, 2–3.5 cm. long, complanate or swollen with mucilage, 1–2 furcate, apices acuminate; conceptacles numerous and very prominent.

Growing on boulders in the middle littoral belt. Islands of San Juan County and vicinity, Washington.

Gardner, Genus *Fucus*, 1922, p. 19, pl. 6.

This form is fairly abundant in the moderately quiet waters among the islands of San Juan County, Washington, and extends into the upper Sound region. It varies considerably in size, both in length and in width of the fronds. Specimens 3 to 4 cm. in height have been taken in full fruit, but these were depauperate forms, in the upper limit on the belt in which they grow. The striking features of this form are the short bunchy habit, the abundance of well developed receptacles appearing simultaneously, and the numerous large caecostomata making the fronds rough, particularly prominent on drying.

12. **Fucus furcatus** f. **linearis** Gardner

Fronds somewhat caulescent, cartilaginous, 30–35 cm. high, profusely branching, dichotomous, dark olive green, black on drying; segments strict, linear, 8–12 mm. wide, caecostomata 40–70 per sq. cm., inconspicuous on drying; receptacles very numerous, definitely delimited, wider than the fronds, entire or bifid, mostly ovate, 1.5–2 cm. long; conceptacles numerous, large.

Growing in quiet water on boulders in the lower littoral belt. Tracyton, Kitsap County, Washington.

Gardner, Genus *Fucus*, 1922, p. 19, pl. 5.

This form is remarkable for the abundance of receptacles it produces on a single plant. Plate 5 of Gardner was made from a portion of a plant that had approximately five hundred and fifty receptacles. It is also rather unusual that so many of the segments should fruit at the same time as is the case in this form. Not a single segment remained sterile in the above mentioned plant. This form does not seem to be abundant in the Puget Sound region.

13. **Fucus furcatus** f. **angustus** Gardner

Fronds narrow, caulescent, rigid, subcartilaginous, 20–35 cm. high, dichotomous, dark olive green, black on drying; segments linear to slightly cuneate, 4–7 mm. wide, apices truncate, midrib distinct and percurrent, caecostomata 125–175 per sq. cm.; receptacles mostly complanate, occasionally inflated, definitely delimited, deeply bifid, 4–7 cm. long, apices acute or acuminate; conceptacles numerous, closely placed.

Growing in abundance on rock ledges in the upper third of the littoral belt. San Juan County, Washington, and the central coast of Oregon.

Gardner, Genus *Fucus,* 1922, p. 18, pl. 4.

This form was found at Sunset Beach, near the mouth of Coos Bay, Oregon, and at Cattle Point, at the south end of San Juan Island, Washington. This latter locality is particularly rich in forms of *Fucus.* There is an intermingling of the waters flowing among the islands to the north and east, which have a varied *Fucus* flora, with the waters from the Strait of Juan de Fuca and the Straits of Georgia, washing the shores of land to the west and north, which have a somewhat different *Fucus* flora. The shore of the south side of Cattle Point is exposed to a swiftfly flowing current and to the action of swells from the Pacific Ocean, through the Straits of Juan de Fuca. Around to the north side of the point the shores are affected but little by the action of the surf and tides.

2. **Fucus membranaceus** Gardner

Fronds variable in size from a few cm. to 4 dm. high, decidedly membranaceous, dark olive brown, to decidedly yellowish above; segments linear to slightly cuneate, strict, alae membranaceous, midrib relatively small but distinct and percurrent, cryptostomata scattered, mostly in the terminal and subterminal segments, relatively small but papillate on drying; receptacles mostly complanate, in part inflated, bifid and acuminate.

Growing in the littoral belt. From the Bering Sea to Puget Sound, Washington.

Gardner, Genus *Fucus*, 1922, p. 32.

Key to the Forms

1. Cryptostomata sparse and inconspicuous.............................3. f. **limitatus** (p. 674)
1. Cryptostomata up to 60 per square centimeter.. 2
   2. Fronds 8–14 cm. high, 5–9 mm. wide, receptacles wider and blunt........ ....4. f. **abbreviatus** (p. 676)
   2. Fronds over 14 cm. high.. 3
3. Fronds 12–20 cm. high, 4–9 mm. wide, receptacles sharply acuminate.............. ....6. f. **acuminatus** (p. 677)
3. Fronds over 10 mm. wide.. 4
   4. Fronds up to 6 cm. wide, cryptostomata 15–20 per square centimeter.... ....2. f. **latissimus** (p. 675)
   4. Fronds less than 3 cm. wide... 5
5. Cryptostomata 20–25 per square centimeter, receptacles acuminate or acute.... ....1. f. **typicus** (p. 674)
5. Cryptostomata 30–40 per square centimeter, receptacles blunt.......................... ....5. f. **obtusus** (p. 676)

1. **Fucus membranaceus** f. **typicus** Gardner

Fronds caulescent, 28–40 cm. high, flaccid, membranaceous, dichotomous, alae wearing away below, leaving the relatively small, thickened, cylindrical midrib, light yellowish brown; segments narrowly cuneate to linear, 10–18 mm. wide, growing point in a slight, crescent shaped depression, midrib moderately developed, alae thin, cryptostomata small, 20–25 per sq. cm., conspicuous on drying, mostly in the terminal and subterminal segments; receptacles relatively large, distinctly delimited, mostly inflated, bifid, apices long attenuate; conceptacles moderately abundant, relatively small, but conspicuous because of their dark color.

Growing on rock ledges and boulders in the middle of the littoral belt. Sitka, Alaska.

Gardner, Genus *Fucus,* 1922, p. 34, pls. 30, 31.

This form was sparsely interspersed in groups among the multiplicity of forms growing in the vicinity of Sitka. It may readily be recognized by its light yellowish color, its mostly inflated receptacles, and by its moderately narrow, long, membranaceous fronds.

2. **Fucus membranaceus f. latissimus** Gardner

Plate 105

Fronds foliaceous, membranaceous, crisped, dichotomous, 22–25 cm. high, dark olive green below, changing to yellowish brown above, holdfast comparatively small, stipe flattened; segments slightly ovate above, narrower and cuneate below, subterminal 4–6 cm. wide, midrib relatively narrow, percurrent, alae thin, membranaceous, frequently inflated with gas, margins undulate, apices round and smooth, growing point inconspicuous, cryptostomata 15–20 per sq. cm., producing abundant protruding paraphyses, prominent on drying; receptacles sparse, complanate, not definitely delimited, widest at the base, bi-tri-furcate.

Growing on boulders in the extreme lower littoral belt. Kadiak Island and Sitka, Alaska.

Gardner, Genus *Fucus*, 1922, p. 35, pls. 33, 34.

In June, 1910, Gardner first observed this form growing in the harbor at Sitka, but at that time was unable to obtain good fruiting specimens. On his second visit to the same place in July, 1917, he located a large bed containing thousands of plants growing along the extreme low-tide level, and was able to procure a number of good fruiting specimens, although the summer season does not seem to be its best fruiting season. This form may be readily distinguished from all others by its width, being the widest of all forms, its membranaceous alae, its very dark lower portion, and usually yellowish upper portion, and by its much crisped habit of growth. Some of the plants of this species collected by G. B. Rigg at Kadiak Island are the widest specimens of *Fucus* that have been reported, some of the fronds measuring over seven centimeters in width.

3. **Fucus membranaceus f. limitatus** Gardner

Fronds distinctly membranaceous, 22–32 cm. high, dichotomous, light yellowish brown, dark brown on drying, stipe and holdfast fragile; segments strict, mostly cuneate, usually wider at each successive forking, 12–20 mm wide, terminal lobes rounded, growing point slightly depressed, midrib not prominent, alae thin, cryptostomata very sparse and inconspicuous; receptacles mostly inflated, bifid, apices acuminate, usually divergent, very variable in size, up to 5 cm. long and 2 cm. wide; conceptacles scattered and not prominent.

Growing on rocks, logs, etc., in sheltered localities in the upper third of the littoral belt. Point Defiance, Tacoma, Washington.

Gardner, Genus *Fucus,* p. 35, pl. 32.

It is not easy to delineate the distinctive characters of this form associating it with the *membranaceus* group, rather than with the *evanescens* group. In many specimens the midrib is quite indistinct. The cryptostomata characters are quite as much of the one group as of the other. It is provisionally placed with the former group largely on account of the predominance of inflated receptacles, on the membranaceous character of the fronds and on the color.

Two forms of *Fucus* were found growing at Point Defiance, representing an interesting case in distribution. Forma *limitatus* occupied for the most part the extreme upper portion of the littoral belt, and grew on logs and boulders. *F. furcatus* f. *reflexus* grew on boulders and occupied the lower third, with an occasional plant of either form invading the central part.

4. **Fucus membranaceus f. abbreviatus** Gardner

Fronds short, membranaceous, flabelliform, profusely branched, 8–14 cm. high, dichotomous or in part secund, yellowish brown; segments strict, narrowly cuneate to sublinear, 5–9 mm. wide, apices truncate midrib moderately prominent, only slightly evanescent, alae thin, cryptostomata few in the lower portions of the plant, 20–40 per sq. cm. in the terminal segments, small but conspicuous on drying; receptacles bifid, mostly swollen with mucilage, apices acuminate or in part blunt, somewhat divergent, sharply delimited; conceptacles numerous and prominent.

Growing on rock ledges exposed to heavy surf, in the upper limit of the littoral belt. Sitka, Alaska.

Gardner, Genus *Fucus,* 1922, p. 32, pl. 27.

Forma *abbreviatus* grew on the same islet on which the forma *acuminatus* was found growing, but mostly higher up, some specimens were even above mean high-tide level. It differs from forma *acuminatus* principally in having shorter fronds, relatively much broader and shorter receptacles, fewer cryptostomata, and it is less mucilaginous. It seems closely akin to J. Agardh's *Fucus bursigerus* from Spitzbergen, but it is more robust, and much more profusely branched than his description and figure call for (cf. J. Agardh, Spets. Alg. Till., 1868, pp. 41, 42, pl. 3). We have seen the specimen of Kjellman's

F. evanescens f. *bursigera*, also collected at Spitzbergen. The plants of Agardh and of Kjellman are undoubtedly of the same lineage, and they are probably allied more closely to the *evanescens* lineage than to any other. The Sitka plants under consideration, on the whole, and particularly on account of size and consistency, seem closer to the *membranaceus* group than to the *evanescens* group. The two groups certainly overlap through these two forms.

5. **Fucus membranaceus** f. **obtusus** Gardner

Fronds slender, more or less caulescent, membranaceous, 30–40 cm. high, dichotomous, olive green to dark brown, very dark on drying; segments strict, linear to slightly cuneate, relatively long, 10–16 mm. wide, midrib percurrent, alae thin, cryptostomata and caecostomata nearly equal in number, 30–40 per sq. cm., small, papillate on drying; receptacles definitely delimited, much inflated, mostly single, in part bifid, 2.5–4 cm. long, 1–1.5 cm. wide, blunt, yellowish brown; conceptacles not numerous, comparatively small, not protruding.

Growing on rocks in the middle and lower littoral belts. Sitka, Alaska.

Gardner, Genus *Fucus*, 1922, p. 34, pl. 29.

This form has characters linking together forma *acuminatus* and forma *typicus* of this species. It has the arborescent habit common to both forms, the width of the fronds is intermediate, and the receptacles are mostly simple and blunt, unlike either form.

6. **Fucus membranaceus** f. **acuminatus** Gardner

Fronds caulescent, 12–20 cm. high, profusely branched, dichotomous to subsecund, dark brown to yellowish brown; segments very slightly cuneate to linear, 4–9 mm. wide, truncate, midrib well developed below, somewhat reduced just below the receptacles, alae thin and membranaceous, cryptostomata varying from few to 50–60 per sq. cm., mostly on the segments just below the receptacles, absent in the older parts, very small but conspicuous on drying; receptacles numerous, regularly and deeply furcate, or, rarely, single, mostly complanate, narrow, acute, 2–3 cm. long; conceptacles relatively numerous.

Growing on rock ledges exposed to heavy surf, in the upper littoral belt. Sitka, Alaska.

Gardner, Genus *Fucus*, 1922, p. 33, pl. 28.

This form has been collected but once. It grew in abundance on a small rocky island in front of Sitka harbor and well up in the littoral belt, exposed to the heavy action of the surf. The plants growing in the most exposed places are quite arborescent in character, the alae wearing away up to the last two or three segments, leaving the much thickened midrib. In depressions and less exposed situations, the alae are usually wider and remain longer on the fronds. The plants in this group become exceedingly mucilaginous on being soaked out after a thorough drying.

3. **Fucus edentatus** De la Pyl.

Fronds usually narrow, more or less flaccid, regularly dichotomous, olive green to olive brown or yellowish, usually very black on drying; segments mostly decidedly linear, at times cuneate, midrib distinct, percurrent, cryptostomata and caecostomata few or none, receptacles mostly narrow, linear-lanceolate, acuminate, inflated or complanate.

Growing in the middle and upper littoral belts. From Sitka, Alaska, to Coos Bay, Oregon.

De la Pylaie, Flor. Terre-Neuve, 1829, p. 84.

Key to the Forms

1. Midrib prominent, percurrent, segments reduced at each forking .... 3. f. **costatus** (p. 680)
1. Midrib less prominent, segments not reduced at each forking 2
   2. Receptacles and segments widely divergent .... 2. f. **divergens** (p. 679)
   2. Receptacles and segments not widely divergent 3
3. Fronds over 25 cm. high, receptacles often inflated .... 1. f. **hesperius** (p. 678)
3. Fronds less than 25 cm. high, not inflated 4
   4. Fronds 9–15 cm. long, receptacles acute, 2–2.5 cm. long..4. f. **acutus** (p. 680)
   4. Fronds 12–22 cm. long, receptacles subulate, 2.5–4.5 cm. long .... 5. f. **divaricatus** (p. 681)

1. **Fucus edentatus f. hesperius** Gardner

Plate 103

Fronds arborescent, 30–40 cm. high, narrow, coriaceous, dichotomous, dark olive green, black on drying, stipe cylindrical; segments strict, linear, 5–10 mm. wide, with truncate apices and well developed, prominent, percurrent midribs, cryptostomata absent or extremely rare; receptacles mostly complanate, or in part much inflated, bi- trifurcate, linear, 3–4.5 cm. long, apices acute; conceptacles numerous.

Growing on rock ledges exposed to the action of the surf, in the upper third of the littoral belt. Cape Arago, at the entrance to Coos Bay, Oregon.

Gardner, Genus *Fucus,* 1922, p. 28, pl. 21.

This form grew in abundance in company with *F. furcatus* f. *angustus.* The two groups of plants were, however, in slightly different altitudes in the belt, and were not indiscriminately intermixed. When the two sets of plants are dried, they are easily distinguishable by the smoothness of the segments, forma *hesperius* being smooth and usually shining, while forma *angustus* is rough, due to caecostomata, and is of a duller color.

2. **Fucus edentatus f. divergens** Gardner

Fronds coriaceous, smooth and glossy, 28–38 cm. high, regularly dichotomous, dark olive green, black on drying; segments divergent, 7–11 mm. (up to 15 mm.) wide, cuneate below, linear above, reduced somewhat above each forking, terminal truncate, growing point inconspicuous, midrib very distinct, percurrent, cryptostomata and caecostomata absent or very sparse; receptacles 3–6 cm. (up to 12 cm.) long, definitely delimited, much wider than the segments, single or bifurcate, and mostly widely divergent, apices acuminate or acute; conceptacles numerous and prominent.

Growing on rock ledges in the lower littoral belt. Kanaka Bay, San Juan Island, Washington.

Gardner, Genus *Fucus,* 1922, p. 29, pl. 22.

This form of *edentatus* is closely related to forma *hesperius.* The fronds average somewhat wider, more robust, the angles between the segments are very much wider and more rounded, and the receptacles mostly deeply bifurcate or single, widely diverging. The average width of the segments is about 10 mm., but a few specimens were found with extremely narrow segments, about 3 mm. These were profusely branched, with wide angles, and small diverging receptacles. Also a few specimens were found with the characters of the form, but were 15 mm. wide. These few specimens are to be considered as the extremes in individual variation in this particular character.

3. **Fucus edentatus f. costatus** Gardner

Fronds slender, subcoriaceous, 15–25 cm. high, regularly dichotomous, yellowish brown, segments distinctly linear, relatively long, reduced in width above each forking, widest 5–8 mm., terminal 2–4 mm., midrib highly developed, percurrent, alae narrow and membranaceous, cryptostomata sparse, prominent; receptacles definitely delimited, simply or mostly bifid, 20–35 cm. long, apices acute; conceptacles moderately abundant and conspicuous.

Growing on rocks in the lower third of the littoral belt. Lower Puget Sound region, Washington.

Gardner, Genus *Fucus*, 1922, p. 30, pls. 23, 24. *Fucus evanescens* f. *angustus*, Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 926; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 284.

The plants distributed in the Phycotheca Boreali-Americana as no. 926 are from the type locality, but were taken from the upper limit of the belt of distribution when the tide was well in; they are considerably battered and worn away, and thus cannot be said to be in typical condition.

This form resembles closely *F. evanescens* f. *angustus* Kjellm. in width of fronds, and was so referred as is cited above. Subsequent to the foregoing publications, material of the species, collected and determined by Kjellman on the Vega expedition, has been received at the Herbarium of the University of California (no. 132699). The lack of a prominent percurrent midrib, almost complete absence of cryptostomata, and especially the very small receptacles of Kjellman's material, indicate unmistakably that our plant is of a different lineage.

4. **Fucus edentatus f. acutus** Gardner

Fronds 9–15 cm. high, arising from a relatively broad, flat holdfast, dichotomous, angles acute, olive green, black on drying; segments linear, 3–4 mm. wide, apices truncate, midrib very prominent, percurrent, alae relatively narrow, persistent, cryptostomata sparse; receptacles single or deeply bifurcate, tapering at both ends, 2–2.5 cm. long.

Growing on sandstone in the middle littoral belt. Bellingham (Fairhaven), Washington.

Gardner, Genus *Fucus*, 1922 p. 31, pl. 25. *Fucus inflatus* f. *linearis*, Setchell and Gardner, Alg. N.W. Amer., 1903, p. 280.

The very dark color on drying, the absence of caecostomata, and the sparseness of cryptostomata in this form seem amply sufficient to ally it with the *edentatus* group rather than with the seemingly more imperfectly defined group *inflatus*. The linear arrangement of the cryptostomata in two rows along the prominent midrib and the relatively small, pointed receptacles distinguish it from all other forms of *edentatus*.

5. **Fucus edentatus** f. **divaricatus** Gardner

Plate 104

Fronds fragile, usually 12–22 cm., but occasionally up to 32 cm. high, regularly dichotomous, with wide angles, stipe and lower branches nearly terete, dark olive brown, receptacles frequently yellowish; segments narrowly linear, reduced in width slightly at each forking, terminal, acute, 2–5 mm. wide, midrib highly developed to the apices, alae almost absent, cryptostomata few and unevenly distributed; receptacles definitely delimited, awl-shaped or slightly flattened, 2.5–4.5 cm. long, mostly simple or deeply furcate; conceptacles conspicuous.

Growing on ledges of sandstone in the lower littoral belt. Bellingham, Washington, Comox and Ucluelet, Vancouver Island, British Columbia.

Gardner, Genus *Fucus*, 1922, p. 31, pl. 26. *Fucus inflatus* f. *filiformis*, Setchell and Gardner, Alg. N.W. Amer., 1903, p. 281; Collins, Mar. Alg. Vancouver Isl., 1913, p. 111.

4. **Fucus evanescens** Ag.

Fronds moderately robust, sometimes arborescent, usually decidedly coriaceous, dichotomous or in part subsecund, olive brown, to yellowish above; segments often quite foliaceous and crisped, in some, narrow, cuneate to linear, midrib more or less distinct, in some cases vanishing more or less in the terminal segments, cryptostomata few to many, scattered; receptacles very variable in shape and size, long and narrow to short and blunt, bi- tri-furcate.

Growing in the littoral and upper sublittoral belts. From Bering Sea to Coos Bay, Oregon.

Agardh, Sp. Alg., vol. 1, part 1, 1820, pp. 92, 93.

Fucus evanescens was established by C. A. Agardh in 1820 (*loc. cit.*) based upon material collected by Chamisso. The type specimen is in the herbarium of J. G. Agardh under no. 00299, labeled Kamtschatka with a query. The name was chosen to signify the vanishing of the midrib toward the outer ends of the segments. Much of the material, however, which has since been assigned to the species, even by J. G. Agardh, does not in the least conform to this character. The name has been used quite extensively to designate plants growing on both the north Atlantic and the north Pacific shores. The original illustration by Agardh in Icones algarum ineditae, 1821, pl. 13, fig. 1, is of a fragment of a frond with complanate receptacles, and was probably from an immature plant. This plate was reproduced by Gardner in The genus *Fucus* on the Pacific Coast of North America, 1922, plate 1, figure 2.

We have selected *evanescens* as the name best suited to include a large aggregation of forms which appear in the northern portion of our region, necessarily having to extend and modify Agardh's original description.

Key to the Forms

1. Typical mature fronds short, up to 15 cm. 2
1. Typical mature fronds over 15 cm. high 4
 2. Plants growing in salt marshes and tide flats .... 21. f. **nanus** (p. 698)
 2. Plants attached to rocks by a disk-shaped holdfast 3
3. Plants dendroid, segments usually much eroded .... 11. f. **dendroides** (p. 691)
3. Plants flabellate, segments cuneate .... 20. f. **cuneatus** (p. 698)
 4. Average width of fronds less than 15 mm. 5
 4. Average width of fronds more than 15 mm. 12
 4. Average width of fronds unknown 18
5. Midrib absent or indistinct .... 19. f. **ecostatus** (p. 697)
5. Midrib distinct, usually percurrent 6
 6. Receptacles simple to deeply bifid, usually blunt 7
 6. Receptacles more or less decompound 10
7. Receptacles with distinct margin free from conceptacles .... 10. f. **marginatus** (p. 690)
7. Receptacles without a free margin 8
 8. Receptacles widened suddenly, almost pedicellate .. 17. f. **contractus** (p. 695)
 8. Receptacles less conspicuously pedicellate 9
9. Cryptostomata none or few .... 2. f. **macrocephalus** (p. 684)
9. Cryptostomata 20–25 per square centimeter .... 18. f. **oregonensis** (p. 696)
 10. Fronds 4–5 mm. wide .... 16. f. **angustus** (p. 694)
 10. Fronds more than 5 mm. wide 11
11. Receptacles more or less cornute .... 12. f. **cornutus** (p. 692)
11. Receptacles not cornute .... 8. f. **flabellatus** (p. 689)
 12. Receptacles bi- tri-furcate, wide, spreading, acute .. 6. f. **stellatus** (p. 687)
 12. Receptacles variously divided, not stellate 13
13. Receptacles very large, tumid, mucilaginous .... 2. f. **magnificus** (p. 686)
13. Receptacles narrower, mostly complanate, at times inflated or mucilaginous 14
 14. Receptacles complanate, up to 22 cm. long .... 9. f. **longifructus** (p. 689)
 14. Receptacles much shorter 15
15. Receptacles with a distinct margin free from conceptacles .... 5. f. **robustus** (p. 687)
15. Receptacles without free margin 16
 16. Receptacles simple to deeply bifurcate, blunt .... 3. f. **pergrandis** (p. 685)
 16. Receptacles variously branched acute or acuminate 17
17. Cryptostomata absent or rare .... 13. f. **rudis** (p. 692)

17. Cryptostomata 12–25 per square centimeter..................7. f. **intermedius** (p. 688)
    18. Fronds fruiting in different zones..........................15. f. **limitatus** (p. 694)
    18. Fronds fruiting in the same terminal zone..19
19. Fronds irregularly branched and distorted......................14. f. **irregularis** (p. 693)
19. Fronds regularly dichotomous..1. f. **typicus** (p. 683)

1. Fucus evanescens f. typicus Kjellm.

Fronds 15–25 cm. high, coriaceous, dichotomous, dark brown; segments cuneate to sublinear, midrib moderately distinct, percurrent, cryptostomata few, small; receptacles mostly complanate, deeply furcate, segments obovate to linear-acuminate.

Growing on rocks in the upper littoral region. Harvester and Kadiak Islands, Alaska.

Kjellman, Om Spets. Thall., II, 1877*a*, p. 3; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 282; Gardner, Genus *Fucus*, 1922, p. 51, pl. 56.

Setchell and Lawson, no. 5122 (Herb. Univ. Calif., no. 99136), Harvester Island, Uyak Bay, Alaska; Rigg, no. 100, Kadiak Island, Alaska.

We have a photograph of Kjellman's type specimen of this form. It represents a plant considerably smaller than the plants which we have allied with it from the Alaskan waters. No. 5122, in particular, is much more robust than Kjellman's description calls for. The receptacles are much longer and wider, but this may possibly be accounted for by difference in age. The plants collected by Rigg are smaller and more nearly coincide with the description. This photograph shows Kjellman's plant to be about 10 cm. high, possessing distinct midribs in many of the segments, and to have relatively small receptacles. There is a plant in the Herbarium of the University of California, sheet no. 132618, contributed by Kjellman and collected on Spitzbergen in "1872–73," labeled in Kjellman's handwriting, "*Fucus evanescens* Ag.," which is almost a duplicate of the type specimen mentioned above. There is also a plant in the same herbarium, collected in 1868 from the same locality and determined by J. G. Agardh as *F. evanescens* Ag., whose fronds are about twice as wide as those of the Kjellman plants. Otherwise all of these three collections of plants are very much alike.

The type specimen of *F. evanescens* Ag. is in the herbarium of J. G. Agardh at Lund under no. 00299. It has been examined by one of us (Setchell) who finds that the plant is slightly smaller than the plant referred to in our Algae of Northwestern America, under f. *typica*, from Harvester Island, Alaska. The latter plant is in the Herbarium of the University of California under no. 99139. It differs only slightly from the wide form of *F. evanescens* from Spitzbergen, mentioned above, having more numerous, larger, and better developed receptacles. There is much greater disparity of size between this specimen and Kjellman's f. "*typica*" than there is between Kjellman's f. "*typica*" and his f. *limitata*. If we admit the specimen determined by J. G. Agardh from Spitzbergen as belonging with f. *typica* Kjellman, then the Harvester Island specimen which is so close to it had probably better be allied with it at present, until more is known of the forms from that island. However, it also seems very close to Kjellman's f. "*cornuta*," but has wider fronds and receptacles than the type specimen of that form.

We are referring here a series of plants collected on Kadiak Island, Alaska, by G. B. Rigg, no. 100. These plants are only slightly wider than the type specimen of Kjellman, and have numerous well developed receptacles. They appear to be the closest in all characters to the type, and we are taking them to be the best representatives of f. *typicus* thus far discovered in Pacific coast waters.

2. **Fucus evanescens f. macrocephalus** Kjellm.

Fronds subcaulescent, 12–18 cm. high, subcoriaceous, dark brown below varying to light brown or yellowish above; segments linear to slightly cuneate, 5–12 mm. wide, midrib well developed, percurrent, alae rather thin, cryptostomata absent or sparse; receptacles distinctly delimited, complanate in part, but mostly very tumid and mucilaginous, light yellow, 2–3.5 cm. long, 1–2 cm. wide, simple, retuse, or bifid; conceptacles conspicuous.

Growing in the middle of the littoral region. Bering Sea to Juneau, Alaska.

Kjellman, Om Beringh. Algflora, 1889, p. 34; De-Toni, Syll. Alg., 1895, p. 202; Saunders, Alg. Harriman Exp., 1901, p. 432, pl. 62, fig. 1; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 282.

Saunders (1901, p. 432) reports this form as growing at Puget Sound, Annette Island, Wrangell, Juneau, Sitka, Glacier Bay, Prince William Sound, Cook Inlet, Kukak Bay, and Shumagin Islands, and states: "This is the most abundant seaweed on the northwest coast."

We have not been able to examine any of the specimens of Saunders' collections, if such exist. There are no numbers quoted, and hence we are not attempting to place them. Most of the plants, particularly of the southern portion of the range, undoubtedly belong to f. *magnificus* Gardner.

3. **Fucus evanescens** f. **pergrandis** Kjellm.

Fronds caulescent, robust, subcoriaceous, up to 40 cm. high, regularly dichotomous, dark brown below to yellowish brown above, black on drying; segments elongated, linear to slightly cuneate, 1–2 cm. wide, midrib distinct, percurrent, cryptostomata varying from none to 20 per sq. cm.; receptacles numerous, mostly complanate, occasionally inflated, mucilaginous, 1–2.5 cm. wide, 2.5–4 cm. long, entire to bifid; conceptacles numerous, large.

Growing on boulders in the middle and upper littoral belts. Unalaska, Alaska, to Puget Sound, Washington.

Kjellman, Om Spetsb. Thall., II, 1877*a*, p. 3; De-Toni, Syll. Alg., 1895, p. 203; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 284; Collins, Mar. Alg. Vancouver Isl., 1913, p. 111; Gardner, Genus *Fucus*, 1922, p. 46, pl. 47.

Setchell and Lawson, nos. 3284, 4049 (Herb. Univ. Calif., nos. 99125, 99123), Amaknak Island, Alaska, and in Collins, Holden and Setchell, Phyc. Bor.-Amer., Exsicc., no. XLVI (sub *F. platycarpus*); Rev. Albin Johnson, no. 5701 (Herb. Univ. Calif., no. 99126), Yakutat Bay, Alaska; Gardner, no. 2230 (Herb. Univ. Calif., no. 201136), Juneau, Alaska; Townsend, no. 5773 (Herb. Univ. Calif., no. 99129), Kyska Island, Alaska; Butler and Polley, no. 20 (Herb. Univ. Calif., 99127), Port Renfrew, British Columbia.

The type locality of this form is Spitzbergen, where Kjellman says it grows at a depth of several fathoms. There are three fragments of the form in the Herbarium of the University of California under no. 132622, from the Spitzbergen Islands, determined by Kjellman. Although authentic, they do not entirely coincide with Kjellman's descriptions and type specimens. Apparently they are not representative specimens of this form.

4. **Fucus evanescens f. magnificus** Gardner

Fronds foliaceous, 20–30 cm. high, subcoriaceous, dichotomous or in part secund, dark brown below, yellowish above, olive brown on drying; segments comparatively short, linear to cuneate, more or less twisted, 2.5–3.5 cm. wide, midrib slightly evanescent above, cryptostomata variable, up to 50 per sq. cm., usually conspicuous with tufts of exserted paraphyses when young; receptacles definitely delimited, very tumid, mucilaginous, simple to decompositely furcate, blunt or acute, very variable in width and length, mostly yellow; conceptacles moderately numerous and very conspicuous.

Growing in great profusion in the middle and upper littoral regions. Juneau, Alaska, to Puget Sound, Washington.

Gardner, Genus *Fucus*, 1922, p. 48, pls. 51, 52.

So far as our observations extend, this form seems to be the most abundant of all the forms included in the above mentioned region. It varies widely in the shape of the receptacles. Some receptacles are simple, others decompositely furcate, many quite obtuse, others decidedly acute, but all are definitely delimited and swollen almost to the bursting point with mucilaginous substance. The segments are wide and foliaceous, not narrowing at the forkings, and the tendency to the strict habit of growth often makes them quite contorted.

One of the distinguishing characters is the sparsity of receptacles maturing at any one time. This habit, marked in only a few of our forms, should receive more study in the field. Our opinion is that the fruiting season extends over a much longer period than in most of the other forms. In the summer season, when we have observed them, one may find on the same individual receptacles varying from completely mature, to others just beginning to form, and many more sterile segments. The fronds fork. One branch of the dichotomy metamorphoses directly into a receptacle and the other continues to grow, and it in turn may fork one or more times without fruiting. This makes the mature receptacle appear to be lateral in origin, whereas in reality it originates just as all others do. This seems to be the condition prevailing in Thuret's *F. platycarpus*. Plate 16 in the Études Phycologiques well illustrates this condition, but illustrates also another condition which does not seem to occur in f. *magnificus*, viz., that the suppressed fruiting segments are alternate, whereas in f. *magnificus* they are secund. We do not know how regularly the condition prevails in *F. platycarpus*, but this condition is too constantly prevalent in f. *magnificus* to be overlooked as a diagnostic character.

5. **Fucus evanescens f. robustus** S. and G.

Plate 107

Fronds distinctly caulescent, 15–25 cm. high, much contorted, with distinct stout stipe and holdfast, dichotomous, terminal portions foliaceous, olive green to dark olive brown; segments broadly cuneate, terminal lobes rounded, 15–28 mm. wide, midrib distinct, slightly reduced near the apices, alae membranaceous, cryptostomata sparse; receptacles broad, oblong, ovate or obcordate, very variable in size, 1.5–3.5 cm. long, complanate, or much inflated, not mucilaginous, with distinct margin free from conceptacles which are large and projecting.

Growing on rocks in sheltered, shaded localities along extreme high-tide limit. St. Paul Island, Alaska, to Friday Harbor, San Juan Island, Washington.

Setchell and Gardner, Alg. N.W. Amer., 1903, p. 283. *Fucus platycarpus?* Setchell, Alg. Prib. Isl., 1899, p. 593; Gardner, Genus *Fucus,* 1922, p. 47, pls. 49, 50.

The type specimen was collected by Miss Ida M. Rogers, no. 5724 (Herb. Univ. Calif., no. 99133), at Sitka, Alaska. One of us (Gardner) collected it at Sitka in June, 1910, when it was in full fruit, and at Friday Harbor in July of the same year. The type and the two co-type specimens have all of the receptacles complanate, and are apparently immature, but in the other collections mentioned many of the receptacles are much inflated. The species is one quite free from mucilage as compared with other species of *Fucus* growing in the same localities but much lower down in the littoral belt. It seems to have become fixed as a form, and has the distinct habit, or character, of being able to persist in the upper two feet of the littoral belt, in which habitat it is necessarily uncovered the greater part of the twenty-four hours each day. It inhabits rock ledges, either steep or sloping, yet it is strictly confined to the upper, very narrow, belt. Its fronds are lighter and somewhat more fibrous than those of any other form.

6. **Fucus evanescens f. stellatus** Gardner

Fronds decidedly flaccid, usually contorted, 25–35 cm. high, dichotomous or subdichotomous, light brown below, yellowish above, dark olive brown on drying, stipe and holdfast relatively small; segments relatively short, cuneate, wider toward the apices, 1.5–2.5 cm. wide, midrib decidedly reduced above, cryptostomata few and inconspicuous;

receptacles definitely delimited, complanate to moderately tumid, decompositely furcate, mostly spreading and acuminate, 3–4.5 cm. long; conceptacles numerous, conspicuous.

Growing on boulders, logs, etc., in the lower littoral belt. Sackman's Point, near Tracyton, Kitsap County, Washington.

Gardner, Genus *Fucus,* 1922, p. 49, pl. 53. *Fucus evanescens,* Tilden, Amer. Alg. (Exsicc.), no. 235.

Tilden's no. 235 seems to belong here, although the specimen in Setchell's copy of her American Algae is only a fragment and just beginning to produce receptacles.

The distinguishing character of this form is the decompositely furcate receptacles, often widely divergent. As many as eight divergent apices have been observed with a common base. The fronds are decidedly flaccid and dissolve rather readily in fresh water after being dried.

7. **Fucus evanescens f. intermedius** Gardner

Fronds foliaceous, flaccid, 12–18 cm. high, light brown to yellowish, dark brown on drying, holdfast and stipe small, angles broad, rounded; segments linear, reduced above each forking, 1–2 cm. wide, cryptostomata 15–25 per sq. cm., midrib narrow, prominent, percurrent, alae relatively wide, membranaceous; receptacles broad at the base, 1–2-furcate, acuminate or acute, complanate or tumid with mucilage, definitely delimited; conceptacles small, numerous.

Growing on rocks in the middle of the littoral belt. East Sound, Orcas Island, Washington.

Gardner, Genus *Fucus,* 1922, p. 44, pl. 44.

This form seems unmistakably connected, through its narrow specimens, with *F. evanescens* f. *costatus* on one side, and, on the other side, through its widest specimens, it seems not unlike certain narrow specimens of *F. evanescens* f. *pergrandis.* It differs from the former in having wider segments not perceptibly reduced in width, as in f. *costatus,* above the forkings, and in having wider, much more robust and blunt receptacles. From the latter it differs in being much less robust throughout, in having fewer cryptostomata, and in having much more delicate and membranaceous alae.

8. **Fucus evanescens** f. **flabellatus** Gardner

Fronds 15–25 cm. high, subcoriaceous, subdichotomous or, in part, secund, light brown to yellowish brown, holdfast small, stipe small, 2–3 cm. long; segments linear to very slightly cuneate, 10–15 mm. wide, strict, apices rounded, slightly truncate, alae relatively thin, midrib slightly reduced below the receptacles, cryptostomata few, small, inconspicuous; receptacles fusiform, 2–3.5 cm. long, simple to bifurcate, not definitely delimited.

Growing on sandstone ledges in the middle of the littoral belt. Bellingham, Washington.

Gardner, Genus *Fucus*, 1922, p. 44, pl. 43.

The majority of the plants seemed scarcely mature in July, when they were collected, but enough of them were selected that appeared mature to be fairly certain that the measurements given for the receptacles are sufficiently accurate. The distinguishing character of the form is the pronounced fan shape of the whole frond when spread out, and particularly of groups of segments, due to the secund method of branching.

The cryptostomata are relatively few and inconspicuous, and there is approximately the same number of caecostomata; thus in this character this form is on the border line between *F. evanescens* and *F. furcatus*. Probably the tendency is in the direction of the degeneration of these organs. The other characters, however, seem sufficiently well represented to ally it with *F. evanescens.*

9. **Fucus evanescens** f. **longifructus** S. and G.

Frond with short stipe and firm holdfast, somewhat caulescent below, foliaceous above, up to 45 cm. high, dark olive brown; segments long and narrow, strict, 1–2 cm. wide, midrib moderately conspicuous, slightly evanescent, cryptostomata absent or very sparse; receptacles usually complanate, not definitely delimited, 2–2.5 cm. wide, 1–3 times forked, with the divisions long, linear or sometimes recurved and pointed, up to 22 cm. long; conceptacles very large and scattered.

Growing on stones in the upper littoral belt. Orca to Juneau, Alaska.

Setchell and Gardner, Alg. N.W. Amer., 1903, p. 283; Gardner, Genus *Fucus,* 1922, p. 50, pl. 54.

Setchell and Lawson, no. 5151 (Herb. Univ. Calif., no. 99110), Orca, Alaska. Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 928; Setchell and Lawson, no. 5186 (Herb. Univ. Calif., no. 99109), Juneau, Alaska.

This form is unlike all other forms in the extremely long, linear-lanceolate, regular, complanate receptacles, frequently spreading or recurved at the apices. In external appearance it approaches *F. furcatus* f. *rigidus*, but that form has an abundance of caecostomata, the receptacles more decompositely furcate, and it is more cartilaginous.

10. **Fucus evanescens f. marginatus** Gardner

Fronds distinctly caulescent, 20–50 cm. high, regularly and repeatedly dichotomous, decidedly rigid and coriaceous, much contorted, yellowish brown, very dark olive brown on drying, stipe terete, tapering upwards among the branches; segments 9–15 cm. wide, strict, not narrowing above forking, truncate, mostly long, linear, midrib moderately prominent, slightly evanescent, alae wearing away unevenly, cryptostomata almost absent; receptacles 1.5–3 cm. long, definitely delimited, single or deeply bifurcate, narrowly ellipsoidal, marginate; conceptacles very prominent.

Growing on rocks in the middle littoral belt. Sitka, Alaska.

Gardner, Genus *Fucus*, 1922, p. 42, pl. 42.

The distinguishing characters of this form are absence of conceptacles from a complete margin of the receptacle, particularly of the rounded terminal portion, coupled with extreme sparsity of both cryptostomata and caecostomata.

It is difficult to decide to which species this form is most closely related. It has evident affinities with *Fucus evanescens* Ag. and with *F. spiralis* L. Its color and consistency, coupled with the slightly vanishing midrib in the terminal segments, seem to ally it with *F. evanescens*, but, if allied with this species, it would be through f. *dendroides* of Stroemfelt as its nearest relative. We have not seen the type nor any authentic specimens of f. *dendroides*, but since no one has questioned the validity of the form as belonging to *F. evanescens*, we are retaining it as such and grouping certain Alaska specimens with it. The narrow, rather long, considerably contorted and profusely branched fronds, the blunt and somewhat fusiform receptacles, and the dendroid habit certainly suggest its close similarity with f. *dendroides*. However, we are inclined to keep it distinct on account of its decidedly more robust habit, the practical absence of cryptostomata, and the much lighter color than that of the other forms within our region which we have placed with f. *dendroides*.

11. **Fucus evanescens f. dendroides** Stroem.

Fronds distinctly caulescent, dense, coriaceous, 7–15 cm. high, rigid, terete at the base and for some distance among the main branches, tapering upward, the narrow alae having worn away leaving only the much enlarged midrib, flabellate-dichotomous, in part subsecund, profusely forked, dark olive green to olive brown, brown on drying; segments strict, somewhat contorted, narrow, 5–8 mm. wide in depauperate specimens, cuneate to slightly linear, widest at the truncate apices, growing point slightly depressed, midrib prominent, percurrent; cryptostomata sparse or entirely absent; receptacles very abundant, single, retuse to bifurcate, subfusiform to ovoid, considerably swollen, 1–3 cm. long; conceptacles numerous, emitting relatively long fascicles of paraphyses.

Growing on rocks exposed to fairly heavy surf, in the upper and middle littoral belts. Agattu Island to Sitka, Alaska.

Stroemfelt, Om Algenveg. vid Islands Kuster, 1886, pp. 35, 36, pl. 3; De-Toni, Syll. Alg., 1895, p. 203; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 284; Gardner, Genus *Fucus,* 1922, p. 41, pl. 41.

Townsend, nos. 5755, 5756 (Herb. Univ. Calif., nos. 99105, 99106), Agattu Island, Alaska; Gardner, no. 2227 (Herb. Univ. Calif., no. 201148), Sitka, Alaska; Setchell and Lawson, no. 4052 (Herb. Univ. Calif., no. 99095, sub. *Fucus evanescens* f. *bursiger*), Summer Bay, Alaska (cf. Setchell and Gardner, 1903, p. 285).

Stroemfelt does not mention the height of the type in his diagnosis, but his illustration, natural size, is 14 cm. high. The size of our plants, their narrow contorted segments, the character of the receptacles, the large firm holdfast and dendroid habit, agree so well with the description and figures of Stroemfelt as to leave little room for doubt as to the affinity of the two. Comparison with the type material may, however, show that the two sets of plants are distinct, as Stroemfelt does not mention the cryptostomata nor the caecostomata, nor does he mention the color, which is very striking in our plants. As the plants hang on the rocks after the receding tide, the shape, appearance, color, and abundance of receptacles reminds one of settled swarms of Italian bees.

12. Fucus evanescens f. cornutus Kjellm.

Fronds subcoriaceous, 20–30 cm. high, regularly dichotomous, dark olive green to dark olive brown; segments strict, linear or very slightly cuneate in the narrower specimens, 5–8 mm. wide, apices truncate, midrib well developed, prominent, very slightly evanescent above, alae narrow, cryptostomata very sparse, small; receptacles distinctly delimited, mostly complanate, simple or bifurcate, blunt to acuminate, apices slightly laterally reflexed, 2–4 cm. long; conceptacles numerous, conspicuous.

Growing on rock ledges in the lower littoral belt. Yakutat Bay, Alaska.

Kjellman, Om Beringh. Algflora, 1889, p. 34; De-Toni, Syll. Alg., 1895, p. 202; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 283 (in part); Gardner, Genus *Fucus,* 1922, p. 50, pl. 55.

Rev. Albin Johnson, no. 5719 (Herb. Univ. Calif., nos. 99103. 99104), Yakutat Bay, Alaska.

This form was first discovered on Bering Island and described by Kjellman (*loc. cit.*). Comparison with a photograph of the type and with a small portion of the type specimen seems to make it fairly certain that the two specimens collected by Albin Johnson, and cited above, are correctly placed, although they are much larger in all parts than Kjellman's description calls for. More study of material in the northern waters is highly desirable to make certain this determination. Neither in the type nor the other material referred to is the cornute habit very pronounced.

13. Fucus evanescens f. rudis Kjellm.

Fronds somewhat caulescent, coriaceous, dark brown, dichotomous; segments strict, cuneate, 1–2 cm. wide, reduced at the forking, terminal lobes truncate, midrib narrow but distinct to the apices, cryptostomata absent or rare; receptacles relatively large, 3.5–5 cm. long, rarely complanate, mostly very tumid and mucilaginous, not definitely delimited.

Growing in the lower littoral and upper sublittoral regions. Bering Sea to Skagway, Alaska.

Kjellman, Om Beringh. Algflora, 1889, p. 34; De-Toni, Syll. Alg., 1895, p. 202; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 282;

Gardner, Genus *Fucus*, 1922, p. 53, pl. 57. *Fucus vesiculosus* Postels and Ruprecht, Illus. Alg., 1840, p. 12, pl. 25 (cf. Kjellman, *loc. cit.*).

Setchell and Lawson, no. 5121 (Herb. Univ. Calif., no. 99131), Harvester Island, Uyak Bay, Alaska. *Fucus evanescens* f. *macrocephalus*, Setchell and Lawson, no. 5178 (Herb. Univ. Calif., nos. 99117, 99118), Orca, Alaska; A. L. Bolton (Herb. Univ. Calif., 99115), Skagway, Alaska.

Kjellman cites plate 30 of Postels and Ruprecht, Illustrationes algarum, as representing this form. Plate 30 is labeled "*Constantinea rosa marina,*" but has in addition a small plant of *Fucus*. This plant has long, acuminate receptacles. Plate 25 of the same work, to which Kjellman probably refers, is labeled *Fucus vesiculosus* and has decompositely furcate receptacles with long, acuminate apices. The plants referred here by Setchell and Gardner (1903, p. 282) have the characteristic receptacles referred to above. Comparison with a photograph of Kjellman's type specimen hardly bears out his conclusion regarding the illustration in Postels and Ruprecht. The fronds are reduced in width above each forking. Some of the receptacles are relatively wide, others are very narrow, and those of Kjellman's type, which we have not seen, are very blunt. Some doubts must be entertained as to the limits of this form. We are referring here plants from Orca and from Skagway, cited above, as more nearly coinciding with Kjellman's type.

14. **Fucus evanescens** f. **irregularis** Kjellm.

Fronds about 15 cm. high, branching for the most part irregularly dichotomous; segments narrow, at times scarcely extending beyond the inconspicuous midrib, apices truncate; receptacles definitely delimited, ovate, obovate, oblong, or obcordate; conceptacles small.

Kjellman, Om Beringh. Algflora, 1889, p. 35.

A photograph of the type specimen indicates that this form, segregated by Kjellman on Bering Island, is hardly to be considered a distinct entity but rather a battered and distorted plant of some other form. To our knowledge it has not been recognized since its original discovery; but if a valid form, it is quite likely to occur on the North American side of the Pacific Ocean, hence we are including it here as a possibility.

15. **Fucus evanescens f. limitatus** Kjellm.

Fronds caulescent or subcaulescent, submembranaceous, dichotomous, spreading, with rounded angles, yellowish brown, darker brown on drying; segments short, cuneate-linear, apices rounded, truncate, midrib distinctly reduced upward, cryptostomata few; receptacles distinctly delimited, subpedicilate, seemingly lateral, entire or bifurcate, ovoid-ellipsoidal, 12–18 mm. long, 8–12 mm. wide.

Growing in the upper sublittoral belt. Port Clarence to Norton Sound, Alaska.

Kjellman, Om Beringh. Algflora, 1889, p. 34; De-Toni, Syll. Alg., 1895, p. 202; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 282; Gardner, Genus *Fucus,* 1922, p. 54, pls. 58, 59.

Kjellman, Port Clarence, Alaska; R. C. McGregor, no. 5683 (Herb. Univ. Calif., no. 99107), Besboro Island, Norton Sound, Alaska.

The only material of which we are aware that has previously been referred to this form since its establishment by Kjellman is that referred by Setchell and Gardner (*loc. cit.*) from Norton Sound, and the same material, two small fragments of plants, is again referred here to the same form, though with some doubt. It is evidently a small form, and according to Kjellman, grows in the sublittoral belt, an unusual habitat for small forms, or even other forms outside of the Arctic regions.

16. **Fucus evanescens f. angustus** Kjellm.

Fronds subdichotomously branched, 20–30 cm. high, 4–5 mm. wide, coriaceous or submembranaceous; segments linear or cuneate-linear, elongated, midrib distinct below, becoming inconspicuous or almost vanishing at the apices, cryptostomata prominent, variable in number; receptacles small, oblong, ovoid to broadly ellipsoid, obtuse or acute inflated or more or less complanate; conceptacles hermaphroditic, antheridia at times sparse; color black on drying.

Kjellman, Algenveg. Murm. Meer., 1877, p. 27; Gardner, Genus *Fucus*, 1922, p. 56.

This form of *evanescens,* first described by Kjellman, has not been clearly identified with any specimens from our region, but is here included because of its close resemblance to certain of our forms, and hence the probability of its occurrence within our waters would seem to warrant its inclusion.

Yendo (1907, p. 16, pl. 1, fig. 1) identifies a plant of the Japanese waters with this form. Setchell and Gardner (1903, p. 284) also identify plants from East Sound and Fairhaven, Washington, with this form, and specimens from East Sound were distributed in Collins, Holden and Setchell's Phycotheca Boreali-Americana, no. 926. On comparison of our plants with a sheet of plants in the Herbarium of the University of California, no. 132699, collected on the Vega expedition near Tjapka and contributed and labeled by Kjellman, *Fucus evanescens* f. *angustus,* it has seemed best to change the determination and to place our plants under *Fucus edentatus* f. *costatus,* under which a detailed account is given. The plants illustrated by Yendo differ decidedly from the Kjellman specimens referred to above, particularly in the size of the receptacles and the prominence of the midrib. It may be doubted whether this form really extends so far south on either coast of the Pacific Ocean as was previously supposed, but its occurrence farther north may well be expected.

17. **Fucus evanescens f. contractus** Kjellm.

Fronds 5–25 cm. high, slightly caulescent, subcoriaceous, irregularly dichotomous or subsecund, dark brown to yellowish; segments mostly strict, cuneate-linear below, linear above, 3–10 mm. wide, apices truncate, midrib distinct below, vanishing above, cryptostomata moderately abundant, 15–20 per sq. cm., inconspicuous; receptacles complanate, distinctly delimited, 1.5–3.5 cm. long, ellipsoidal or obcordate, single or bifid; conceptacles few, but prominent.

Growing in the littoral region. Bering Sea, Alaska.

Kjellman, Om Beringh. Algflora, 1889, p. 34; De-Toni, Syll. Alg., 1895, p. 202; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 284; Gardner, Genus *Fucus*, 1922, p. 55.

Setchell, nos. 5239, 5252 (Herb. Univ. Calif., nos. 99097, 99101), St. Michael, Alaska; McGregor, nos. 5673, 5679 (Herb. Univ. Calif., nos. 99099, 99100), Golofin Bay, Alaska. Not Gardner, no. 90 (Herb. Univ. Calif., no. 99096), Whidbey Island, Washington, sub *F. evanescens* f. *bursiger* (cf. Setchell and Gardner, 1903, p. 285).

Kjellman does not mention in his description of this form the decided and sudden difference between the width of the segments and the receptacles which they bear. This difference makes the receptacles appear stipitate, since they are over twice as wide as the base of the segments. Presumably this is the character upon which the form is based.

No. 5252 of Setchell (Herb. Univ. Calif., no. 99101) from St. Michael, Alaska, quoted above, is as near the type as could be desired in every particular. The plants are about 10 cm. high, thus representing the upper limits in size as stated by Kjellman. The plants under the other numbers referred to are all larger in all parts than the measurements given by Kjellman, but they seem too closely linked to the type to warrant separation without further studies of quantities of material in the field. There is not the sudden widening of the receptacles in any of the latter forms as in the type. The receptacle character seems more closely allied to that of f. *macrocephalus*.

18. **Fucus evanescens f. oregonensis** Gardner

Plate 106

Fronds distinctly caulescent, 15–20 cm. high, subcoriaceous, dichotomous below, subsecund above, yellowish brown; segments narrow, sublinear or slightly cuneate, 4–7 mm. wide, flaccid, smooth, midrib narrow and distinct below, slightly evanescent above, cryptostomata small, inconspicuous, 20–25 per sq. cm.; receptacles tumid, distinctly delimited, much wider than the segments bearing them, single or bifid, broadly fusiform, apices very obtuse; conceptacles moderately conspicuous.

Growing on floats, piles, stones, etc., in the middle and upper littoral belts. East side of Coos Bay, opposite North Bend, Oregon.

Gardner, Genus *Fucus*, 1922, p. 40, pl. 40.

This form seems decidedly distinct from all other forms previously described. Judging from its size, color, character of the midrib, and its general consistency, its nearest relatives are to be found in the *evanescens* group, and close to forma *flabellatus*. The plants are smaller, segments narrower and regularly dichotomous instead of subsecund, and the receptacles are shorter and blunter than in that form. The only locality from which it has been reported is the one given above, where it grew in profusion. Doubtless it may be found in other localities on the same bay.

19. **Fucus evanescens f. ecostatus** Gardner

Fronds submembranaceous, 12–18 cm. high, dichotomous or subsecund, yellowish brown, darker brown on drying, stipe and holdfast fragile; segments strict, cuneate, 5–12 mm. wide, growing point inconspicuous, midrib very inconspicuous throughout, nearly vanishing in the terminal lobes, alae thin and membranaceous, cryptostomata very few and inconspicuous; receptacles variable, inflated or complanate, mostly narrow, bifid, acuminate; conceptacles inconspicuous.

Growing on sandstone, wooden floats, etc., in the upper littoral belt. Coos Bay, Oregon.

Gardner, Genus *Fucus,* 1922, p. 39, pl. 39.

Forma *ecostatus* is quite abundant at various localities from the mouth of Coos Bay up to its headwaters where several streams of fresh water flow in. This form seems to be definitely fixed, and does not appear to grade into any of the forms that are found growing outside of the bay. More investigation, however, may show that it is only a depauperate form of some definite species; on the other hand, it may prove to be a distinct species. It varies considerably in size and width of the fronds. The receptacles, though mostly pointed, are at times wide and blunt; at least there are specimens growing in the same habitat which have the general characters but differ only in the character of the receptacles, and in such cases the segments are generally wider. They are connected, however, by almost imperceptible gradations. The size of the plants may be somewhat influenced by the substratum, mostly wood and soft sandstone, neither of which is suited to holding plants for a very great length of time. They usually do not persist in such localities beyond a single fruiting period. If the vanishing of the midrib is to be considered as having any diagnostic value, this form eminently belongs with the *evanescens* group. The midrib in some specimens is scarcely discernible in any part of the frond, and in all it vanishes in the terminal segments.

20. **Fucus evanescens f. cuneatus** Gardner

Fronds small, 5–10 cm. high, membranaceous, regularly dichotomous, olive brown; basal segments decidedly cuneate, terminal segments almost linear, 4–8 mm. wide, apices truncate, midrib inconspicuous, slightly evanescent above, cryptostomata few, inconspicuous; receptacles complanate or occasionally swollen, deeply bifid, usually acuminate, not definitely delimited, large relative to the size of the plant; conceptacles relatively large and numerous.

Growing on sandstone in the upper littoral region. Near Empire, Coos Bay, Oregon.

Gardner, Genus *Fucus,* 1922, p. 39, pl. 38.

One becomes somewhat exasperated in attempting to deal with such forms as the one mentioned above. Ordinarily it might be considered a depauperate form of some other well developed and characteristic form. There were several square rods of fruiting plants growing on very gently sloping sandstone near high-tide level. There were no other plants growing near, and there was seemingly no reason why, from the standpoint of anchorage, they should not grow much farther down in the littoral belt. The reduced size could not be due to superabundance of fresh water, for several much larger forms were found growing from three to six miles farther up the bay where the water is much less saline. Many plants have well-developed mature receptacles.

Its general characters seem to favor its being grouped with *F. evanescens,* although it will fit practically as well into the *edentatus* group. We are placing it with the former until more can be learned of its life-history.

21. **Fucus evanescens f. nanus** Kjellm.

Fronds minute, 4–5 cm. high, 2–5 cm. wide, without distinct stipe and usually without holdfast, branching very irregularly, considerably twisted, color variable, yellowish brown to olive green, fruiting sparsely; segments extremely variable in shape and size, midrib slightly developed below, usually vanishing above, cryptostomata few or absent; receptacles entire or bifid, ovate-ellipsoidal or with divergent, blunt or acuminate apices.

Growing mostly on mud flats at extreme high-tide limit, or even considerably above, among various salt marsh plants, covered more or less by fresh water. Yakutat Bay, Alaska, to Puget Sound, Washington.

Kjellman, Om Spetsb. Thall., II, 1877*a*, p. 4; De-Toni, Syll. Alg., 1895, p. 203; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 285; Gardner, Genus *Fucus*, 1922, p. 37, pl. 37.

Rev. Albin Johnson, no. 5712 (Herb. Univ. Calif., no. 99121), Yakutat Bay, Alaska; Gardner, no. 2256 (Herb. Univ. Calif., no. 201154), Sitka, Alaska; T. C. Frye (Herb. Univ. Calif., no. 132931), Tokeland, Washington.

After considerable observation in several different localities, we have come to the conclusion that f. *nanus* cannot be considered as a distinct form of any one species, but is in reality composed of a mixture of dwarfed plants of whatever species or forms of species that happen to inhabit the region. The dwarfs are always found on mud flats, salt marshes, and quite commonly at the mouths of rivers and smaller streams where such mud flats and marshes may occur. At extreme high tides, frequently, a great abundance of plants, of whatever species of *Fucus* happens to be growing in the vicinity, are thrown up and lodge among other plants that grow there. The spores are shed, and, being in a moist place, they germinate and persist for a longer or shorter time. The plants are always much gnarled and distorted, and rarely come to fruit. At the mouth of the Indian River at Sitka, Alaska, is a favorable place for the study of such dwarfed plants. There are many different forms of *Fucus* growing in the vicinity, and a great many plants are constantly being cast up on the gradually sloping flat at the mouth of the stream. There are enormous numbers of dwarfed plants in all possible stages of development and distortion. One can come to no other conclusion than that these are dwarfed plants, that they are the offspring of whatever plants may by chance be thrown up there, and that their specific identity cannot be traced, growing as they do in such abnormal environmental conditions.

5. **Fucus nitens** Gardner

Plate 102

Fronds moderately flaccid, coriaceous, 30–40 cm. high, regularly dichotomous, dark brown to yellowish brown, very dark on drying; segments strict, 9–18 mm. wide, smooth and glossy, cuneate, terminal wider, slightly ovate, truncate, growing point very slightly depressed, midrib moderately prominent, cryptostomata absent or very sparse; receptacles yellowish, complanate when young, frequently becoming tumid at maturity, bi- tri-furcate, 4–7 cm., rarely 10 cm. long; conceptacles large.

Growing on boulders and rock ledges. San Francisco Bay, California.

Gardner, Genus *Fucus*, 1922, p. 26, pls. 18, 19.

This relatively small group of *Fucus* plants, although very much circumscribed in its distribution, seems so distinctly marked off in its combination of characters from other species, particularly from those in the southern portion of our range, that it is worthy of specific rank. The combination of characters that distinguish this species consists of the following: relatively long and narrow, smooth and glossy fronds, strict, even overlapping habit of the terminal and subterminal segments, the dark brown color with yellowish receptacles at maturity, absence of caecostomata, and the cryptostomata, when present, inconspicuous. Its affinities with *F. edentatus* may possibly be traced, but they seem too remote to merit much serious consideration.

66. **Pelvetia** Dec'ne and Thur.

Fronds of tough, firm consistency, flexuose, the whole plant when young, and the young terminal growing parts considerably flattened, without midrib, becoming more or less terete with age, especially toward the base, arising from a solid, disk-shaped holdfast; growing region apical; branching dichotomous, usually abundant; reproductive organs, antheridia and oogonia, developed in conceptacles limited to the terminal, metamorphosed parts of the branches, the receptacles; oogonia developing two viable gametes, or eggs; monoecious.

Decaisne and Thuret, Rech. sur Antherid., 1845, p. 12.

This genus was founded on the *Fucus canaliculatus* of Linnaeus (Syst. Nat. II, 1759, p. 716) based largely upon the fact that the oogonium produces but two viable eggs instead of eight, the characteristic number for the genus *Fucus*. Eight nuclei are formed in the oogonium, but six of them are extruded between the two eggs at the time of their formation and become functionless. The eggs are fertilized outside of the oogonia as in the genus *Fucus*.

Pelvetia fastigiata (J. Ag.) De-Toni

Mature fronds terete below, compressed above, narrowly linear, profusely branched, branching often beginning just above the base, dichotomous, fastigiate, 2–4 dm. (up to 10 dm.) high, 5–10 mm. diam. below, tapering above; color yellowish brown to dark olive green; the central portion of the fronds consisting of long, branched, colorless filaments with thick gelatinous walls, surrounded by a layer of large parenchymatous cells, becoming smaller toward the surface consisting of a single layer of small, compact cells; oogonia on one-celled stalks, broadly elliptical, dividing longitudinally or occasionally obliquely into two (very rarely into three) oospheres; antheridia very numerous, on short branches in the basal portion of the conceptacles, paraphyses not at all, or only slightly. extruded; receptacles moderately swollen, occasionally forked, variable in shape, some conical, others fusiform.

Always growing on rocks, in the middle of the littoral belt. Extending from Coos Bay, Oregon, to the west coast of Lower California (Ensenada).

De-Toni, Syll. Alg., vol. 3, 1895, p. 215; Gardner, Nuclear Extrusion, 1910, p. 130, pl. 17, figs. 11–16; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), nos. 176 and CXIII. *Fucus* (*Pelvetia*) *fastigiata* Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 110. *Fucus fastigiatus* J. Ag., Symb. I, 1841, p. 3; Harvey, Ner. Bor.-Amer., 1851, p. 68, pl. 3 A.

The plants of *Pelvetia fastigiata* vary considerably in size. So far as has been observed, they reach their greatest length in southern California, where at San Pedro plants 10 dm. long have been observed. Usually when the plants are growing where they are subjected to a heavy surf, the fronds become much thicker and much more rigid and less branched than those growing in more sheltered situations. This is the typical condition of plants on the west end of the Monterey peninsula, the type locality. Here the branches are widespreading and the angles much rounded, and some of the fronds measure 2 cm. wide near the base.

Pelvetia fastigiata f. gracilis S. and G.

Plate 78*a*

Plants profusely and dichotomously branched, central branches becoming much longer than those on the outside of the mass, giving to the whole plant a more or less spherical outline; frequently branches arise from near the base and develop a mass of short branchlets; fronds slender, the terminal branchlets 1–3 mm. diam.; fruiting in the summer and autumn.

Growing in the middle of the littoral belt. Carmel Bay, Pacific Grove, and Santa Catalina Island, California.

Setchell and Gardner, *in* Gardner, New Pac. Coast mar. alg., I, 1917, p. 386.

In the above mentioned localities, plants grow in groups, quite separate from the typical *P. fastigiata*. The plants as a whole are to be distinguished chiefly by their very slender fronds throughout as compared with the typical form.

67. **Pelvetiopsis** Gardner

Fronds arising from a disk-shaped holdfast, frequently the holdfasts confluent, cylindrical at the base soon becoming flattened and more or less concave-convex and contorted, ecostate, receptacles conspicuous, terminal, almost cylindrical and acuminate or flattened and blunt; oogonium producing but one viable gamete, or egg, the other seven nuclei extruded in a single, small, non-viable sphere cut off from the lower part of the oosphere; cryptostomata sparse on the young plants; hermaphroditic.

Gardner, Nuclear Extrusion, 1910, p. 127, New Fucaceae, 1913, p. 320.

This genus is well marked both macroscopically and microscopically. It is more closely related to the genus *Pelvetia* than to the genus *Fucus* in its gross morphological characters, but differs from both in the production of but a single viable gamete in the oogonium. In this latter respect it is like the genus *Hesperophycus*, but differs decidedly from that genus in its gross morphological characters.

Pelvetiopsis limitata (Setchell) Gardner

Two fairly well defined forms of this species have been found along the California coast, but not growing together.

Pelvetiopsis limitata f. typica Gardner

Plate 46, fig. 6

Fronds narrow, 8–10 cm. long, when young beginning to fruit before branching and when only 2–3 cm. long; receptacles nearly cylindrical, often long-attenuate; conceptacles conspicuous.

Growing along high-tide level or above, where the surf dashes against rocks. Ranging from Vancouver Island to central California.

Gardner, Nuclear Extrusion, 1910, p. 127, pl. 16, figs. 1–7, New Fucaceae, 1913, p. 321, pls. 38, 39, figs. 8–30. *Pelvetia fastigiata* f. *limitata* Setchell, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1238. *Pelvetia fastigiata* Tilden, Amer. Alg. (Exsicc.), nos. 233 and 517.

Pelvetiopsis limitata f. lata Gardner

Fronds comparatively robust, 15–18 cm. long, frequently much contorted, receptacles flat, wide and mostly blunt, in age often inflated.

Growing usually near high-tide limit. Observed along the coast of central California, from Tomales Point to Half Moon Bay.

Gardner, Nuclear Extrusion, 1910, p. 127, New Fucaceae, 1913, p. 321, pls. 40, 41, figs. 31–43; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. CXIV.

68. **Hesperophycus** S. and G.

Fronds complanate, arising from a solid, disk-shaped holdfast, dichotomous, with distinct percurrent midrib, a short compressed stipe and linear segments, oogonia developing but one viable gamete, or egg, seven nuclei falling to the bottom of the oosphere being cut off and forming a non-viable part.

Setchell and Gardner, *in* Gardner, Nuclear Extrusion, 1910, p. 127, New Fucaceae, 1913, p. 317.

Hesperophycus Harveyanus (Dec'ne) S. and G.

Frond 2–4 dm. high, dichotomous, usually one of the dichotomies outgrowing the other, forming several main axes, some of the laterals with several branches close together becoming flabellate; color dark olive green, or yellowish brown when in exposed situations; segments 5–10 mm. wide, with a row of cryptostomata extending longitudinally on either side of the midrib, having an abundance of extruding paraphyses; receptacles simple but in part bifurcate, 1.5–3 cm. long, cylindrical to ellipsoidal.

Growing on rocks in a restricted belt a few feet below high-tide limit. The present known range is from Monterey Bay to Lower California (Ensenada).

Setchell and Gardner, *in* Gardner, Nuclear Extrusion, 1910, p. 127, pl. 16, figs. 8–10, New Fucaceae, 1913, pp. 317–320, pls. 36–37; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. CXII. *Fucus Harveyanus* Dec'ne, Voyage Venus, 1864, p. 9, Altas, 1846, pl. 4. *Fucus ceranoides* f. *Harveyanus* Tilden, Amer. Alg. (Exsicc.), no. 339.

Family 25. SARGASSACEAE De-Toni (lim. mut.)

Fronds differentiated into holdfast, stipe and more or less indistinguishable from it the main rhachis of the frond which bears the variously modified or differentiated branches arising on all sides of the rhachis, and usually far surpassing it in length; stipe and main rhachis perennial, the growing region at the apex of the rhachis somewhat obscure, primary branches fruiting, then disintegrating back to the rhachis, leaving scars on the constantly elongating axis; oogonia usually few and large; receptacles small, cylindrical, or slightly complanate, terminal or subterminal.

De-Toni, Syst. Uebers. Fucoid., 1891, p. 174.

Key to the Genera

1. Vesicles absent in our species....69. **Blossevillea** (p. 705)
1. Vesicles present.... 2
    2. Vesicles single....73. **Sargassum** (p. 711)
    2. Vesicles seriate.... 3
3. Stipe short in our species, merging into the hapteres....70. **Cystophyllum** (p. 706)
3. Stipe long, persistent.... 4
    4. Stipe decidedly angular....72. **Cystoseira** (p. 708)
    4. Stipe terete, more or less geniculate....71. **Halidrys** (p. 707)

69. **Blossevillea** Dec'ne (orthog. mut.)

Erect fronds either arising directly from a mass of branched hapteres or from other prostrate "runners" attached by branched hapteres, usually divided into several main portions which are terete or slightly flattened and two-edged; these main divisions usually developing numerous side branches, either on all sides or pinnate along the two edges of flattened forms, in such species the frond bending at each node, giving the whole frond a marked geniculate appearance; the terminal ramuli give rise to the receptacles; air vesicles may or may not be present, when present non-septate.

Decaisne, Sur Thalass., 1840, p. 409; Gardner, New Fucaceae, 1913, p. 325, *et seq.*

In the last mentioned publication, a discussion is given as to the reasons for the use of the term, *Blossevillea* of Decaisne, instead of *Cystophora* of J. G. Agardh, for the plant we are here including in our account.

Blossevillea Brandegeei S. and G.

Erect fronds developing from short, irregularly branched, prostrate filaments attached to rocks by small, disk-shaped holdfasts; fronds cylindrical or subcylindrical at the base, gradually becoming flattened, with a midrib, occasionally forked, 23–35 cm. high, 4–6 mm. wide, alternately pinnatifid, producing a geniculate appearance throughout the whole plant; pinnae arising from the margins only, slightly midribbed, twice or thrice pinnatifid, 5–8 cm. long; vesicles absent; dried plants black and very brittle; receptacles terminating the ultimate ramuli, 10–15 mm. long; conceptacles mammiform, usually in two fairly well defined rows on each side of the slightly flattened receptacles; one oosphere in each oogonium; monoecious.

Known only from Guadalupe Island, off the coast of Lower California.

Setchell and Gardner, *in* Gardner, New Fucaceae, 1913, p. 325, pl. 46.

We have no data as to the abundance of this species, nor as to its habitat. It has not been reported since its discovery by Dr. Edward Palmer in 1897, on the above mentioned island.

70. Cystophyllum J. Ag.

Fronds arising from a broad, flattened, irregular, parenchymatous holdfast, several fronds apparently arising from the same holdfast, the main stipe soon disappearing as such; main fronds comparatively long, giving rise to very small, flattened branches, and to numerous long, filiform, nearly terete branches; these long branches bearing numerous, short, lateral branches, variously dissected into ramuli bearing small, usually solitary, vesicles beyond which the receptacles develop oosphores single in an oogonium; plants perennial.

J. G. Agardh, Sp. I, 1848, p. 228.

When J. G. Agardh founded the genus *Cystophyllum* (*loc. cit.*), he enumerated and described nine species, all of which had been previously published under other genera. The first species mentioned in his account, the type of the genus, was *C. onustum* founded on *Fucus onustus* of Mertens (Sur plusieurs espèc. du *Fucus*, 1819, p. 183) and the *Sargassum onustum* of Agardh (Sp. Alg., 1820, p. 32). He placed it in the family Fucaceae, in which it was retained by Kjellman in Engler and Prantl (1893, pp. 279 and 283). De-Toni (1895) shifted the genus to the much modified family, Sargassaceae, in which we are retaining it.

Cystophyllum geminatum (Ag.) J. Ag.

Stipe arising from a solid, conical, fibrous disk, at first producing numerous, long, cylindrical, filiform with alternate branches, 6–24 dm. long, later producing several alternate side branches similar to the main stipe, these in turn producing the filiform branches; the filiform branches produce numerous, short, alternate, or fasciculate branches producing in turn, near their bases a few, alternate, linear or spatulate, ribless branches (leaves), and toward their apices ramuli terminated mostly by single, broadly fusiform air vesicles; these at first apiculate, later the receptacles developing from the apiculate part; plants dioecious.

Growing in the lower littoral and upper sublittoral belts. Extending from the Bering Sea, Alaska, to Puget Sound, Washington.

J. G. Agardh, Sp. Alg., vol. 1, 1848, p. 232; Setchell and Gardner, Alg. N.W. Amer., 1903, p. 285. *Cystophyllum Lepidium* Harvey, Coll. Alg. Vancouver Island, 1862, p. 163; Saunders, Alg. Harriman Exp., 1901, p. 432; Tilden, Amer. Alg. (Exsicc.), no. 232. *Cystoseira*

Lepidium Ruprecht, Tange Ochot. Meeres, 1851, p. 347; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XLVII. *Cystoseira geminata* Agardh, Syst. Alg., 1824, p. 286.

Since publishing our account in the Algae of Northwestern America, we have not been able to secure any additional data by which to separate the four species of the genus *Cystophyllum,* accredited to our region and which we united into one species under the foregoing combination.

71. **Halidrys** Lyngb.

Plants consisting of a solid holdfast, a stipe, flattened and terete fronds; the flattened fronds alternate on the stipe, these metamorphosing into pinnately branched filiform branchlets; cysts in a series, developing in the flattened fronds, leaving a margin on either side of the series; these fronds terminating in branched receptacles; one egg cell in each oogonium; monoecious or dioecious; perennial, the fruiting fronds dying back to the stipe each year.

Lyngbye, Hydrophyt. Dan., 1819, p. 37.

But two species of this genus, as restricted by Greville (Alg. Brit., 1830, p. xxxiv), are at present known, *H. siliquosa* (L.) Lyngbye, on the Atlantic coast of Europe, and the following species on the coast of southern California.

Halidrys dioica Gardner

Stipe arising from a flattened, solid, warted base, terete, bent at the "nodes," 40–50 cm. long, 4–6 mm. diam., solid, flexible, not forked; primary pinnae annual, arranged alternately upon the stipe, always arising just below the growing point, 10–18 dm. long, flat and linear at the base, pinnately branched above, the linear portion 10–25 cm. long, 8–12 mm. wide; secondary branches or pinnules sessile, flat, acute or obtuse at the apex, the oldest ones entire, the younger ones variously notched and incised, the incisions increasing in depth, and the segments increasing in length toward the apex of the branch, the uppermost becoming pinnately branched; the upper secondary branches develop flattened, margined, lanceolate, acuminate, short pediceled air vesicles, divided into 5–9 chambers, slightly constricted at the divisions, the oldest rounded at the base and mucronate at the apex; the apex of the younger ones developing farther into branched filiform receptacles and these in turn bearing many conceptacles; plants perennial, dioecious, the two sexes being indistinguishable by external morphological characters; color varying from dark brown to olive green.

Growing in the littoral and sublittoral belts on exposed rocks, or in the sublittoral belt in quiet water. San Pedro, Redondo and at Avalon, Santa Catalina Island, southern California and at least as far south as Ensenada, Lower California.

Gardner, New Fucaceae, 1913, p. 323, pls. 42–45; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), nos. CXVI, CXVII.

72. **Cystoseira** Ag.

Frond differentiated into holdfast, stipe and branches of various orders; holdfast somewhat fibrous and woody, solid or more or less cavernous, conical in general outline; usually each holdfast giving rise to one main stipe, decidedly angular, with terminal meristem, and giving rise on all sides to a few main divisions having terminal growing points; the primary branches arising from the main stipe and its divisions and far surpassing them in length, flattened and pinnately lobed at the base, resembling certain fern leaves, but divided above into more or less filiform branches and branchlets bearing the receptacles at their termini, and vesicles, usually seriate, in branchlets of different orders; oosphere single in the oogonium; plants monoecious or dioecious, perennial.

Agardh, Sp. I, 1820, p. 50.

Agardh enumerated fifty-seven species under his newly founded genus. *Cystoseira ericoides* came first in the list and may be considered the type of the genus. It was founded on *Fucus ericoides* of Linnaeus (Sp. pl. 1763, p. 1631). Agardh's combination is still retained and the plant is well illustrated by Harvey in Phycologia Britannica (vol. 3, pl. 265).

Key to the Species

1. Fronds robust throughout, 2–4.5 m. long .... 1. **C. osmundacea** (p. 709)
1. Fronds shorter, up to 1.5 m. long, more slender 2
    2. Fructiferous ramuli aggregated into short, dense clusters, vesicles 6–8 mm. diam. .... 2. **C. Setchellii** (p. 710)
    2. Fructiferous ramuli not densely aggregated, vesicles 2–3 mm. diam. .... 3. **C. neglecta** (p. 710)

1. Cystoseira osmundacea (Menz.) Ag.

Fronds robust, perennial, up to 6 m. long; stipe nearly triangular in cross-section, somewhat geniculate, having numerous prominent scars caused by the disintegration of the primary branches; flattened portion in the lower part of the primary branches with deep rounded sinuses and prominent pinnae, rounded at the outer ends, very closely resembling the fronds of certain ferns, gradually reduced in size toward the outer end of the rhachis and finally merging into the long, branched, filiform branches; vesicles 5–12 seriate, 4–6 mm. diam., mostly in the branches having only the receptacular ramuli beyond; receptacles conspicuous, abundant, often much branched, terminating the ramuli; plants dioecious.

Growing in tide pools in the lower littoral belt and in the upper sublittoral belt, usually in moderately sheltered localities.

Central Oregon (Coos Bay) to Lower California (Ensenada).

Agardh, Sp. I, 1820, p. 69; Gardner, New Fucaceae, 1913, p. 333. *Fucus osmundaceus* Menzies, *in* Turner, Hist. Fuc., vol. 2, 1809, p. 92, pl. 105.

The type locality of the species is Port Trinidad, Humboldt County, California. Two forms, fairly constant in structure, have been noted as follows:

Cystoseira osmundacea f. typica Gardner

This form comprises the shorter specimens, more robust throughout, usually with fewer (5–8) vesicles in a series. It grows, as a rule, in more exposed localities in tide pools along low-tide level, and seems to be limited largely to the central and northern parts of the range.

Gardner, New Fucaceae, 1913, p. 335, pls. 51, 52.

Cystoseira osmundacea f. expansa (Ag.) Setchell

Forma *expansa* includes the more delicate and slender, much elongated (up to 6 m. long) specimens with smaller vesicles and a larger number (7–12) in a series. It is most luxuriant in the southern part of the range.

Setchell, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. XLVIII; Gardner, New Fucaceae, 1913, p. 336, pl. 53. *Cystoseira expansa* Agardh, Syst. Alg., 1824, p. 290. *Cystoseira osmundacea* Collins, Holden and Setchell, *loc. cit.*, nos. XCVI and CXV *a*, not *b*. Both distributions are small parts of plants.

2. **Cystoseira Setchellii** Gardner

Stipe developing from an irregularly conical-shaped solid base, flexible, cartilaginous, irregularly and sparingly forked, 2–3 dm. long, 8–10 mm. diam., triangular in cross-section, giving rise to numerous, alternate, flattened branches at short intervals, always from just below the growing point; flattened branches coriaceous, annual, deciduous, thus producing prominent scars on the stipe, serrated at the base, deeply and pinnately lobed or divided in the middle, 3–4 times pinnately divided into filiform ramuli at the apex; the pinnate segments often in turn becoming serrated, lobed, and divided; color of the living plant dark brown, turning black when dry; receptacles terminal on the ramuli, 15–25 mm. long; vesicles 1–3 seriate, terminal one frequently mucronate, spherical, containing internal, longitudinal, white fibers, without a margin, 6–8 mm. diam., situated at the base of the serrated segments, or at the base of the filiform branches; whole plant 6–8 dm. long; perennial; dioecious, the two sexes being very similar in external appearance.

Growing in the sublittoral belt. San Pedro and Redondo, southern California.

Gardner, New Fucaceae, 1913, p. 329, pls. 47–50. *Cystoseira osmundacea*, Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. CXV *b*.

3. **Cystoseira neglecta** S. and G.

Stipe arising from an irregular, conical-shaped, somewhat fibrous holdfast, flexible, rather sparingly forked, 5–15 cm. long, 4–6 mm. diam., triangular in cross-section, giving rise to flattened branches alternately arranged just below the terminal growing point; flattened branches coriaceous, flexible, becoming rigid and brittle when dry, dying back after fruiting, leaving a permanent angular scar on the stipe, when young divided into rounded alternate lobes by a deep sinus rounded at the base; the lobes of the lower and middle portion of the branches becoming 2–3 times pinnatified, and the upper lobes becoming repeatedly divided into cylindrical branches terminating in numerous receptacles; air vesicles developing on separate filiform branches, solitary or few in a series but separated 1–3 mm. from each other, spherical, smooth, 2–3 mm. diam., whole plant 4–7 dm. long; color of living plant light brown, turning black when dry; perennial; dioecious.

Growing in the upper sublittoral belt. Avalon, Santa Catalina Island, California.

Setchell and Gardner, *in* Gardner, New Pac. Coast Mar. Alg. I, 1917, pp. 388–390, pls. 34, 35.

73. **Sargassum** Ag.

Plants attached by a more or less irregular, warty, solid, parenchymatous base, or by numerous stolon-like growths from the main axis, at most but a few decimeters high; frond variously branched, consisting of a main basal part, or stipe-like portion terete or slightly angled remaining short with transition region near the end, bearing few to many branches on all sides, alternately arranged; these main branches more or less elongated, filiform, terete or slightly angled, more or less branched, developing short, flattened, generally more or less horizontal, sterile branches (leaves) with midrib and cryptostomata; the receptacles and vesicles, variously arranged and modified, developing in the axils of these leaves; plants monoecious or dioecious; oogonia large, containing a single egg.

Agardh, Sp. I, 1820, p. 1.

In treating of the species of *Sargassum* found within our territory, we are accepting the genus as established by C. A. Agardh in Species Algarum in 1820, following the arrangement and restriction of the species as proposed by J. G. Agardh in his Species Sargassorum, 1889, and further modified and amplified by A. Grunow in Additamenta, 1915, 1916. There is still much need of further investigation of the species growing in the Gulf of California and around the islands in the Pacific Ocean off the coast of Mexico.

Key to the Species

1. Leaves on all orders of branches decompound........................1. **S. Palmeri** (p. 712)
1. Leaves simple.. 2
    2. Vesicles, leaves, and receptacles intermixed, forming a heteroclyte cyme.. 3
    2. Vesicles, leaves, and receptacles not intermixed, not forming a heteroclyte cyme.. 6
3. Receptacles two edged, apex and margin serrate-dentate..5. **S. Bryantii** (p. 714)
3. Receptacles terete.. 4
    4. Leaves slightly flattened to filiform........................3. **S. guardiense** (p. 713)
    4. Leaves flattened, asymmetrical, dentate.. 5
5. Vesicles and receptacles not spinose..............................2. **S. acinacifolium** (p. 713)
5. Vesicles and receptacles more or less spinose............4. **S. lapazeanum** (p. 714)
    6. Receptacles ancipitally angulate, margins serrate-dentate, conceptacles on lateral surfaces.. 7
    6. Receptacles cylindrical, more or less papillate, conceptacles on all sides..11

7. Cryptostomata conspicuous... 8
7. Cryptostomata minute or none.. 9
    8. Branches and branchlets muricate............................6. **S. horridum** (p. 715)
    8. Branches and branchlets smooth.........................7. **S. Marchantae** (p. 715)
9. Leaves lanceolate, acuminate, spinulose-dentate............8. **S. Liebmanni** (p. 716)
9. Leaves more or less asymmetrical...10
    10. Primary branches long and very slender, branchlets sparse.................
    ....10. **S. insulare** (p. 717)
    10. Primary branches more robust, branchlets abundant.........................
    ....9. **S. Agardhianum** (p. 716)
11. Cryptostomata absent...12
11. Cryptostomata sparse or abundant..13
    12. Leaves blunt...11. **S. Brandegeei** (p. 718)
    12. Leaves acute..16. **S. herporhizum** (p. 720)
13. Fronds muricate..................................13. **S. polyacanthum** f. **americanum** (p. 718)
13. Fronds smooth..14
    14. Leaves narrowly lanceolate to filiform, ecostate, vesicles ellipsoidal....
    ....14. **S. Johnstonii** (p. 719)
    14. Leaves lanceolate, with percurrent midrib, vesicles subspherical to ovate...17. **S. paniculatum** (p. 721)
    14. Leaves lanceolate, with percurrent midrib, vesicles spherical....................15
15. Cryptostomata sparse, inconspicuous, receptacles acuminate.........................
    ....12. **S. sinicola** (p. 718)
15. Cryptostomata abundant, conspicuous, receptacles blunt...............................
    ....15. **S. cylindrocarpum** (p. 720)

1. **Sargassum Palmeri** Grunow

Plate 41, fig. 56, and plate 94

Frond arising from a solid, rugose, more or less disk-shaped holdfast, 4.5–7 dm. high; stipe terete, verrucose, up to 18 cm. long, bearing 2–5 terete or slightly angled, alternate branches at its summit disintegrating after fruiting; the primary branches giving rise to sterile segments (leaves) alternately arranged and often densely crowded, dendroidally and dichotomously dissected into 15–25 slightly flattened segments 2–3 cm. long, subcostate; older branches and at times the ramuli, more or less muriculate; numerous lateral terete secondary branches arising in the axils of the leaves, longer below, shorter above; these bearing reduced leaves similar to those on the main fronds, producing vesicles and the receptacles in their axils; vesicles usually solitary, smooth, spherical, 3.5–6 mm. diam., on the ends of pedicels as long or longer than their diameter; receptacles densely racemose, substipitate, often with a vesicle or reduced leaf as a part of the group; the fruiting fronds often appearing nude as the leaves wear away; conceptacles conspicuous; dioecious; plants perennial.

Grunow, Add. cog. Sargass., 1915, p. 338; Gardner, New Pac. Coast Mar. Alg. II, 1918, p. 448. *Sargassum piluliferum* Farlow, Anderson and Eaton, Alg. Exsicc. Amer. Bor., no. 102; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 537*a* (not 537*b*). Not C. Agardh, Sp. I, 1820, p. 27. Not Yendo, Fucaceae Japan, 1907, p. 54. Not *Fucus pilulifer* Turner, Fuci, vol. 1, 1808, p. 145, pl. 65. *Sargassum dissectifolium* Setchell and Gardner, *in* Gardner, New Pac. Coast Mar. Alg. I, 1917, p. 386.

2. **Sargassum acinacifolium** S. and G.

Basal parts unknown; branches terete, smooth; leaves 12–16 mm. long, asymmetrical, the upper margin concave and smooth, the lower margin and apex coarsely dentate, ecostate, cryptostomata absent; vesicles situated at the base of the receptacles or more rarely among the receptacles, subspherical, smooth, apiculate, 1.5–2.5 mm. diam., on pedicels shorter than the diameter; receptacles 2–3 times forked, nearly cylindrical, not spiny, acuminate, more or less denticulate toward the apices.

Cast ashore, Guaymas (?), Mexico.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 732, pl. 21, fig. 82.

This species of *Sargassum* is a near relative, apparently, of *S. lapazeanum* and of *S. Bryantii*, but it differs sufficiently in leaf, bladder, and receptacle characters to warrant giving it separate characterization.

3. **Sargassum guardiense** S. and G.

Basal parts unknown; primary branches up to 5 dm. high; secondary branches long and slender; branches and ramuli all smooth, terete; leaves slightly flattened, to filiform, ecostate, margins smooth, cryptostomata absent or rare; vesicles situated at the base of the fructiferous ramuli or among the branches of the receptacles, subspherical to slightly cylindrical, 2–4 mm. long, smooth, tapering at both ends, apiculate, on pedicels shorter than the diameter; receptacles 1–3 times forked, terete, not spinose, 5–8 mm. long, forming with the vesicles short heteroclyte cymes.

Cast ashore at Angel de la Guardia Island, Gulf of California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 732, pl. 19, fig. 64.

Unfortunately we have no complete specimens of this seemingly very well defined species of *Sargassum*. The character of the holdfast and of the main stipe, which are in many instances of much value in classification, cannot be stated. We have several clean primary branches which are in good fruiting condition and otherwise seemingly characteristic. The loose, open character of the branching and the shape and size of the vesicles remind one very much of some members of the genus *Cystophyllum* J. Ag. It has perhaps its nearest relative in *S. carpophyllum* but differs in leaf characters and in the vesicles being regularly lateral or terminal to the receptacles.

4. **Sargassum lapazeanum** S. and G.

Fronds 4.5–6 dm. high, arising from a solid parenchymatous disk; stipe 1.5 cm. long; primary branches 5–7, terete, smooth, giving rise to numerous long, slender, secondary branches; leaves 0.5–1.5 cm. long, asymmetrical, widest toward the apices, with very short petioles, the basal half of the upper margin smooth and concave, the remainder of the blade sharply dentate, midrib inconspicuous, cryptostomata abundant and conspicuous; vesicles scattered among the receptacles, ellipsoidal, 1–2 mm. long, transformed from the base of a leaf, mostly crowned by the remnants of the blade; receptacles 4–7 mm. long, 2–3 times forked, branches strict, spinulose, intermixed with leaves and receptacles forming a heteroclyte cyme.

Cast ashore, La Paz, Lower California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 733, pl. 20, fig. 74.

5. **Sargassum Bryantii** S. and G.

Basal parts unknown; branches terete, more or less contorted; leaves 6–12 mm. long, 0.5 as broad as long, ecostate, asymmetrical, the upper margin concave and smooth, the lower margin and the end unevenly serrate; cryptostomata few and irregularly placed; vesicles numerous along the ramuli or, more rarely, intermixed with the receptacles, subspherical, marginate when young, spinose, short- petiolate; receptacles short, 4–8 mm. long, 1.5–3 mm. broad, irregular cylindrical below, blunt or pointed, at times slightly spinose and crowned with a rudiment of a leaf.

Cast ashore near La Paz, Lower California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 733, pl. 21, fig. 83.

The characters of the receptacles do not agree in every particular with those given by J. Agardh (Sp. Sargas. Austral.) in his key to

Eusargassum. They are not regularly two-edged and serrate-dentate along the margins. Many of them are slightly flattened above, somewhat spinose, and crowned with a leaf rudiment. The species fits into this section better than into any other.

6. **Sargassum horridum** S. and G.

Basal parts unknown; branches and branchlets muricate, leaves linear-lanceolate, acute, midrib percurrent, margins deeply and doubly serrate; cryptostomata numerous and conspicuous on the leaves, stems, and vesicles; vesicles sparse, occupying the position of leaves near the base of the ramuli or scattered among the receptacles, spherical, 4–8 mm. diam., short-petiolate; receptacles decompoundly ramose, decidedly spinose.

Cast ashore, La Paz, Lower California.

Setchell and Gardner, Mar. Alg., Gulf Calif., 1924, p. 734, pl. 20, figs. 65, 66.

Like the majority of our specimens from the Gulf of California, the specimens of this species have neither holdfast nor stipe. Presumably many of them grow only in the sublittoral belt and collectors have observed only such specimens as have been cast ashore, and these are usually fragmentary. Otherwise the specimens of *S. horridum* are in excellent condition.

7. **Sargassum Marchantae** S. and G.

Basal parts unknown; primary branches 4.5–6 dm. high, terete, smooth; secondary branches numerous, densely fructiferous; leaves 4–6 cm. long, 3–5 mm. wide, linear-lanceolate, acute, midrib percurrent, margins irregularly serrate-dentate; cryptostomata numerous and conspicuous; vesicles sparse, spherical, on short pedicels near the base of the ramuli or near the base of the branching receptacles, 4–6.5 mm. diam., smooth; receptacle several times forked, occasionally one fork developing into a leaf or a vesicle forming a "heteroclyte cyme (?)," but all others fructiferous and from a single pedicel, supported near the base of a leaf, cylindrical, blunt, spinulose, the whole cyme 10–15 mm. long.

Cast ashore, Eureka, near La Paz, Lower California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 735, pl. 19, fig. 63.

Sargassum Marchantae is probably closely related to *S. Liebmanni* J. Ag.

8. **Sargassum Liebmanni** J. Ag.

Plate 45, fig. 81

Fronds about 30 cm. high, arising from a parenchymatous disk, stipe terete, very short; primary branches filiform, slender, smooth; leaves lanceolate, acuminate, costate, cryptostomata absent, margins undulate, spinulose-dentate; vesicles spherical, submarginate, apiculate, sparse, on pedicels shorter than their diameter, smooth; receptacles densely aggregated into a racemose cyme, more or less twisted, triangular, with each angle bearing a row of spinescent teeth.

West coast of Mexico.

J. Agardh, Nya Alg., 1847, p. 8, Sp. Sargass. Aust., 1889, p. 91, pl. 5; Grunow, Ad. cog. Sargass., 1915, p. 398.

The exact locality whence the type material of this species was obtained by Liebmann is not known. Agardh states ''På mexicanska stranden af Stillen Oceanen.'' Possibly the locality is St. Augustin. It apparently has not been seen since the original discovery was made.

9. **Sargassum Agardhianum** Farlow

Plate 39, fig. 46; plate 41, fig. 55, and plate 92

Plants anchored by a firm, expanded, warty, parenchymatous holdfast; perennial; fronds 25–35 cm. high, rarely up to 9 dm. high, terete, slender, simple at first but later branching a few millimeters above the base; branches few to many, filiform, terete or slightly angled, much surpassing the main frond or stipe which remains comparatively short; as the lower branches fruit and disintegrate, new ones arising from the transition region above; the fronds and branches giving rise either to leaf-like segments alternately arranged, linear-lanceolate, with sharply toothed margins and apex, and with a midrib and scattered cryptostomata, or to filiform segments beset with sharp teeth; in the axils of the segments either short branches bearing clusters of small vesicles, 2–6 in number, or longer secondary branches bearing leaf-like segments and vesicles in turn; vesicles on pedicels 1–1.5 mm. long, spherical or slightly ellipsoidal, smooth or in part slightly margined and toothed, with few cryptostomata, apiculate, 1.5–2.5 mm. diam.; receptacles in small clusters in the axils of certain segments, simple or bearing few sharp tooth-like projections; conceptacles conspicuous.

Growing in the lower littoral and upper sublittoral belts. Southern California and Lower California (Ensenada).

Farlow, List of Mar. Alg. U. S., 1876, p. 706 (nomen nudum), *in* Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 103, MS; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), nos. 179 and CXVIII; J. G. Agardh, Sp. Sargass. Aust., 1889, p. 93; Grunow, Add. cog. Sargass., 1915, p. 401.

The type locality of *S. Agardhianum* is San Diego, California. The form of the species is considerably modified by habitat. It is common in rather shallow rockpools in the lower half of the littoral belt or in deeper pools higher up. In these situations it is always covered with water and grows short and stocky with the secondary lateral branches more highly developed. When growing in quiet water in the sublittoral belt, it becomes much more elongated and attenuated, reaching a length of nearly a meter. It grows in profusion on the harbor side of the government breakwater at San Pedro, California, but is wholly absent on the exposed side. The antheridia and oogonia in this species are often in separate conceptacles on the same individual, or even in the same receptacle.

10. **Sargassum insulare** S. and G.

Fronds 7–9 cm. high, arising from a parenchymatous disk; stipe small, 5–10 mm. long; primary branches cylindrical throughout, 1–2 mm. diam., smooth, moderately and alternately branched; leaves 1–2 cm. long, about half as wide as long, asymmetrical, the upper margin concave and mostly smooth, the lower margin and apex convex and crenate or dentate, ecostate; cryptostomata sparse; vesicles intermingled with the receptacles, spherical or subspherical, 1.5–2.5 mm. diam., short petiolate, often crowned by the remnant of a leaf; receptacles moderately branched, standing on a single pedicel on the base of a leaf, irregular in shape, clothed with scattered blunt spines, sometimes crowned by a rudiment of a leaf.

Growing on rocks in the upper sublittoral belt. San Marcos Island, Gulf of California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 735, pl. 20, figs. 67, 68, and pl. 21, fig. 78.

11. **Sargassum Brandegeei** S. and G.

Basal parts unknown; branches and branchlets terete, smooth, without cryptostomata; branching rather dense in the upper parts; leaves 15–25 mm. long, 4–8 mm. wide, apices blunt, base cuneate, margins deeply serrate, cryptostomata absent; vesicles spherical, small, 2–3 mm. diam., smooth, apiculate or crowned by a rudiment of a leaf, supported by pedicels mostly shorter than their diameter, occupying positions of leaves toward the base of the ramuli, or scattered among the receptacles; receptacles in short dense racemes, with short distinct pedicels below but with sessile branches above, mostly blunt.

Cast ashore, Guaymas (?), Mexico.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 736, pl. 21, fig. 79.

12. **Sargassum sinicola** S. and G.

Basal parts unknown; branches and branchlets smooth, terete; leaves linear-lanceolate, acute, margins serrate-dentate, midrib percurrent, cryptostomata sparse, inconspicuous; vesicles numerous, mostly borne near the base of pedicel supporting the receptacles, spherical, smooth, 3–5 mm. diam., pedicels equaling the diameter; receptacles 1–3 times forked, the lower pedicellate, the upper sessile, cylindrical, with acuminate apices, not spinose.

Cast ashore, Eureka, near La Paz, Lower California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 736, pl. 20, fig. 73.

This species seems nearly related to *S. podocanthum* Sond. and to *S. spinuligerum* Sond. but the leaves are much more "glandular" and the receptacles much more branched.

13. **Sargassum polyacanthum** f. **americanum** S. and G.

Basal parts unknown; branches and branchlets up to 1.5 mm. diam., moderately muricate, leaves 3–4 cm. long, narrowly lanceolate, acute, margins serrate-dentate, midrib percurrent, cryptostomata sparse; vesicles spherical, smooth, up to 8 mm. diam., occupying positions of leaves along the ramuli or at times supported by a leaf; receptacles 1–2 times forked, 2.5–4 mm. long, obtuse-conical.

Cast ashore, La Paz (?), Lower California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 736.

This form stands very close to *S. spinuligerum* Sond. The leaves are longer and narrower than in that species. There are also other specific differences.

14. **Sargassum Johnstonii** S. and G.

Basal parts unknown; primary branches relatively robust, terete, smooth, up to 8 dm. long, secondary branches numerous, densely crowded with fructiferous ramuli; leaves narrowly lanceolate, ecostate, margins sparsely denticulate, cryptostomata almost absent, 1.5–2.5 cm. long, 2–4 mm. wide; vesicles, smooth, narrowly elliptical, merging gradually below into a short petiole, crowned by a mucron or a remnant of a blade, scattered along the fruiting rhachis among the receptacles, 3–5 mm. long, on pedicels shorter than their length; receptacles single or 2–3 times forked, nearly cylindrical, mostly blunt, with slightly denticulate apices.

Cast ashore, Georges Island, Gulf of California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 737, pl. 20, fig. 72 and pl. 21, fig. 80.

Sargassum Johnstonii is related to *S. galapagense* Grun. but differs in having elongated, long-apiculate vesicles, and slightly denticulate receptacles and in details of leaf characters.

Sargassum Johnstonii f. **laxius** S. and G.

Basal parts unknown; primary branches up to 13.5 dm. long, secondary branches very much less frequent and much longer than in the species; leaves filiform, 1–2 cm. long, cryptostomata sparse, inconspicuous; vesicles subspherical, mostly long-mucronate; receptacles 1–2 times forked, rarely simple, not denticulate.

Cast ashore at Guaymas, Mexico.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 737, pl. 21, figs. 75 and 81.

This form differs from the species in the following particulars: the secondary branches and fructiferous ramuli are very much more widely scattered and several times longer, the leaves are narrower, in fact they are filiform, the vesicles are very much shorter, about one and a half times as long as broad, and the receptacles are less branched and rarely, if ever, denticulate at the apices.

Sargassum Johnstonii f. gracile S. and G.

Basal parts unknown; branches of all orders very slender, long, and wide apart, up to 1 mm. diam.; leaves filiform; vesicles narrowly ellipsoidal.

Cast ashore, Guaymas, Mexico.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 738, pl. 21, fig. 76.

This differs from the species in being decidedly more slender throughout, much less frequently branched, and in having the branches much longer and more delicate, and in having filiform leaves. In these respects they more nearly coincide with f. *laxius* but are much more delicate throughout than in that form. The receptacles are young in the specimens at hand. The vesicles are practically the same in form as those of the species.

15. **Sargassum cylindrocarpum** S. and G.

Basal parts unknown; primary branches and branchlets smooth, terete; leaves 5–8 cm. long, 3–5 mm. wide, linear-lanceolate, acute, serrate-dentate, midrib percurrent, cryptostomata abundant and conspicuous; vesicles 5–8 mm. diam., spherical, smooth, on stipes shorter than the diameter, occupying positions of leaves toward the base of the fructiferous ramuli; receptacles several times forked, cylindrical, blunt, 1–2 cm. long.

Cast ashore, La Paz, Lower California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 738, pl. 21, fig. 77.

16. **Sargassum herporhizum** S. and G.

Fronds 6–8 dm. high, attached at first by a small parenchymatous disk, later the short stipe giving rise to erect primary branches in part and to horizontal branches which in turn develop attaching branches, hapteres, below and to erect branches above; primary branches slender, terete, smooth, densely clothed with leaves and with scattered secondary branches below and with fructiferous branches above; lower leaves sublinear, upper linear-lanceolate and acute, lower 3–5 mm. broad, upper 1–2 mm. broad, midrib percurrent, margins sparsely denticulate, cryptostomata absent; vesicles numerous, scattered among the receptacles, spherical to subspherical, smooth, rarely apiculate, 1–2 mm. diam., on pedicels as long as or longer than the diam.; receptacles short, 5–10 mm. long, subcylindrical, acuminate, only sparsely branched, tuberculate with conspicuous conceptacles; plants very dark on drying.

Growing in the upper sublittoral belt. Georges Island, Gulf of California.

Setchell and Gardner, Mar. Alg. Gulf Calif., 1924, p. 739, pl. 20, figs. 69–71.

17. **Sargassum paniculatum** J. Ag.

Plate 46, fig. 5

Basal parts unknown; main branches and branchlets relatively slender, terete, smooth; secondary branches arising near the middle of the primary branches, longest below, gradually diminishing upward, the fructiferous ramuli arising on the base of the leaves of the secondary branches; leaves linear-lanceolate, acute, midrib percurrent, margins acutely denticulate-serrate, in part doubly so, cryptostomata scattered, or in a fairly regular row on each side of the midrib, inconspicuous; vesicles subspherical to ovate 2–4 mm. long, smooth, on pedicels as long as or longer than the diameter, occupying positions of leaves at the base of the fructiferous ramuli or scattered among the receptacles; receptacles cylindrical, acuminate, more or less branched, forming loose racemes.

Guadalupe Island, off the coast of Mexico.

J. Agardh, Sp. Alg., vol. 1, 1848, p. 315, Sp. Sargass. Aust., 1889, p. 122, pl. 12, figs. 1–3; Grunow, Add. cog. Sargass., 1916, p. 177.

We are including this species in our account, based upon a portion of a frond collected by Dr. E. Palmer at Guadalupe Island, Lower California, Mexico, communicated to the Herbarium of the University of California (no. 170615) by Dr. W. G. Farlow, and are placing it in *S. paniculatum* on the authority of Th. Reinbold, who examined the specimen. The plant agrees fairly well with the descriptions and figures of J. Agardh (*loc. cit.*).

We have no knowledge of the "*Sargassum fuliginosum* var. (?) *Californica*" described by Grunow, 1916, p. 173. "Hab. ad littora Californiae (leg. Askenasy)," and hence are not including it in our flora until we obtain further information concerning its structure and distribution.

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EXPLANATION OF PLATES

PLATE 34

Dictyota Binghamiae J. Ag.

Fig. 1. Habit sketch of a robust plant. × 0.5.

Fig. 2. Cross-section of a frond showing the character of the cells at the margin. × 125.

Dictyota flabellata (Collins) S. and G.

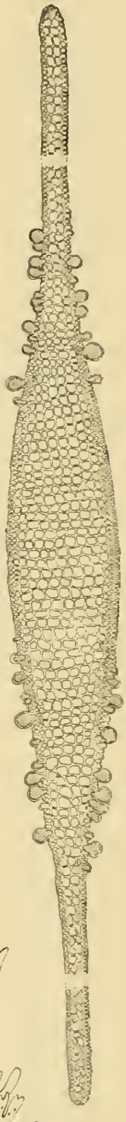
Fig. 3. Habit sketch of a part of a frond. × 0.5.

Neurocarpus zonarioides (Farlow) Howe

Fig. 4. Cross-section of a frond showing the position of the fruit, the alae (shortened) and the thickened central portion. × 45.

Zonaria Farlowii S. and G.

Fig. 5. Habit sketch of a terminal fragment of a frond showing the method of development. × 1.



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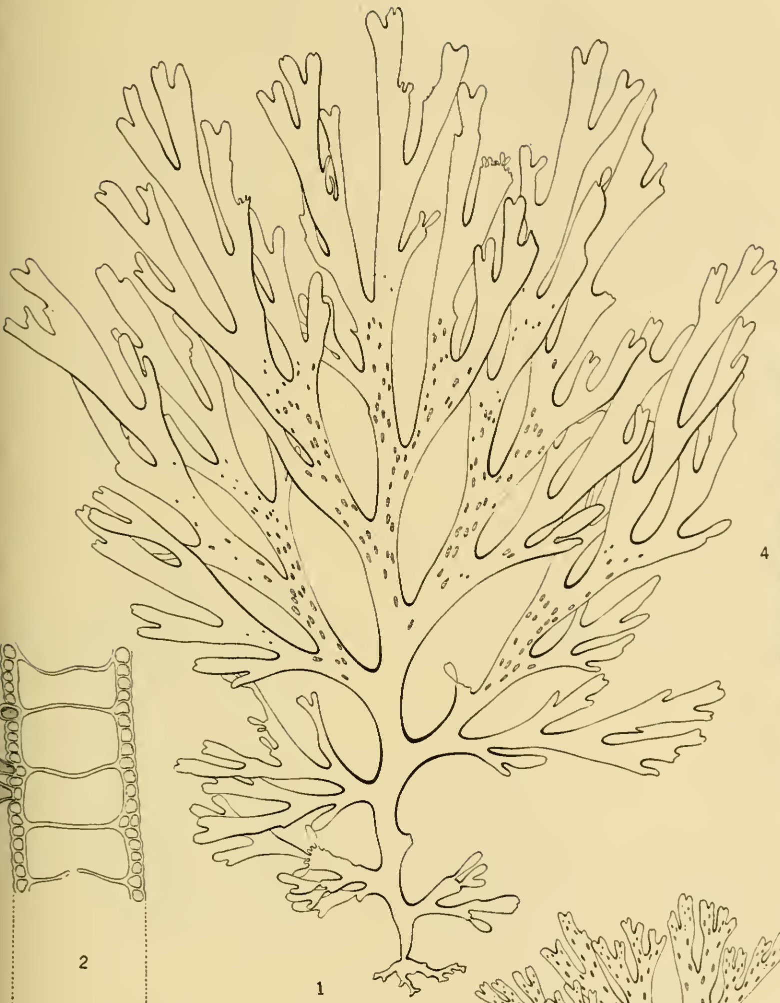

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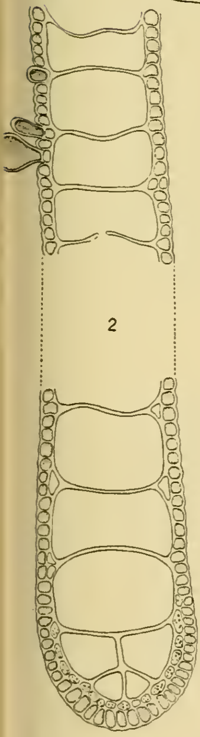

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PLATE 35

Punctaria occidentalis S. and G.

Fig. 6. Cross-section of a frond showing the character of the cells, the character and position of the zoosporangia, and two groups of hairs. × 250.

Dictyota flabellata (Collins) S. and G.

Fig. 7. Cross-section through a group of oogonia. × 125.

Halorhipis Winstonii (Anderson) Saunders

Fig. 8. Cross-section showing groups of hairs and superficial zoosporangia. × 125.

Taonia Lennebackerae Farlow

Fig. 9. Cross-section of a frond showing its structure and the position of the oogonia. × 125.

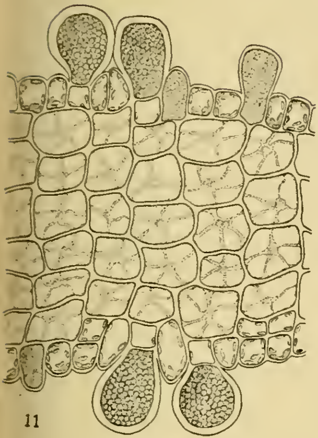
Fig. 10. Surface view. × 65.

Neurocarpus zonarioides (Farlow) Howe

Fig. 11. Cross-section showing the characters of the cells. × 200.

Myrionema strangulans Grev.

Fig. 12. A portion of the margin of the basal disk of cells showing the method of cell division and branching of the filaments. × 125.



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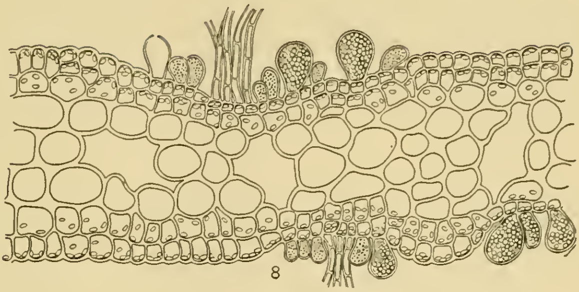

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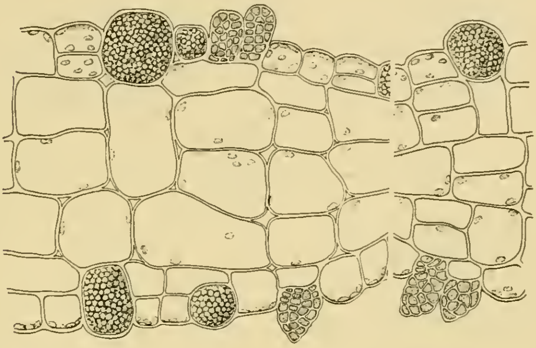

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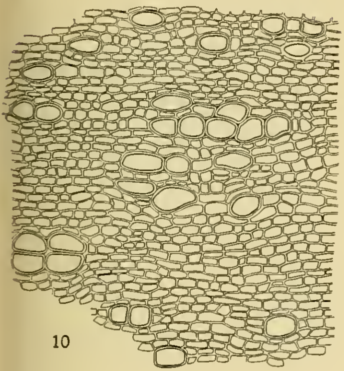

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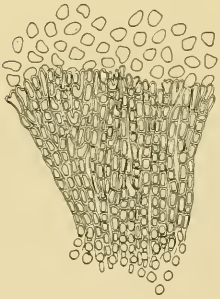

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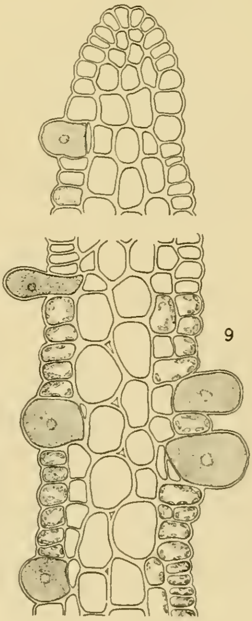

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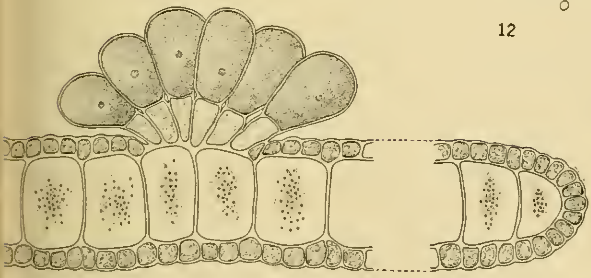

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PLATE 36

Dictyota flabellata (Collins) S. and G.

Fig. 13. A group of mature hairs. × 125.

Fig. 14. Young plants growing in position from tetrasporangia before division. × 125.

Fig. 15. Same as fig. 14, further advanced. × 125.

Fig. 16. Cross-section of a frond showing the early stage in the development of hairs and young tetrasporangia. × 125.

Fig. 17. A mature tetrasporangium. × 125.

Heterochordaria abietina (Rupr.) S. and G.

Fig. 18. Portion of a cross-section of a frond showing zoosporangia, paraphyses, and hairs. × 250.

Fig. 19. A group of gametangia as seen in cross section. × 250.

Zonaria Farlowii S. and G.

Fig. 20. A longitudinal section at the margins (*a*) and through a young sorus (*b*). × 125.

Neurocarpus zonarioides (Farlow) Howe

Fig. 21. Habit sketch of a portion of a frond showing the distribution of the sori along the mid-rib. × 2.

Ralfsia californica S. and G.

Fig. 22. Section perpendicular to the surface of a frond showing the character of the basal cells, and zoosporangia and paraphyses in various stages of development. × 125.

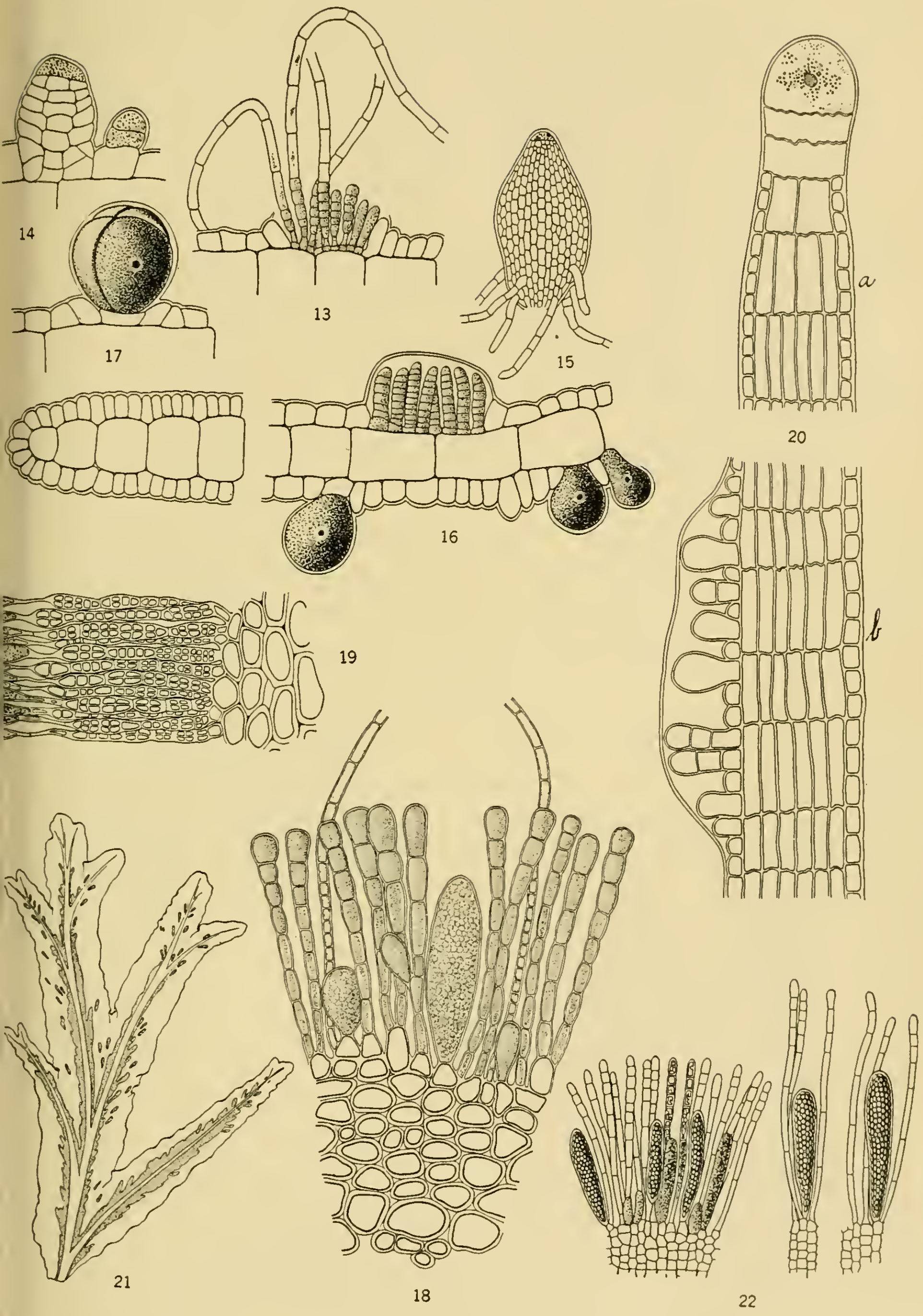
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PLATE 37

Sphacelaria californica Sauv.

Fig. 23. Habit sketch showing the method of branching. × 10.

Fig. 24. Cross-section in the mature part. × 125.

Fig. 25. End view of a frond. × 125.

× 125.

Fig. 26. Portion of the main frond and a branch with one propagulum.

Fig. 27. A branch with a terminal zoosporangium. × 125.

Sphacelaria subfusca S. and G.

Fig. 28. A terminal branch with propagula and a free propagulum. × 125.

Sphacelaria furcigera Kuetz.

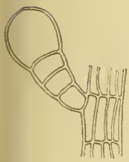
Fig. 29. Terminal portion of a ramulus with a short hair and two propagula. × 125.

Punctaria hesperia S. and G.

Fig. 30. Habit sketch. × 1.

Pylaiella littoralis f.

Fig. 32. Fruiting ends of ramuli showing opposite branching and intercalary zoosporangia. × 125.



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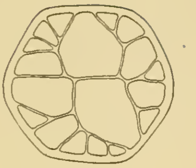

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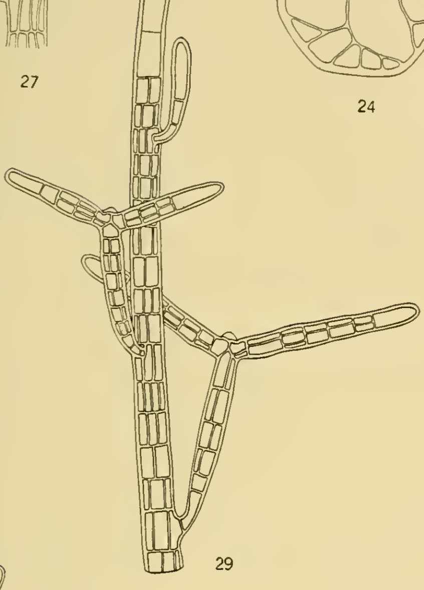

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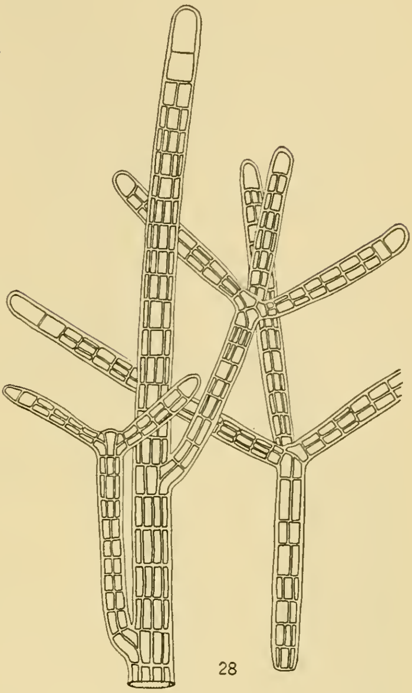

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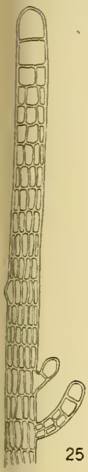

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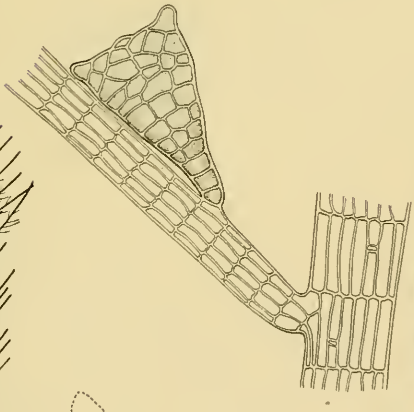

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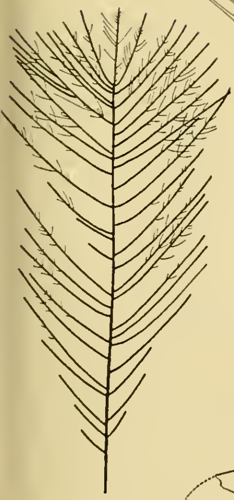

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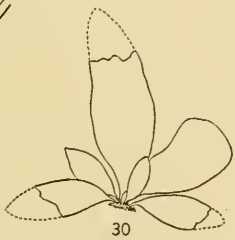

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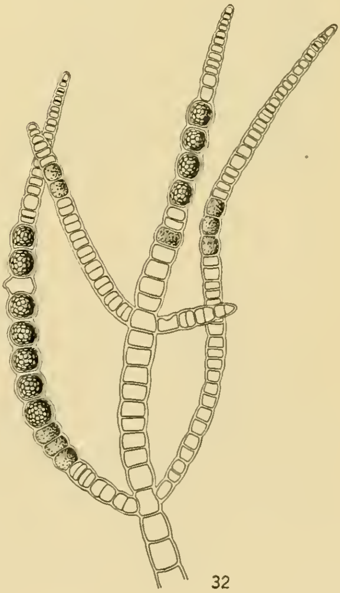

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PLATE 38

Elachistea fucicola (Velley) Aresch.

Fig. 33. Habit sketch showing the relative size of the solid basal portion to the free filaments. × 8.

Fig. 34. A portion of the fruiting region showing zoosporangia, paraphyses, and the base of one of the assimilating filaments. × 125.

Fig. 35. A few cells of the basal, widest, and apical portions of an assimilating filament. × 125.

Phaeostrophion irregulare S. and G.

Fig. 36. Cross-section of a mature frond. × 250.

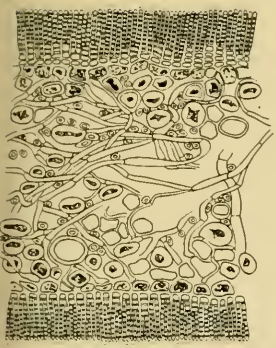
Endarachne Binghamiae J. Ag.

Fig. 37. Cross-section. × 125.

Fig. 38. Fascicle of hairs and a group of cells in surface view. × 125.

Neurocarpus zonarioides (Farlow) Howe

Fig. 39. Group of hairs. × 200.



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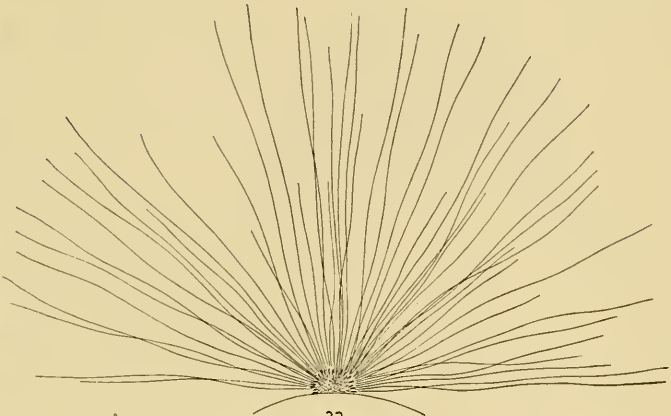

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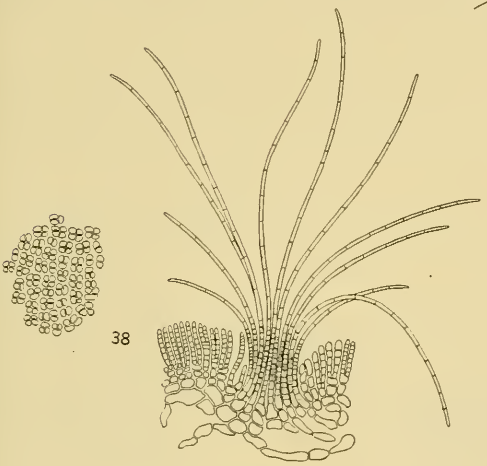

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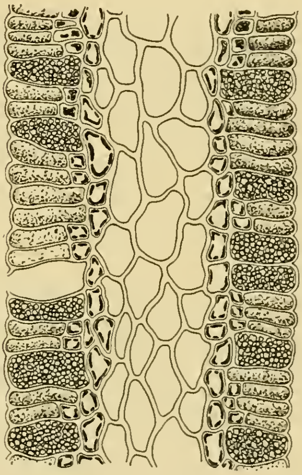

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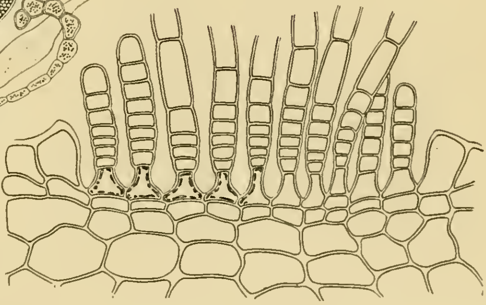

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PLATE 39

Soranthera ulvoidea f. *typica* S. and G.

Fig. 40. Section through a sorus showing zoosporangia, paraphyses, and hairs. × 250.

Fig. 41. Section through a sorus. × 75.

Petrospongium rugosum (Okamura) S. and G.

Fig. 42. A few filaments, perpendicular to the surface, showing method of branching, character of the cells, rhizoidal filaments, and zoosporangia. × 125.

Fig. 43. Habit sketch. × 0.5.

Chordaria flagelliformis f. *typica* Kjellm.

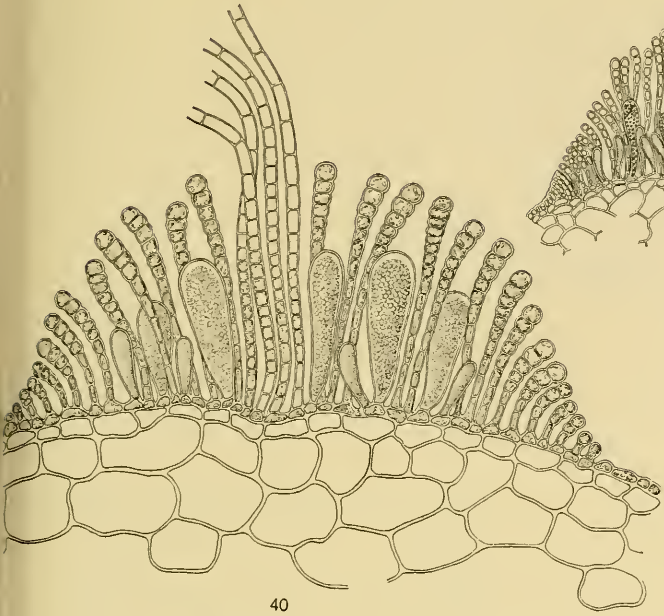
Fig. 44. Portion of a section showing hairs, paraphyses, and characters of the cells. × 250.

Scytosiphon Lomentaria f. *typicus* S. and G.

Fig. 45. Porton of section with gametangia and one paraphysis (?). × 250.

Sargassum Agardhianum Farlow

Fig. 46. A segment of the frond showing the character of a leaf, vesicles, and receptacles. × 2.5.



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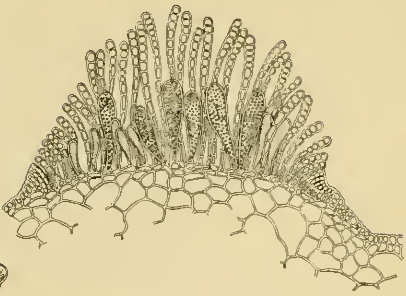

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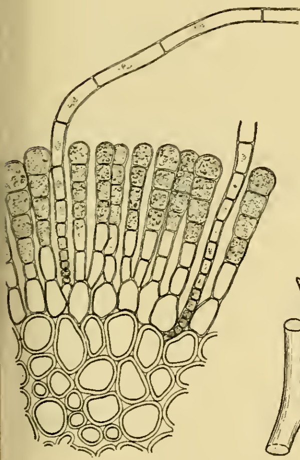

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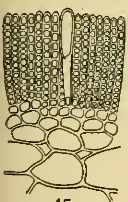

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42

PLATE 40

Dictyosiphon foeniculaceus (Huds.) Grev.

Fig. 47. Habit sketch of a terminal portion of a frond. × 2.

Fig. 48. Tip of a branch showing the character of the surface and hairs. × 125.

Fig. 49. Portion of a cross-section of a frond showing the character of the cells, the base of a hair, and a zoosporangium. × 250.

Myelophycus intestinalis f. *tenue* S. and G.

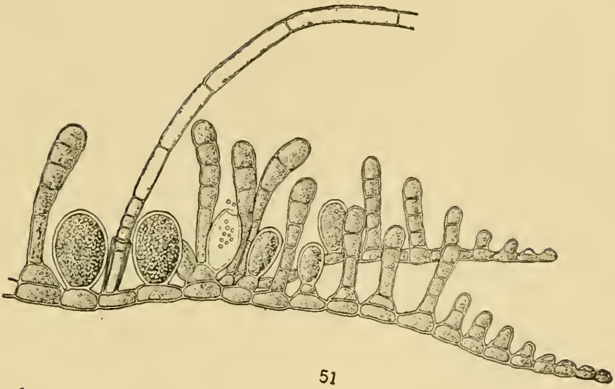
Fig. 50. Cross section of a frond showing zoosporangia and paraphyses. × 250.

Myrionema strangulans Grev.

Fig. 51. Basal filaments bearing erect filaments and zoosporangia. × 250.

Leathesia difformis (L.) Aresch.

Fig. 52. A few surface filaments showing a hair, gametangia and "paraphyses," with large terminal cells filled with chromatophores. × 250.



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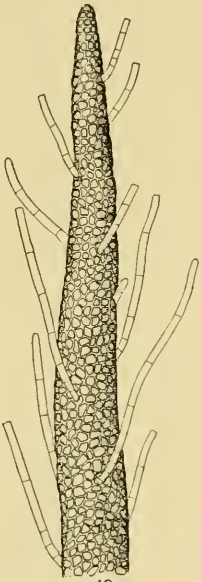

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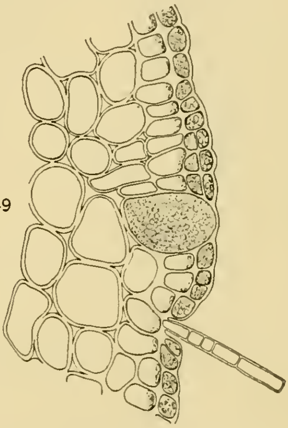

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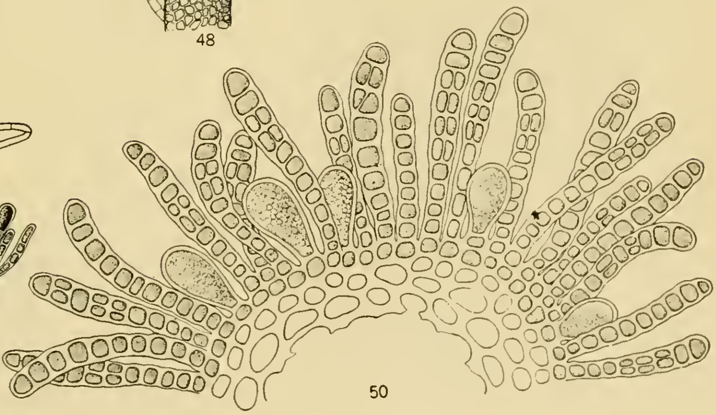

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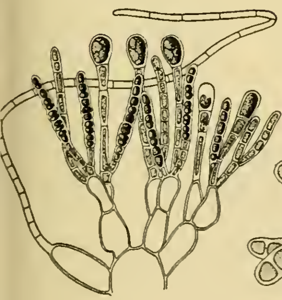


52

PLATE 41

Streblonema pacificum Saunders

Fig. 53. Plants in various stage of development creeping among the sporangia of the host, with gametangia projecting beyond the host. × 250.

Hapterophycus canaliculatus S. and G.

Fig. 54. Section of the thallus through a cryptostoma highly magnified.

Sargassum Agardhianum Farlow

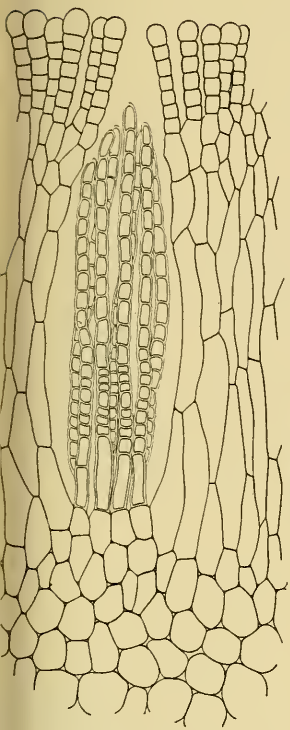
Fig. 55. Habit sketch of the end of a branch. × 1.

Sargassum Palmeri Grunow.

Fig. 56. Piece of a frond bearing a dissected leaf, a vesicle, and a group of receptacles. × 1.5.

Chordaria dissessa S. and G.

Fig. 57. Section perpendicular to the surface showing the character of the cells, hairs, paraphyses, and zoosporangia. × 125.



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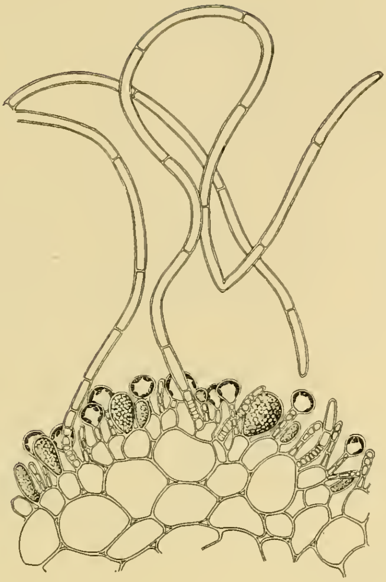

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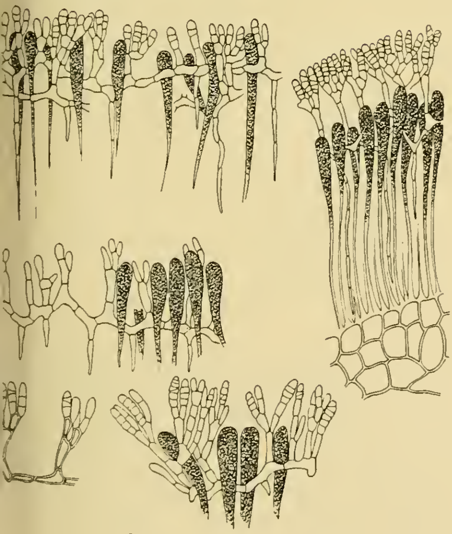

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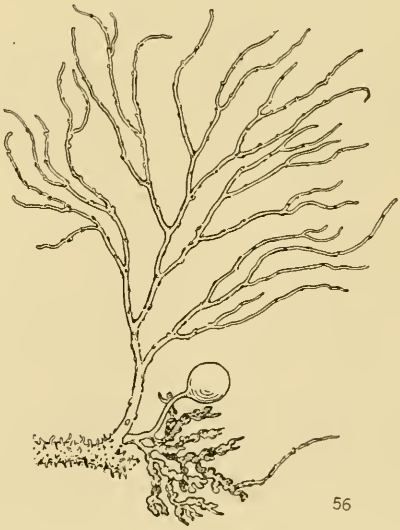


56

PLATE 42

Gobia simplex (Saunders) S. and G.

Fig. 58. View of internal filaments extending longitudinally and a group of surface filaments showing hairs, paraphyses, and zoosporangia. × 250.

Ægira virescens (Carm.) S. and G.

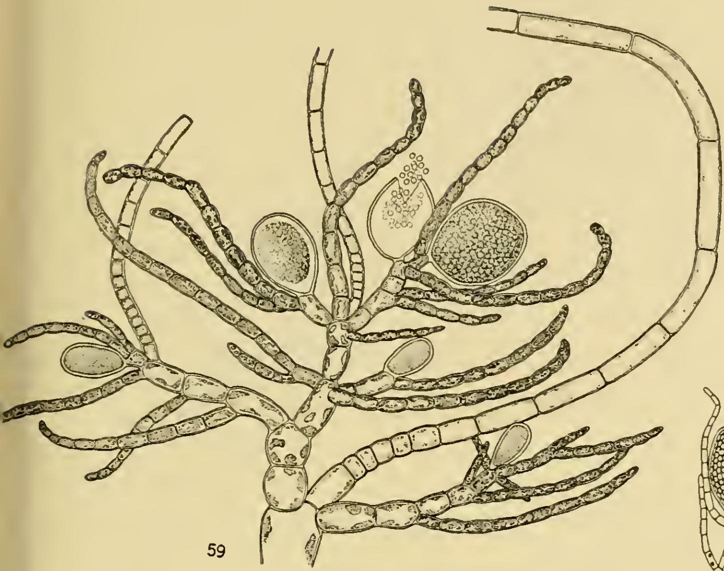
Fig. 59. Surface filaments bearing zoosporangia and hairs. × 250.

Fig. 60. Surface filaments bearing a hair and zoosporangia. × 125.

Scytosiphon Lomentaria f. *cylindricus maculatus* S. and G.

Fig. 61. Longitudinal section of a part of a frond showing the characters of the interior and the surface cells. Not fruiting. × 250.

Fig. 62. Cross-section of a portion of a frond showing the characters of the cells, paraphyses, and gametangia in various stages of development. × 250.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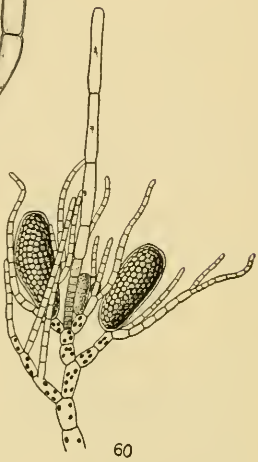
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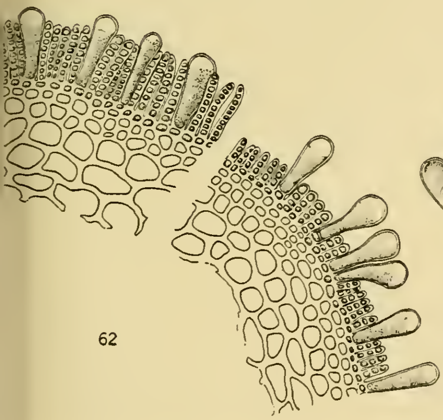
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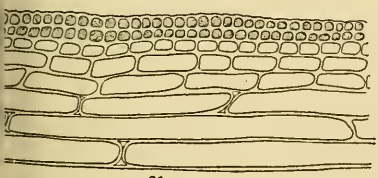
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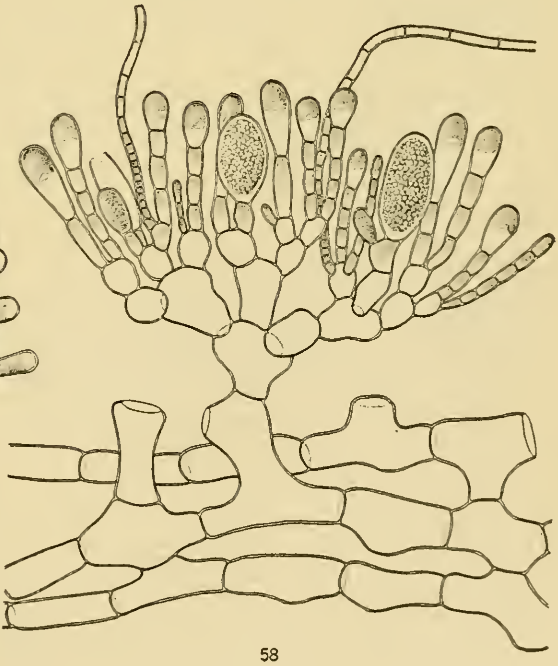
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PLATE 43

Zonaria Farlowii S. and G.

Fig. 63. Habit sketch indicating parallel and radiating lines of cells. Diagrammatic.

Leathesia amplissima S. and G.

Fig. 64. Section perpendicular to the surface of the frond showing the characters of the cells, hairs, paraphyses, and zoosporangia. × 250.

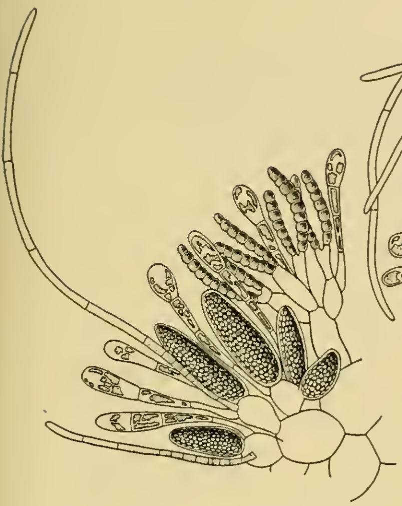
Leathesia difformis (L.) Aresch.

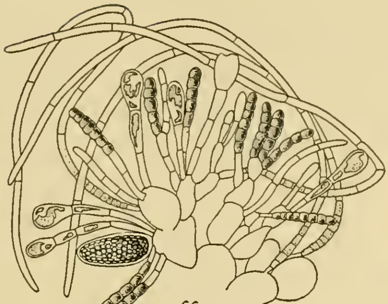
Fig. 65. Section perpendicular to the surface of the frond showing the characters of the cells, hairs, paraphyses, and gametangia. × 250.

Fig. 66. Section perpendicular to the surface of the frond showing the character of the cells, zoosporangia, gametangia, hairs, and paraphyses × 250.

Leathesia nana S. and G.

Fig. 67. Section through the frond perpendicular to the surface showing the character of a few filaments bearing hairs, gametangia, and paraphyses. × 125.





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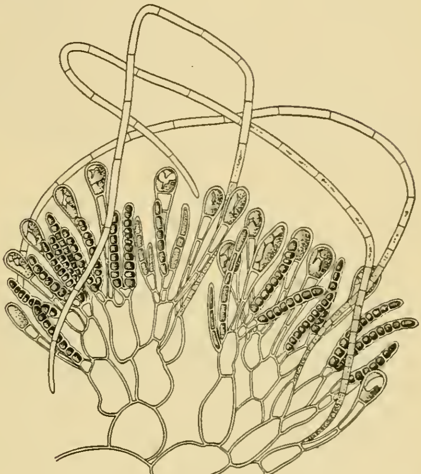

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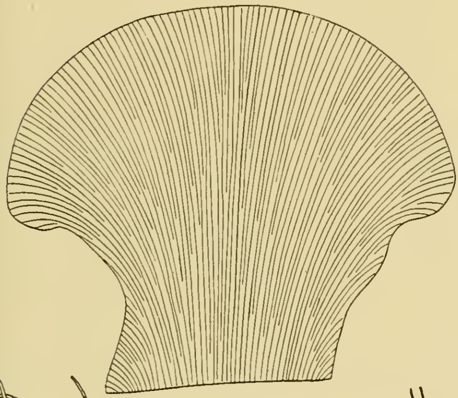

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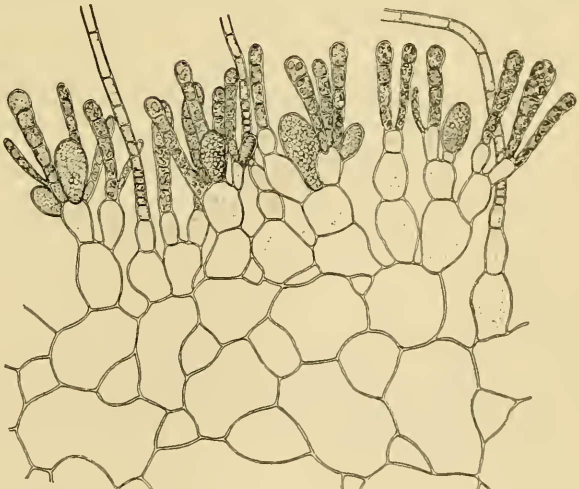

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PLATE 44

Ilea Fascia f.

Fig. 68. Cross-section of a frond at the edge showing gametangia in continuous sori. × 190.

Ilea Fascia f.

Fig. 69. Cross-section of a portion of a frond through several sori on both sides. × 100.

Ilea Fascia f.

Fig. 70. Cross-section through a portion of a frond showing gametangia and paraphyses (?). × 500.

Ilea Fascia f.

Fig. 71. Cross-section of a portion of a frond showing mature gametangia and paraphyses (?). × 125.

Scytosiphon Lomentaria (Lyngb.) J. Ag.

Fig. 72. Cross-section through different parts of the frond: near the base; farther up; mature gametangia. × 125.

Ilea Fascia f.

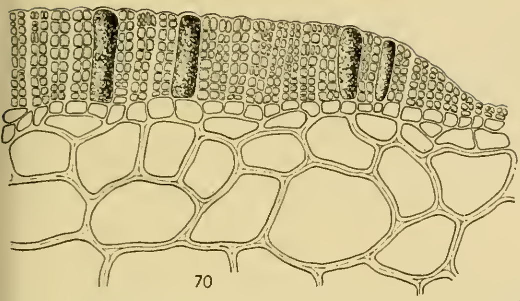
Fig. 73. Cross-section through gametangia in sori on both sides. × 125.

Scytosiphon Lomentaria f. *complanatus minor* S. and G.

Fig. 74. Cross-section through the margin showing short filaments extending into the cavity and a sorus of gametangia extending around the margin. × 125.

Scytosiphon Lomentaria f. *typicus* S. and G.

Fig. 75. Cross-section showing the character of the cells, gametangia, hairs, and paraphyses (?). × 250.



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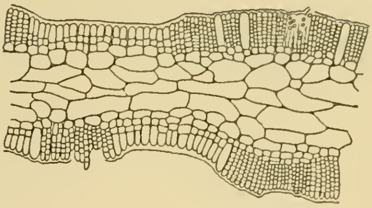

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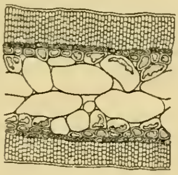

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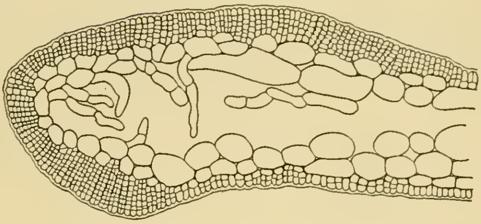

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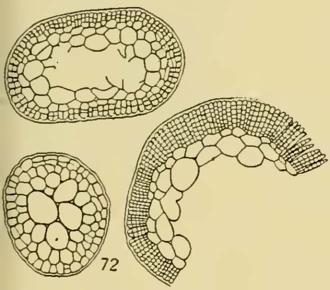

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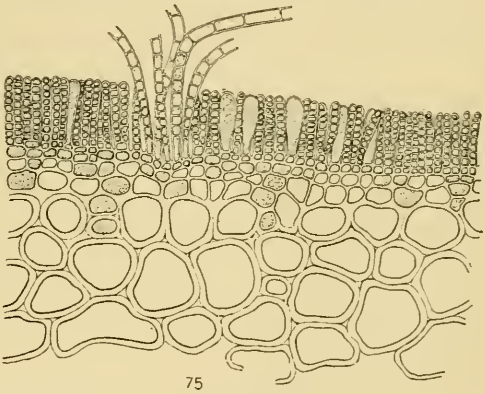

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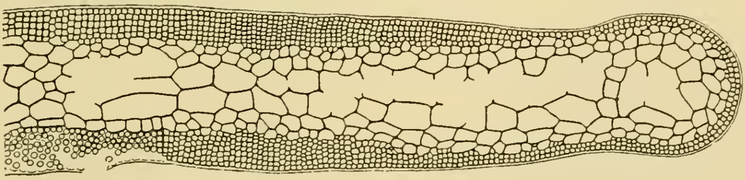

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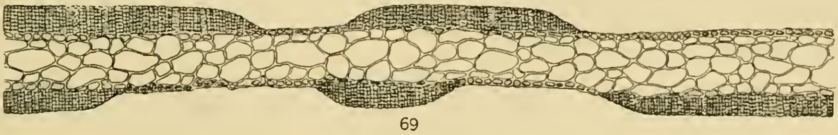

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PLATE 45

Coilodesme rigida S. and G.

Fig. 76. Section perpendicular to the surface of the frond. × 125.

Coilodesme bulligera Stroemf.

Fig. 77. Surface view. × 250.

Fig. 78. Cross-section. × 250.

Punctaria chartacea S. and G.

Fig. 79. Cross-section of a sterile frond. × 250.

Sargassum Liebmanni J. Ag.

Fig. 81. A segment showing the character of the stem, leaves, fruit, and vesicles. × 2.

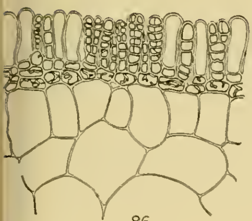
Colpomenia sinuosa f.

Figs. 82, 83. Cross-section showing unusually long gametangia. × 250.

Fig. 84. Cross-sections. × 250.

Fig. 85. Cross-section showing paraphyses and enlarged at outer end. × 250.

Fig. 86. Cross-section showing some gametangia divided. × 250.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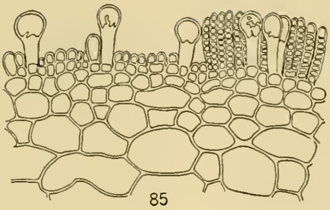
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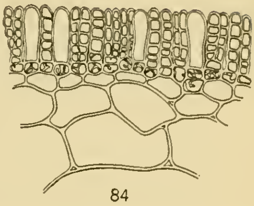
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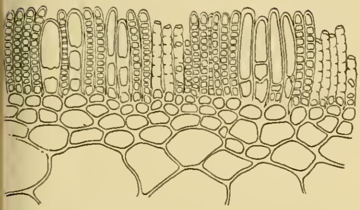
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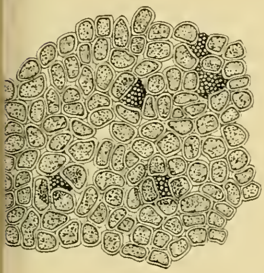
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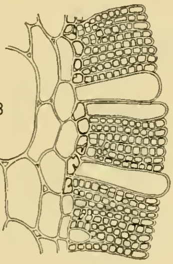

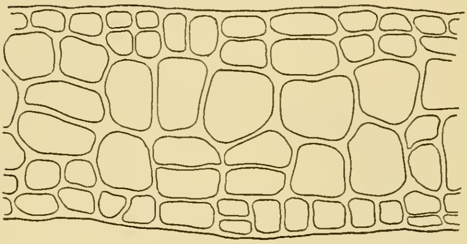
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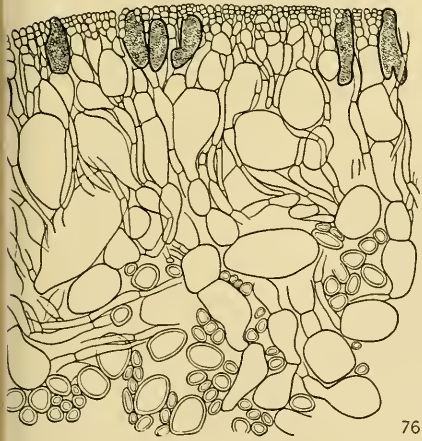
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PLATE 46

Coilodesme californica (Rupr.) Kjellm.

Fig. 1. Surface view. × 250.

Fig. 2. Cross-section. × 250.

Coilodesme corrugata S. and G.

Fig. 3. Surface view. × 250.

Fig. 4. Cross-section. × 250.

Sargassum paniculatum J. Ag.

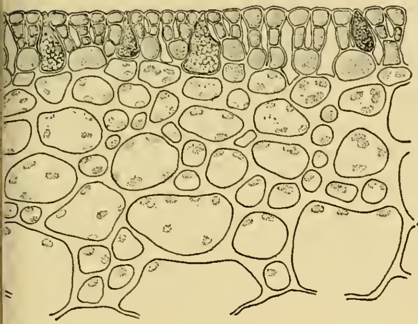
Fig. 5. Segment showing the characters of the stem, leaves, receptacles, and vesicles. × 1.5.

Pelvetiopsis limitata f. *typica* Gardner

Fig. 6. Diagrammatic section through a conceptacle. Stained.

Ectocarpus confervoides f. *variabilis* Saunders

Fig. 7. Ramulus showing gametangia and zoosporangia (?). × 250.



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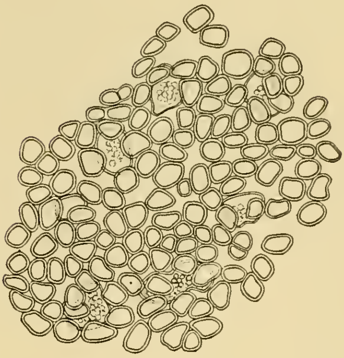

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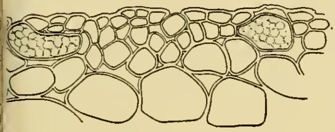

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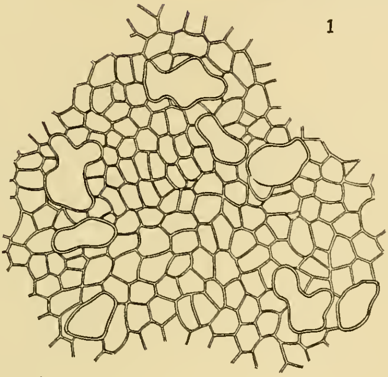

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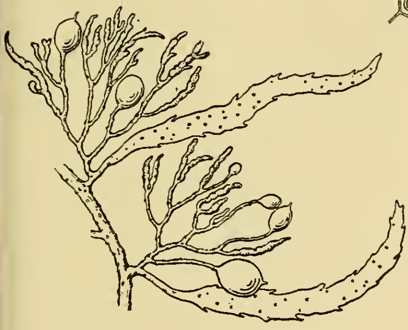

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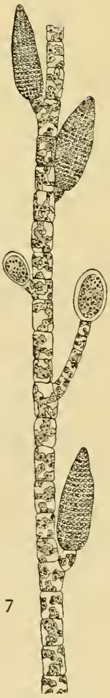

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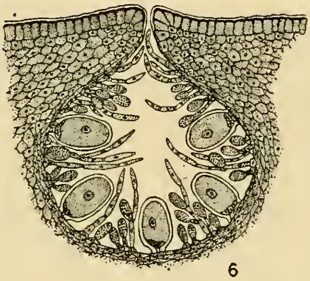

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PLATE 47

Myriogloia Andersonii (Farlow) Kuckuck.

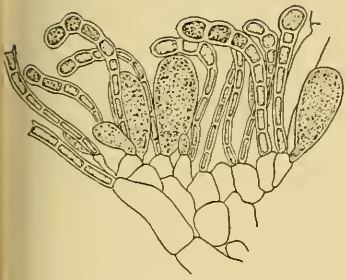
Fig. 8. Habit sketch of the tip of a frond, highly magnified.

Fig. 9. Young, colorless filaments giving rise to young cortical filaments and an assimilating hair. Highly magnified.

Fig. 10. Segment of the surface showing zoosporangia and clavate paraphyses. × 375.

Meneghiniella Brandegeei S. and G.

Fig. 11. Fascicle of gametangia, highly magnified.



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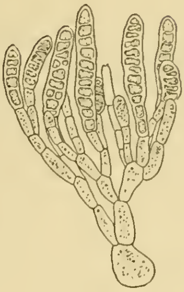

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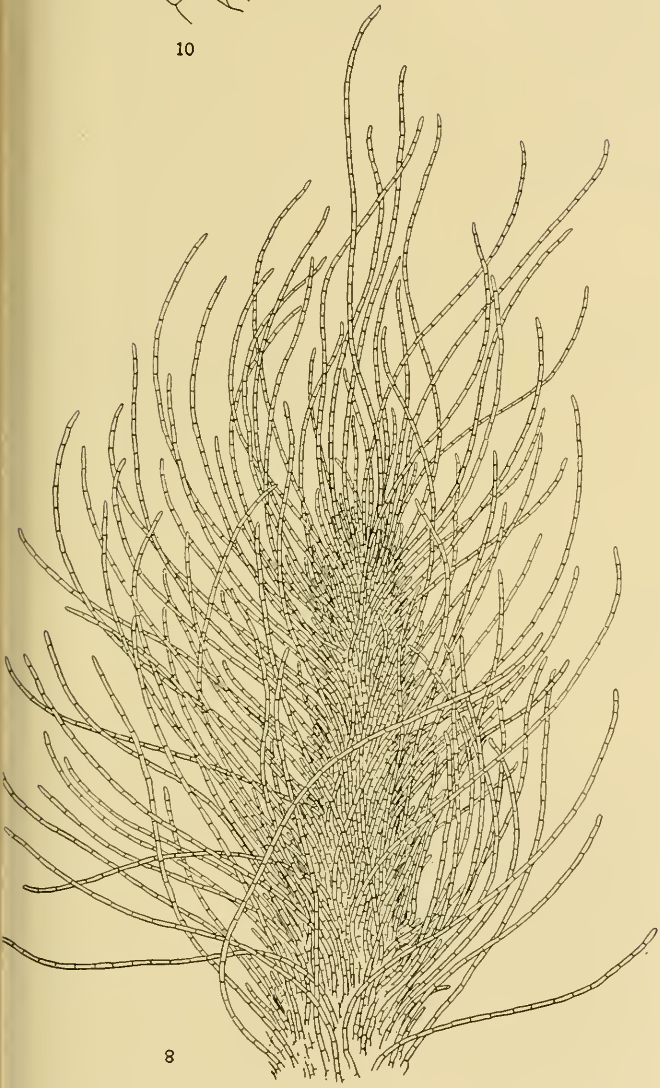

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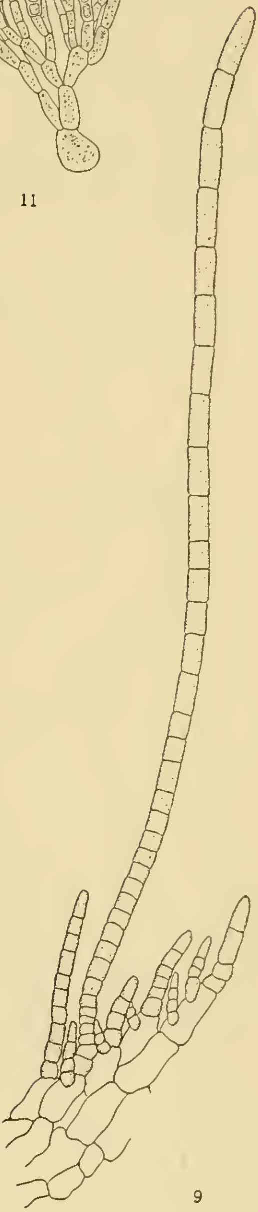

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PLATE 48

Myriogloia Andersonii (Farlow) Kuckuck.

Figs. 12, 13, 14. Segments of the surface of three different collections showing variations in shapes and sizes of the different parts. × 375.

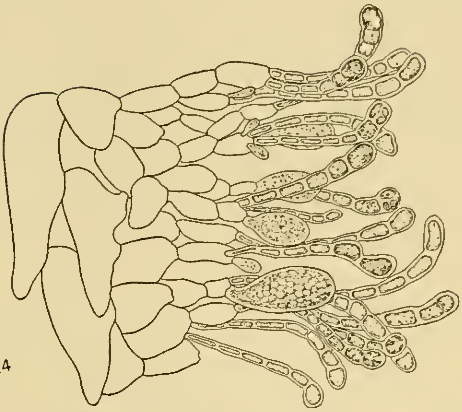

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PLATE 49

Ectocarpus Parksii S. and G.

Fig. 15. Portions of a frond taken at different levels. × 250.

Meneghiniella Brandegeei S. and G.

Fig. 16. Portion of the surface of a frond showing cortical assimilating filaments and gametangia. Highly magnified.

Myriogloia Andersonii (Farlow) Kuckuck.

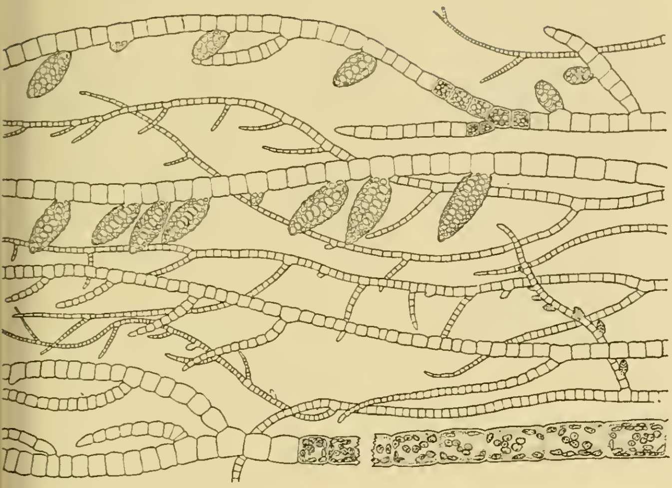
Fig. 17. Segment of the surface of a filament showing stipitate zoosporangia and irregularly clavate, uncinate assimilating filaments. × 375.

Punctaria hesperia S. and G.

Fig. 18. Sections of a sterile, and of a fruiting frond, respectively showing protruding conical gametangia. × 250.

Punctaria expansa S. and G.

Fig. 19. Section showing gametangia and hairs. × 250.



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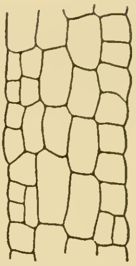

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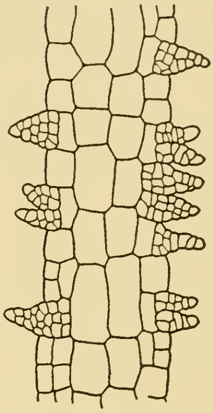

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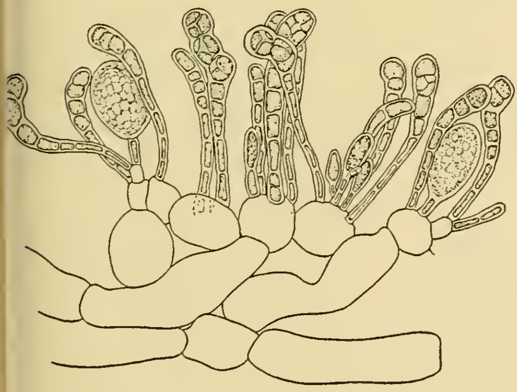

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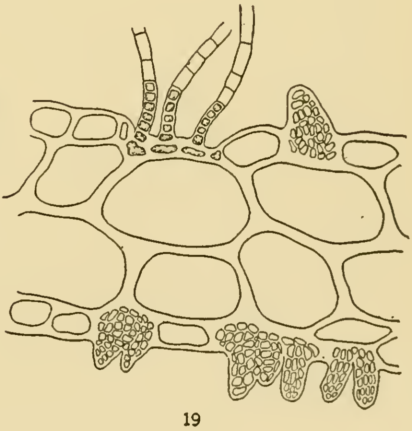

19

PLATE 50

Chlanidophora abyssicola S. and G.

Fig. 1. Two specimens of mature plants. Natural size.

Fig. 2. Young aplanosporangium in the distromatic portion of the frond. The two small cells below represent cross-sections of hairs.

Fig. 3. Cross-section showing three mature aplanosporangia with numerous aplanospores and two paraphyses.

Fig. 4. Surface view of a portion of the growing margins of a frond showing the method of cell division.

Fig. 5. Portions of four cross-sections showing the character of the cells in different parts of the frond. The upper is the younger, near the growing margin. The others are successively older toward the base.

Fig. 6. Longitudinal section through the margins.

Fig. 7. Longitudinal section in the older part of the frond showing the origin and prostrate position of hairs. Figures 2–7. × 250.

Phaeostrophion irregulare S. and G.

Fig. 8. Cross-section of the frond with zoosporangia. × 250.

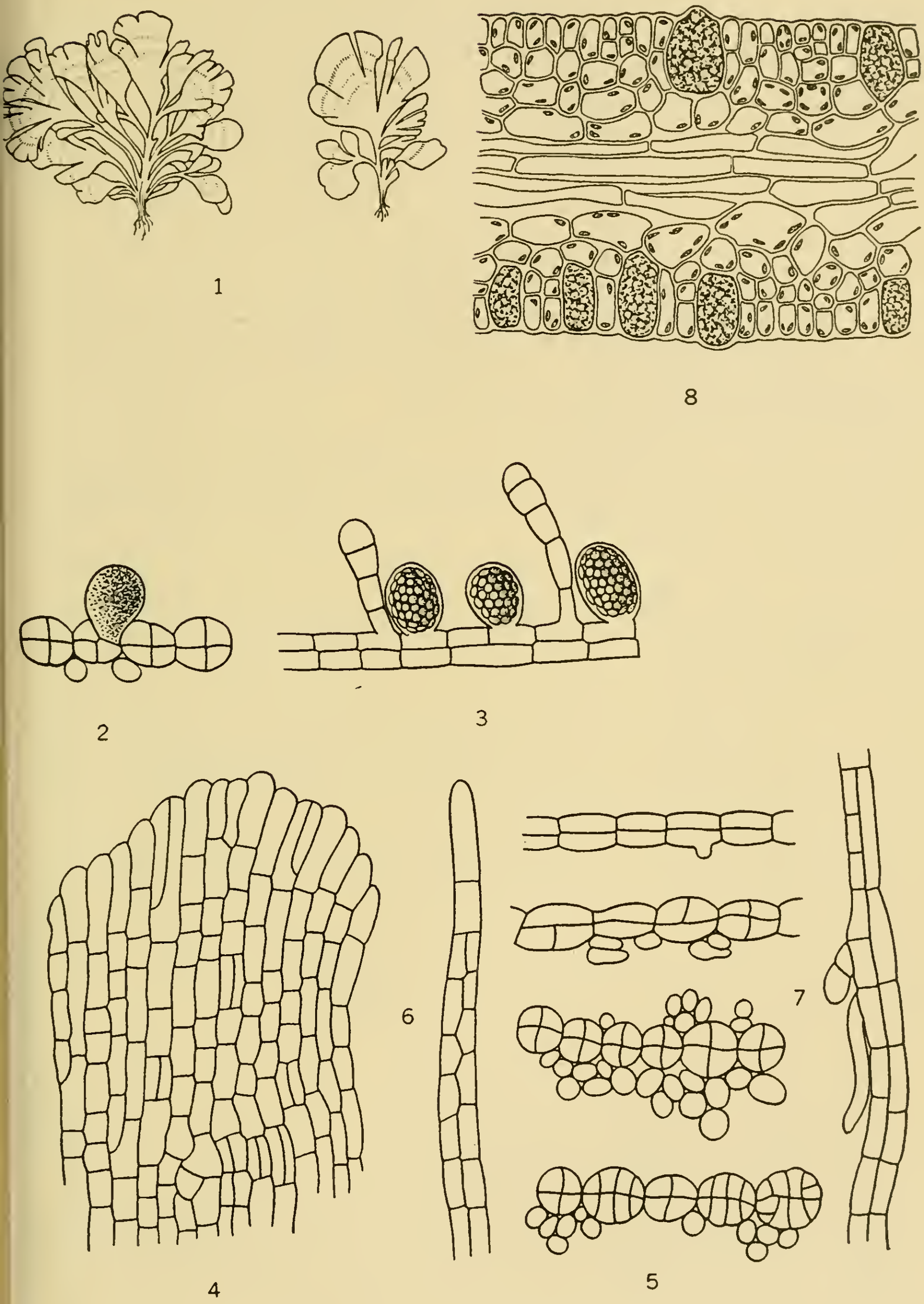
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PLATE 51

Ectocarpus socialis S. and G.

Fig. 12. Small group of plants showing rhizoids, a few cells with chromatophores, and the positions and shapes of the zoosporangia. $\times$ 125.

Fig. 13. Selection of parts of filaments showing the positions and relative shapes and sizes of the gametangia. $\times$ 125.

Ectocarpus cylindricus f. *codiophilus* S. and G.

Fig. 14. Group of young plants showing both zoosporangia and gametangia, the two parts of ramuli on the left representing these organs on the same plant. $\times$ 60.

Ectocarpus Taoniae S. and G.

Fig. 15. Portion of a creeping filament showing erect filaments and the positions and relative shapes and sizes of the gametangia on both the creeping and the erect filaments. $\times$ 250.

Ectocarpus affinis S. and G.

Fig. 16. Diagrammatic representation of a small group of plants on their host.

Fig. 17. Portions of filaments illustrating positions, relative shapes and sizes of gametangia. $\times$ 225.

This plate is a reprint of Setchell and Gardner, Univ. Calif. Publ. Bot., vol. 7, p. 420, pl. 46, 1922.

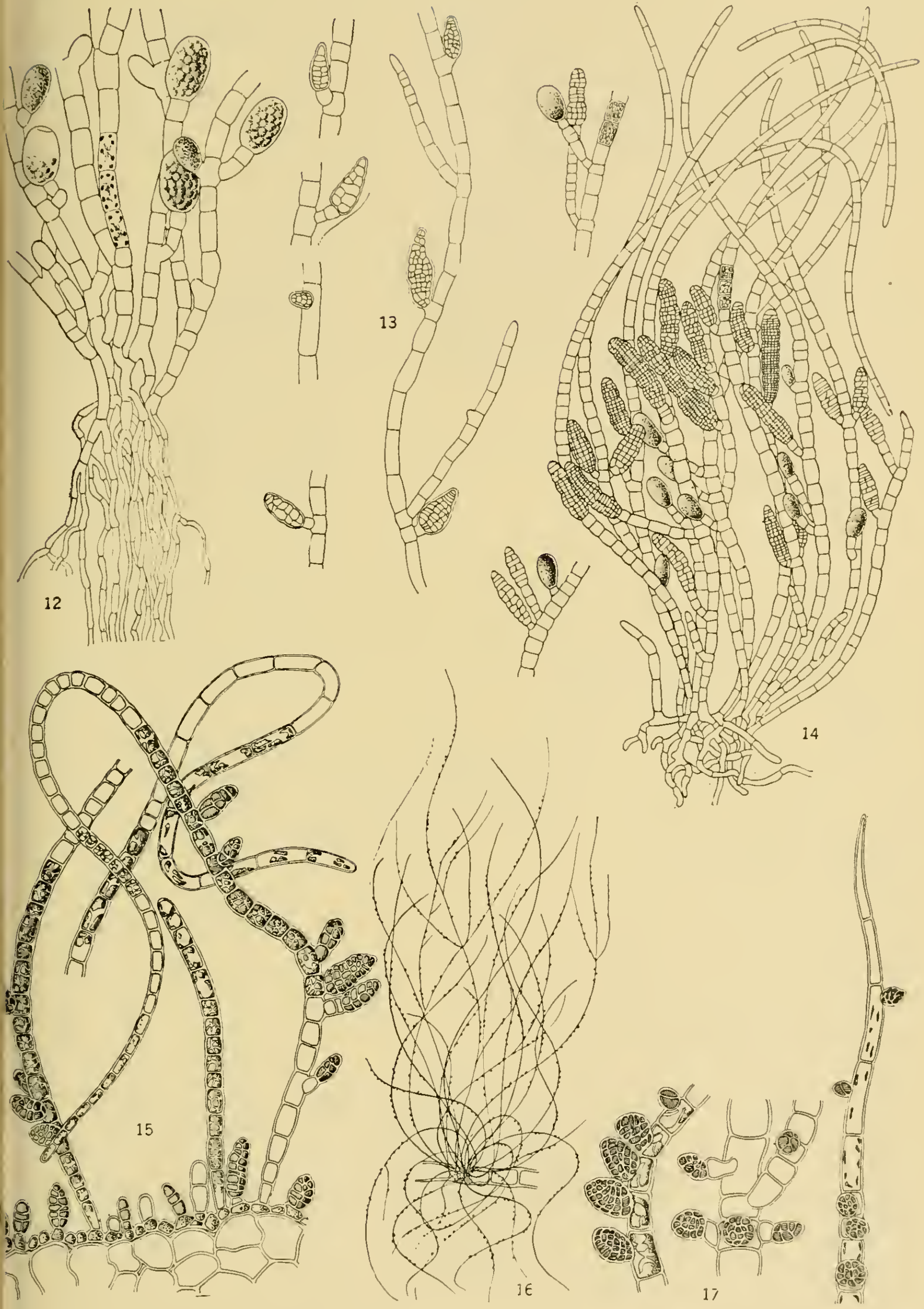

PLATE 52

Streblonema anomalum S. and G.

Fig. 1. Part of a plant freed from its host bearing gametangia. × 250.

Figs. 2, 3. Fragments of plants bearing zoosporangia, some of which contain mature zoospores. The cells of the main filaments are divided longitudinally. × 250.

Streblonema Johnstonae S. and G.

Fig. 4. Parts of plants showing characteristic creeping and erect filaments and gametangia. × 125.

Streblonema rugosum S. and G.

Fig. 5. Section through the host perpendicular to its surface, showing the papillate character caused by the presence of *Streblonema*. Diagrammatic.

Fig. 6. Surface view of figure 5. Diagrammatic.

Fig. 7. Section showing the structure of the *Streblonema* plants and their relation to the host. × 250.

Streblonema corymbiferum S. and G.

Fig. 8. Fragments of typical plants freed from their host. × 250.

This plate is a reprint of Setchell and Gardner, Univ. Calif. Publ. Bot., vol. 7, p. 400, pl. 43, 1922.

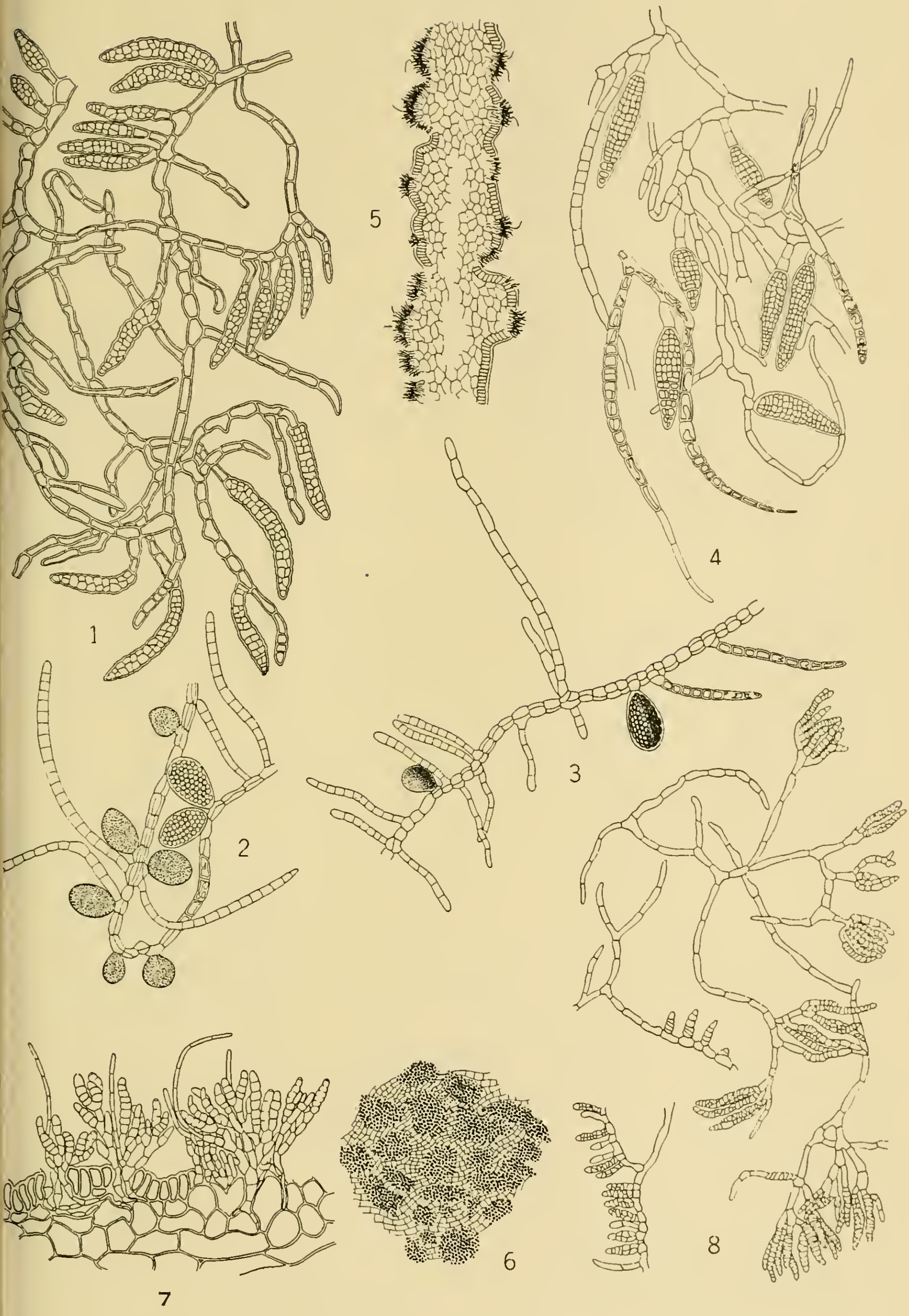
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PLATE 53

Hecatonema clavatum S. and G.

Fig. 1. Section through a typical mature plant showing penetrating rhizoids from the basal layer, the lcavate, sterile, erect filaments, and typical gametangia. × 250.

Fig. 2. Same as figure 1, but showing "ascocysts." × 250.

Fig. 3. Small fragment without rhizoids. × 125.

Fig. 4. Segment of the base at its margin. × 250.

Hecatonema Lawsonii S. and G.

Fig. 5. Two segments of the base showing frequent radial divisions of the cells. × 250.

Fig. 6. Young plant before any erect filaments have begun to develop. × 250.

Fig. 7. Typical gametangia and true hairs. × 250.

This plate is a reprint of Setchell and Gardner, Univ. Calif. Publ. Bot., vol. 7, p. 382, pl. 40, 1922.

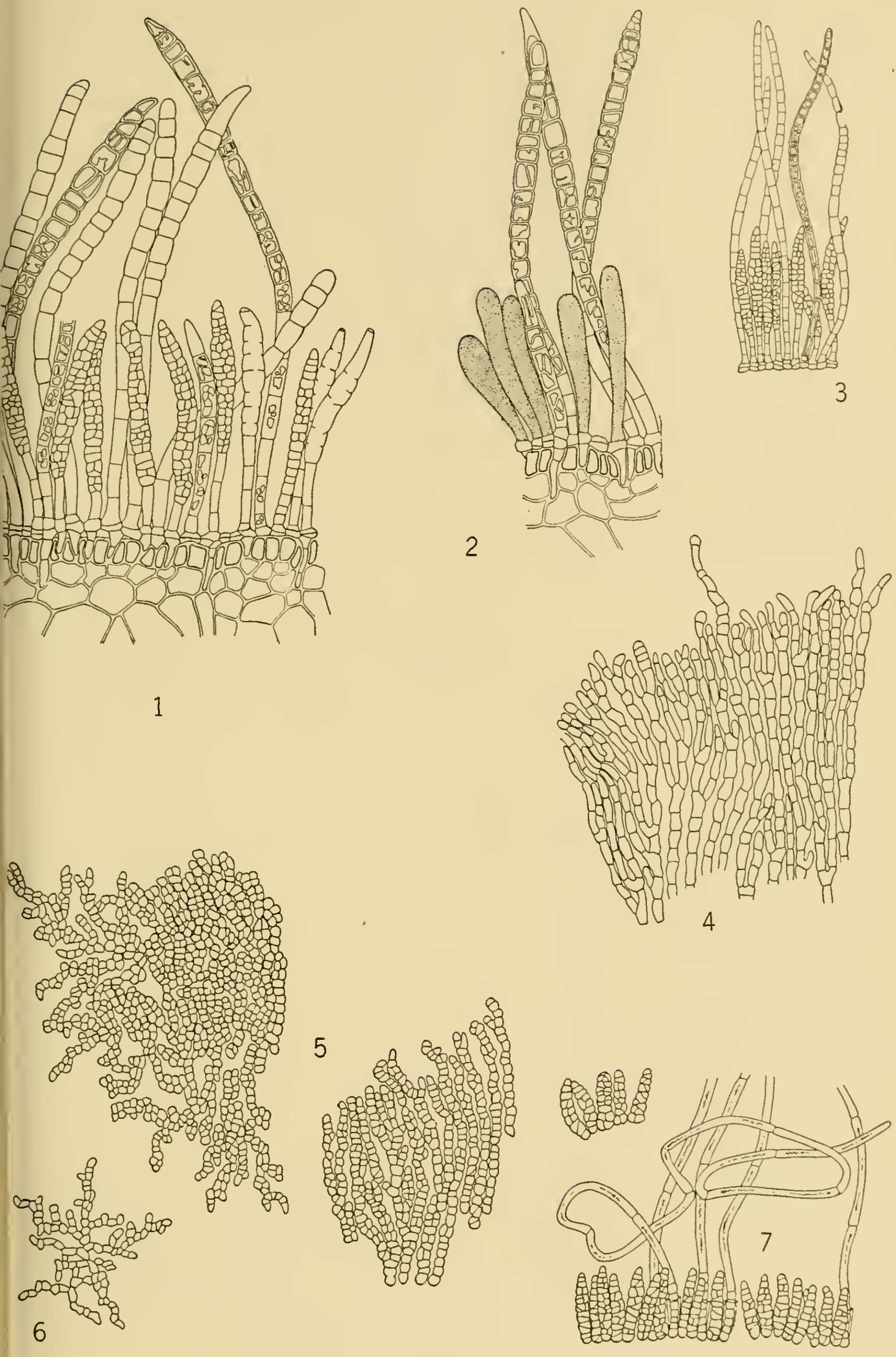
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PLATE 54

Compsonema secundum S. and G.

Fig. 1. Three fragments of plants showing small gametangia on short pedicels from a basal filament and complex terminal gametangia with mostly secund lateral developments. × 125.

Fig. 2. Fragment of a plant showing a modification in which the gametangia are mostly terminal and erect, and only rarely possessing lateral protuberances. × 125.

Compsonema pusillum S. and G.

Fig. 3. Three fragments of plants showing shapes and positions of zoosporangia and gametangia. Character of the creeping and of the erect filaments, and a few branches pushing between the surface cells of the host. × 125.

Compsonema secundum f. *terminale* S. and G.

Fig. 4. Fragment of a plant showing the characteristic terminal and large lateral gametangia. × 125.

Fig. 5. Filament which seems to be producing zoosporangia below an empty gametangium. × 125.

Compsonema tenue S. and G.

Fig. 6. Fragments of plants showing erect filaments, true hairs, and zoosporangia (?) and gametangia sessile on the creeping filaments. × 250.

This plate is a reprint of Setchell and Gardner, Univ. Calif. Publ. Bot., vol. 7, p. 372, pl. 37, 1922.


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PLATE 55

Myrionema minutissimum S. and G.

Fig. 1. Two groups of gametangia, the left, younger, and the right, older. × 125.

Fig. 2. Segment of the base showing the typical splitting of the terminal cells. × 250.

Fig. 3. Small groups of gametangia showing different lengths of pedicels. × 250.

Myrionema attenuatum f. *doliiforme* S. and G.

Fig. 4. Fragment showing relatively large erect sterile filaments and relatively small and few gametangia. × 250.

Fig. 5. Fragment showing the opposite condition to that of figure 4. × 250.

Myrionema attenuatum S. and G.

Fig. 6. Fragment taken near the margin of the frond. × 250.

Fig. 7. Fragment taken near the center of the frond. × 250.

Myrionema foecundum f. *divergens* S. and G.

Fig. 8. Sections taken from four different places in the frond. × 125.

Fig. 9. Segment of the base at the margin of the frond. × 250.

Myrionema compsonematoides S. and G.

Fig. 10. Section of a characteristic frond showing the erect sterile filaments, gametangia, and "ascocysts." × 125.

Myrionema hecatonematoides S. and G.

Fig. 11. Five fragments showing the nature of the base, the shapes, sizes, and positions of the gametangia, and the erect filaments. × 125.

Myrionema primarium S. and G.

Fig. 12. Section through a typical frond and its host perpendicular to the latter. × 250.

This plate is a reprint of Setchell and Gardner, Univ. Calif. Publ. Bot., vol. 7, p. 352, pl. 34, 1922.

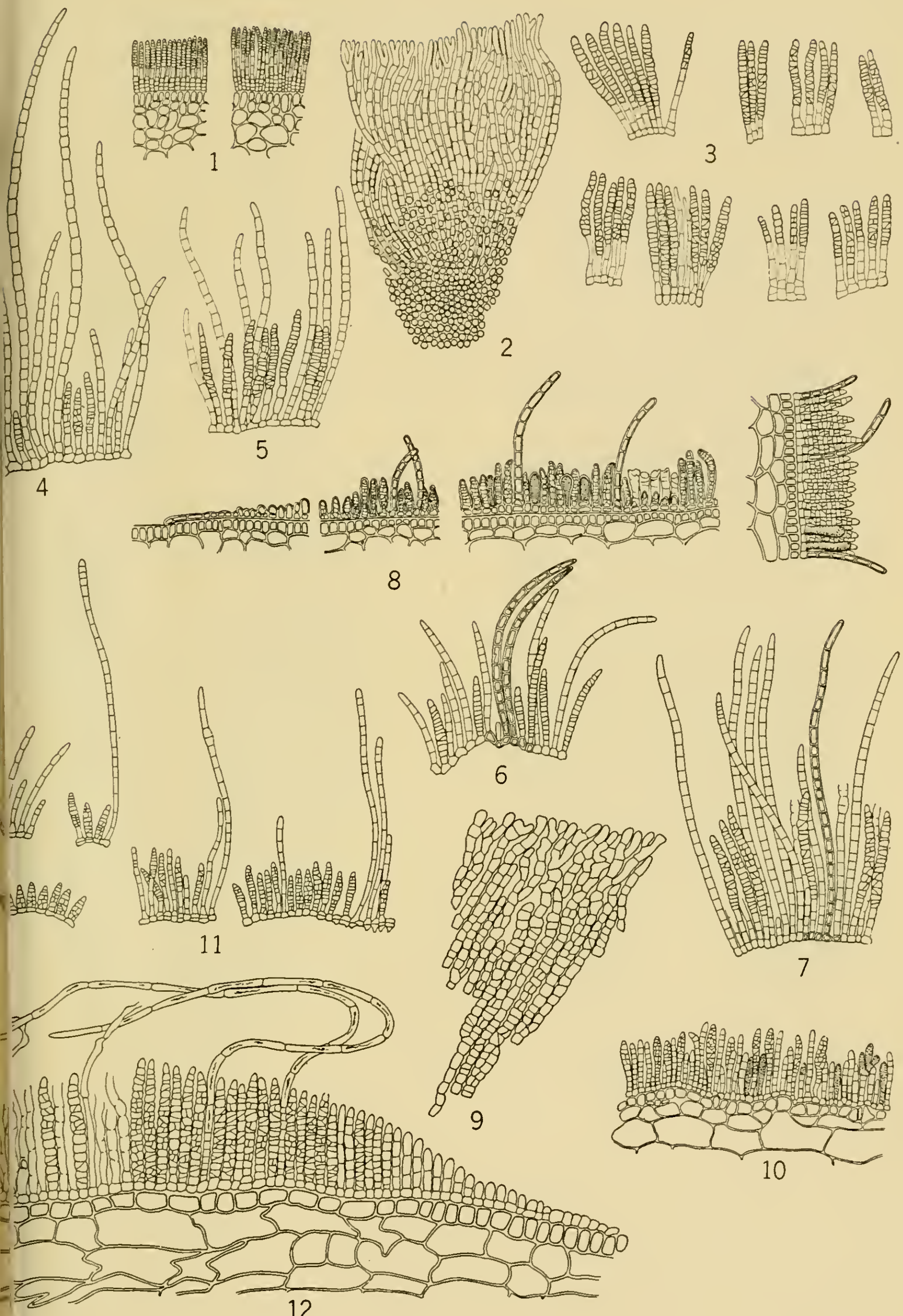
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PLATE 56

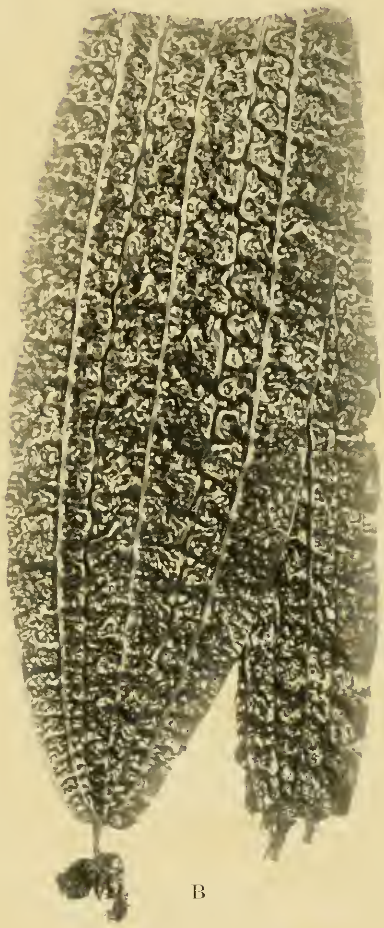
A. *Laminaria Farlowii* Setchell

From a photograph of a plant showing typical bullations, but abnormal as to the deep splitting of the blade.

B. *Costaria costata* (Turn.) Saunders

From a photograph of a typical plant of moderate dimensions.

A



B

PLATE 57

Laminaria complanata (S. and G.) Setchell

From a photograph of a typical plant showing flattened crooked stipe.

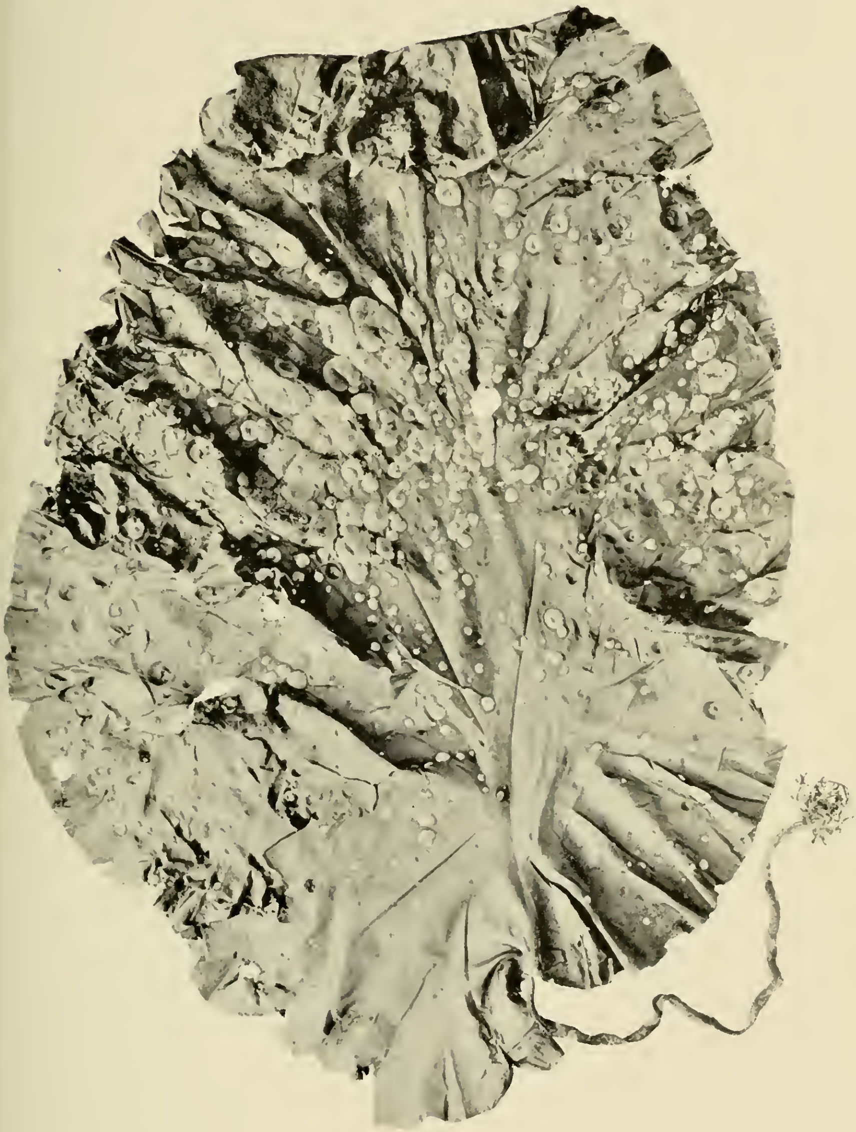


PLATE 58

Laminaria ephemera Setchell

From a photograph of a series of plants to show variation in the splitting of the blade, difference in its width, and character of its base.

PLATE 59

A. *Laminaria cuneifolia* J. Ag.

From a photograph of a plant showing a short flat stipe, cordate base, and a split blade free from bullae.

B. *Laminaria cuneifolia* J. Ag.

From a photograph of a plant with two rows of bullae within the margin, leaving a smooth central strip and showing entire blade.

B

A

PLATE 60

Laminaria cuneifolia J. Ag.

From a photograph of a plant showing a short blade bullate all over.

PLATE 61

Laminaria personata S. and G.

From a photograph of a typical plant with three small specimens at the base.

PLATE 62

Macrocystis integrifolia Bory.

From a photograph of a plant showing the character of the hapteres and flattened "rhizome."

PLATE 63

Agarum cribrosum Bory.

From a photograph of a short, wide specimen showing the distribution and irregular form of the perforations and the very ample scrolls at the base.

PLATE 64

Macrocystis pyrifera (Turner) Ag.

From a photograph of a series of young plants showing early stages in development.

PLATE 65

Macrocystis pyrifera (Turner) Ag.

Representing an early stage in the development in advance of those represented on plate 64.

PLATE 66

Alaria marginata Post and Rupr.

From a photograph of a plant medium in all of its characters, with most of the sporophylls removed.

PLATE 67

Lessoniopsis littoralis (Farlow and Setchell) Reinke

From a photograph of a young plant showing the method of branching by the splitting of the blade from the base upwards.

PLATE 68

Lessoniopsis littoralis (Farlow and Setchell) Reinke

From a photograph of a fragment of a plant showing the method of branching and the origin and character of the sporophylls.

PLATE 69

Postelsia palmaeformis Rupr.

From a photograph of a group of typical plants with many of the sporophylls removed.

PLATE 70

Dictyoneurum californicum Rupr.

From a photograph of a group of young plants showing the method of origin of new blades by splitting in the transition, meristematic region.

PLATE 71

Agarum fimbriatum Harvey

From a photograph of half of a plant and of the basal part of another, the latter showing well the character of the stipe.

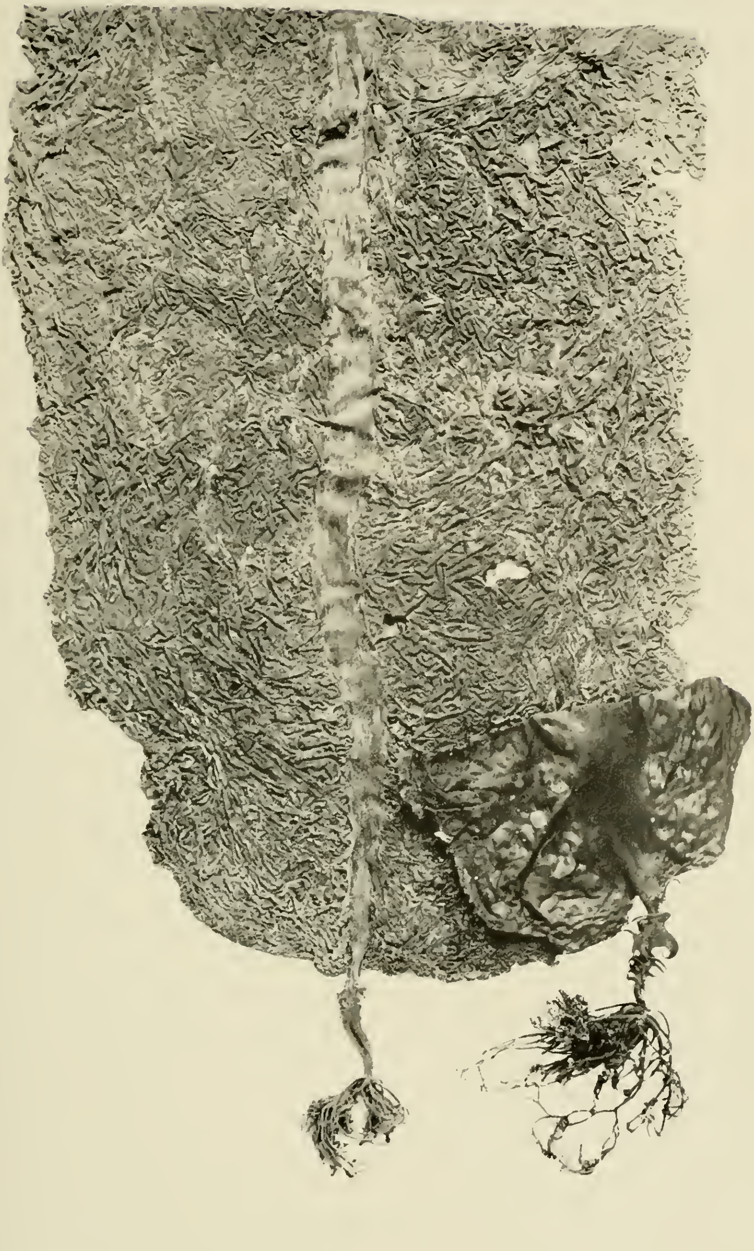


PLATE 72

Thallassiophyllum Clathrus (Gmel.) Post. and Rupr.

From a photograph of a typical plant.

PLATE 73

Hedophyllum sessile (Ag.) Setchell

From a photograph of a typical plant.

PLATE 74

Pterygophora californica Rupr.

From a photograph of a typical young plant.

PLATE 75

Chordaria dissessa S. and G.

From a photograph of a fragment of a plant.

PLATE 76

Myriogloia Andersonii (Farlow) Kuckuck

From a photograph of a typical young plant, showing the myriads of assimilating hairs.

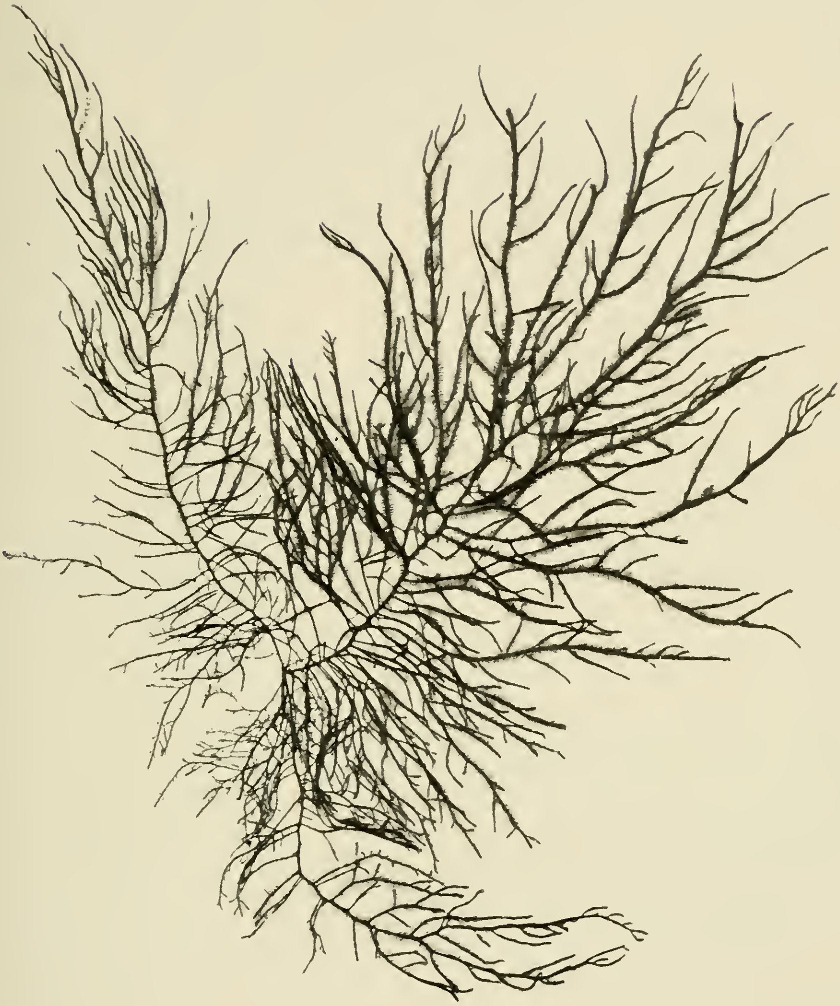


PLATE 77

Hapterophycus canaliculatus Setchell

From a photograph of a group of typical plants, taken from above and from below.

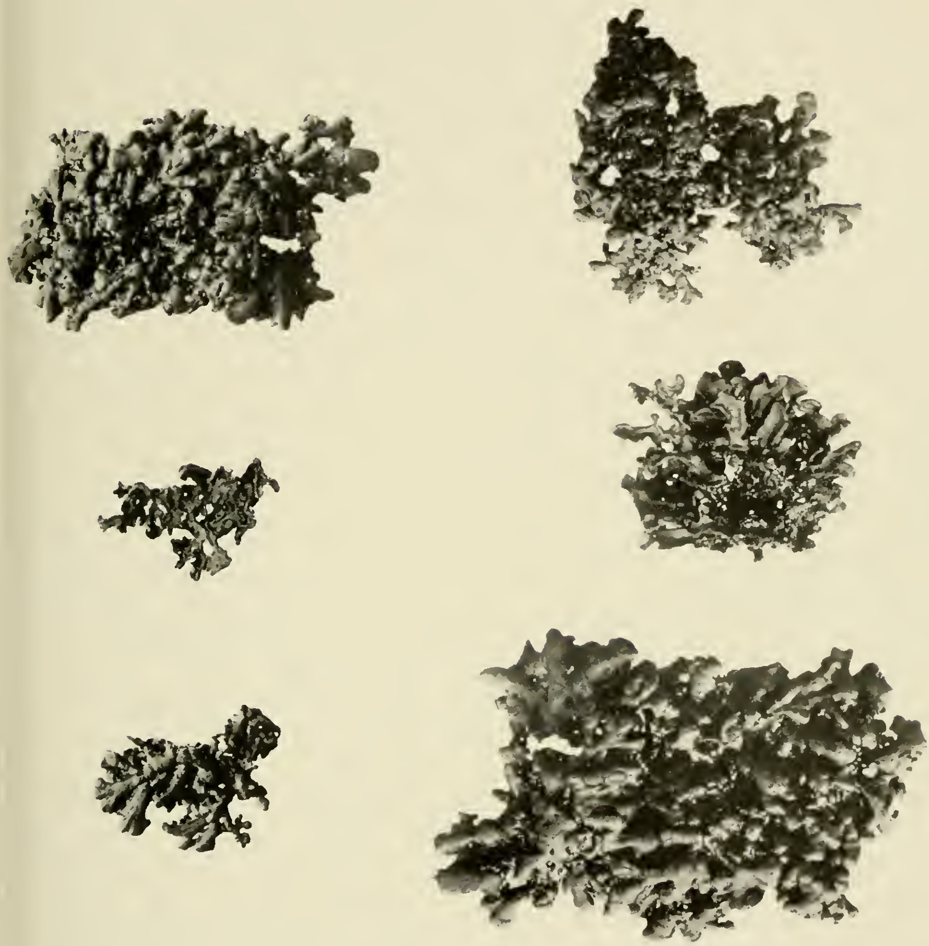


PLATE 78

A. *Pelvetia fastigiata* f. *gracilis* S. and G.

From a photograph of a typical plant with most of the branches removed.

B. *Gobia simplex* (Saunders) S. and G.

From a photograph of a group of typical plants removed from their host.


B
A

PLATE 79

A. *Costaria costata* (Turn.) Saunders

From a photograph of a form with very wide, short blade and long, wide stipe.

B. *Coilodesme rigida* S. and G.

From a photograph of a group of young plants in position on the host.

B

A

PLATE 80

A. *Pleurophycus Gardneri* Setchell and Saunders

From a photograph of a typical plant.

B. *Punctaria occidentalis* S. and G.

From a photograph of a typical plant.

A

B

PLATE 81

Punctaria chartacea S. and G.

From a photograph of three plants representing variations in size.

PLATE 82

Coilodesme polygnampta S. and G.

From a photograph of a group of typical plants.

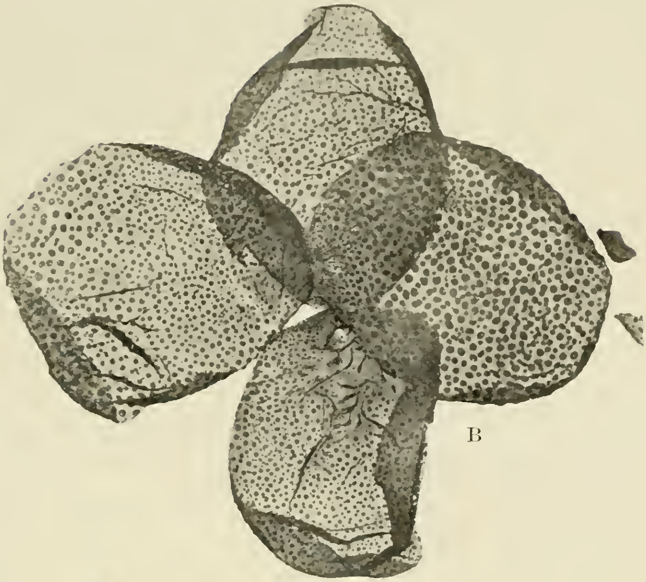
PLATE 83

A. *Endarachne Binghamiae* J. Ag.

From a protograph of a series of plants representing shapes and sizes.

B. *Soranthera ulvoidea* f. *typica* S. and G.

From a photograph of a group of dried plants.



B

A

PLATE 84

Chordaria gracilis S. and G.

From a photograph of a series of typical plants.

PLATE 85

Phacostrophion irregulare S. and G.

From a photograph of a series of old plants.

PLATE 86

Coilodesme californica (Rupr.) Kjellm.

From a photograph of a group of young plants in position on the host.

PLATE 87

Desmarestia ligulata (Lightf.) Lamour.

From a photograph of a typical plant of moderate size.

PLATE 88

Desmarestia herbacea (Turner) Lamour.

From a photograph of a typical young plant with hairs still in position.

PLATE 89

Desmarestia munda S. and G.

From a photograph of a part of a typical plant showing the characteristic toothed margins.

PLATE 90

Desmarestia latifrons (Rupr.) Kuetz.

From a photograph of the basal part of an old frond and the upper part of a younger frond.

PLATE 91

Heterochordaria abietina (Rupr.) S. and G.

From a photograph of a group of typical mature plants.

PLATE 92

Sargassum Agardhianum Farlow

From a photograph of a typical plant.

PLATE 93

Padina Durvillaei Bory

From a photograph of a typical plant.

PLATE 94

Sargassum Palmeri Grunow

From a photograph of a form with very finely dissected "leaves."

PLATE 95

Neurocarpus zonarioides (Farlow) Howe

From a photograph of a typical plant.

PLATE 96

Taonia Lennebackerae Farlow

From a photograph of a typical plant.

PLATE 97

Zonaria Farlowii S. and G.

From a photograph of a typical plant.

PLATE 98

Fucus furcatus f. *abbreviatus* Gardner

From a photograph of fresh material of the type specimen, showing relatively large, wide, and scarcely matured receptacles. Three-fourths natural size.

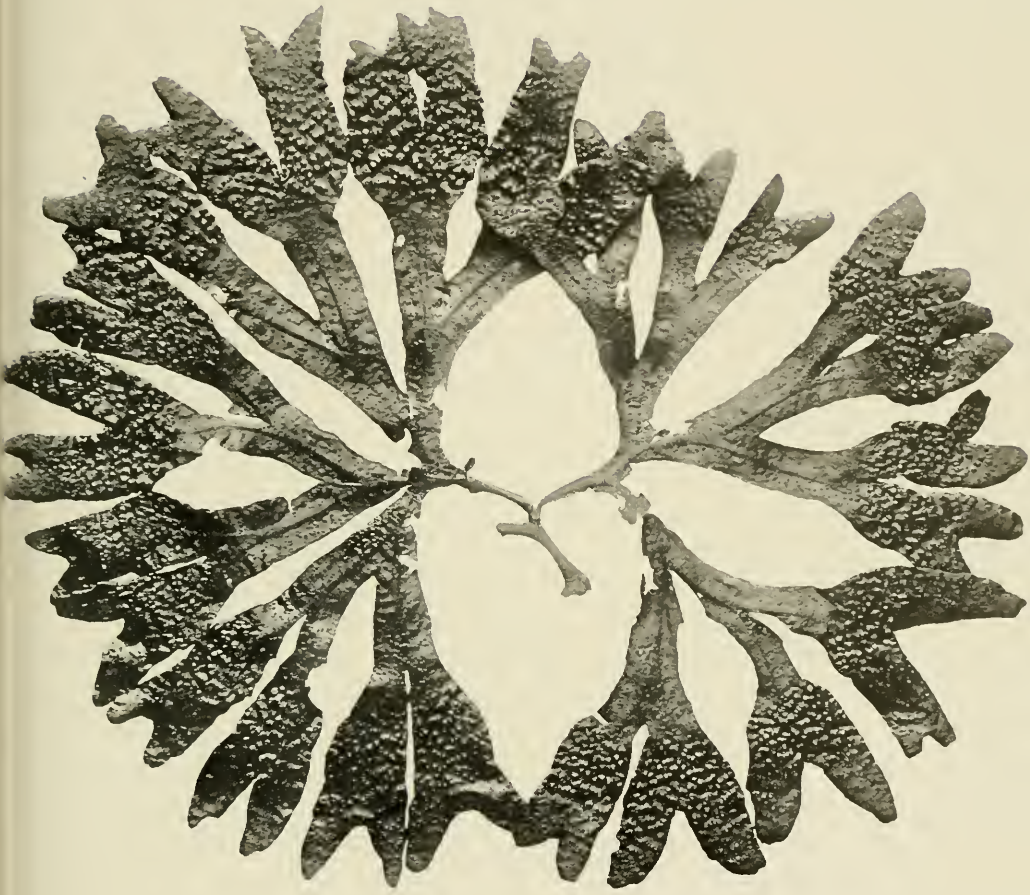


PLATE 99

Fucus furcatus f. *luxurians* Gardner

From a photograph of the type specimen, a young plant fruiting for the first time, showing many, sterile terminal segments. One-third natural size.

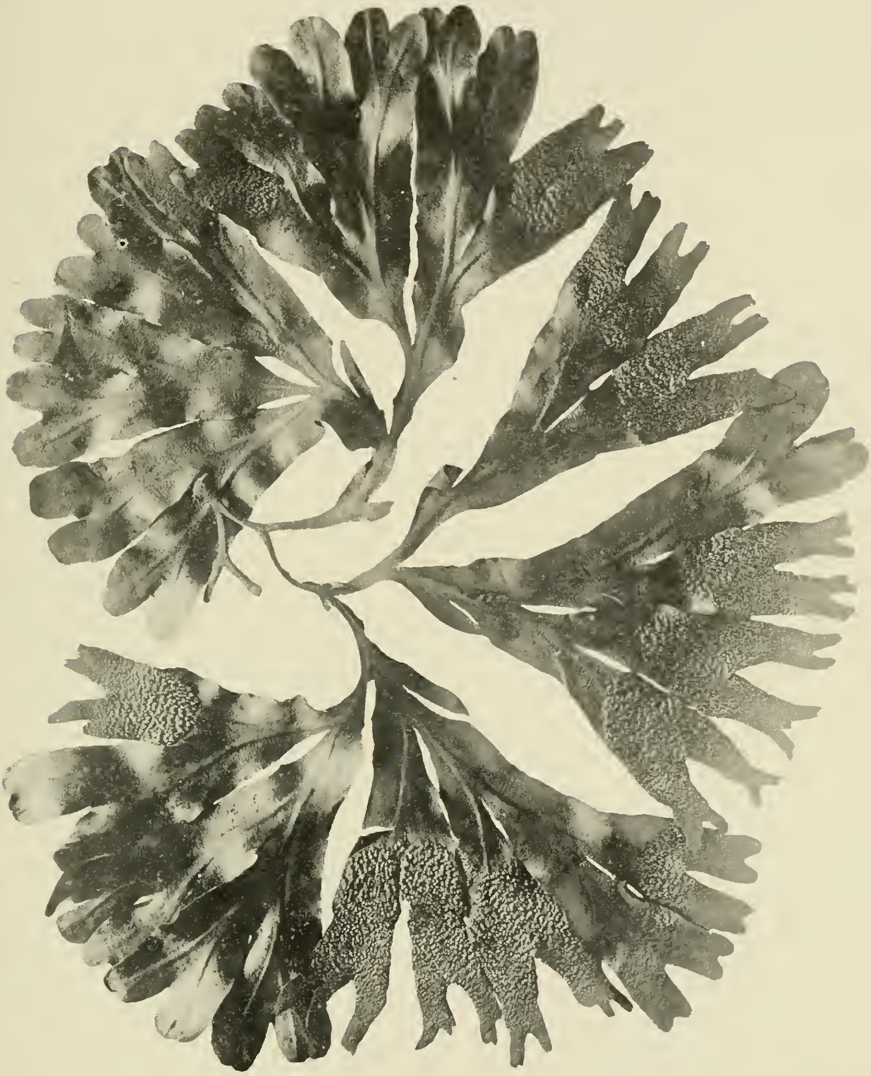


PLATE 100

Fucus furcatus f. *rigidus* Gardner

From a photograph of the type specimen. One-third natural size.

PLATE 101

Fucus furcatus f. *latifrons* Gardner

From the photograph of the type specimen, a young plant just beginning to fruit. Two-fifths natural size.

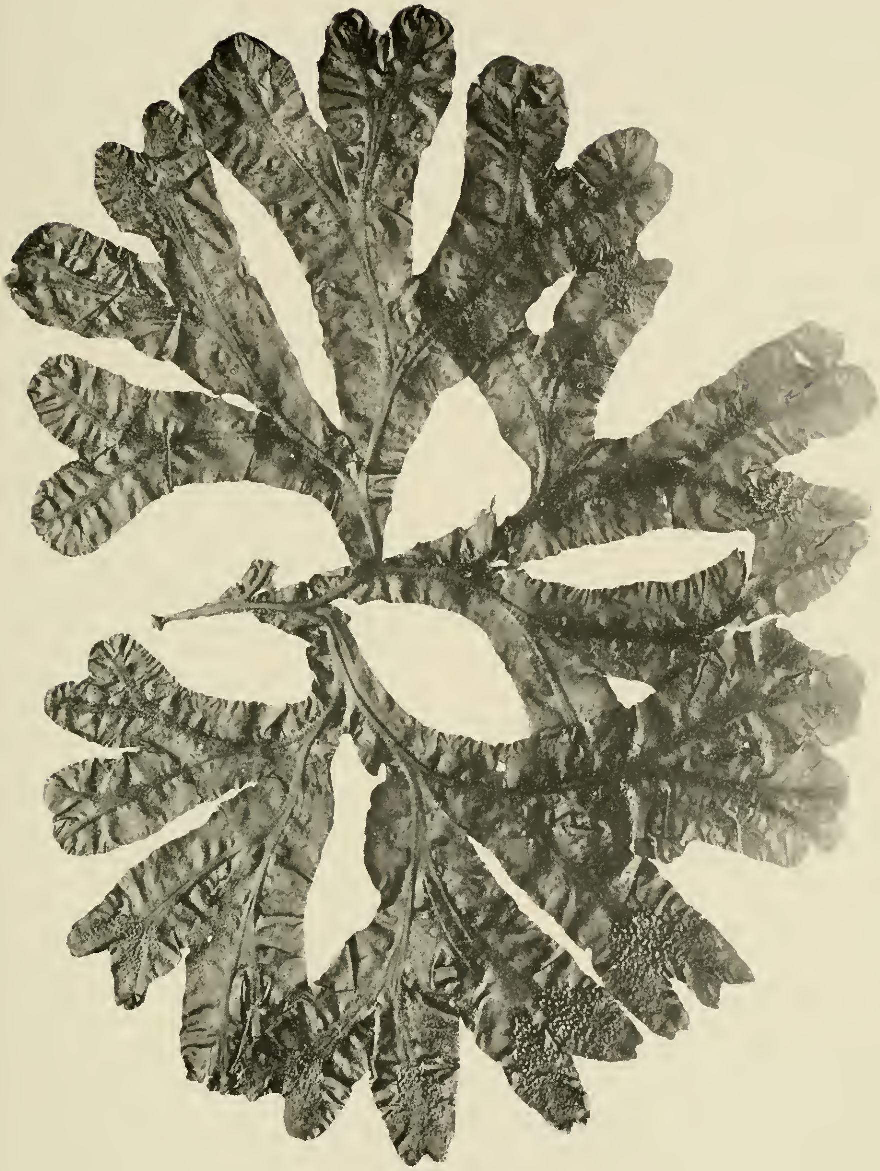


PLATE 102

Fucus nitens Gardner

From a photograph of the type specimen showing mature receptacles, mostly swollen. Two-fifths natural size.

PLATE 103

Fucus edentatus f. *hesperius* Gardner

From a photograph of a portion of a plant, the type. One-third natural size.

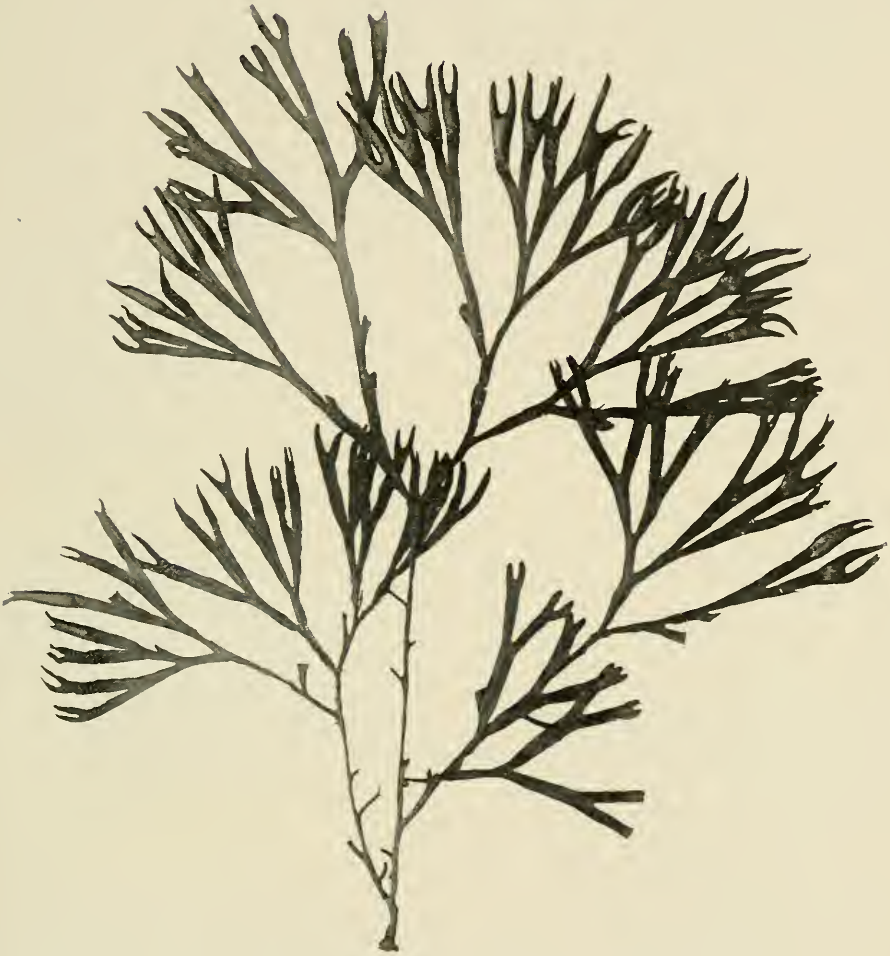


PLATE 104

Fucus edentatus f. *divaricatus* Gardner

From a photograph of a fruiting plant. Three-fifths natural size.

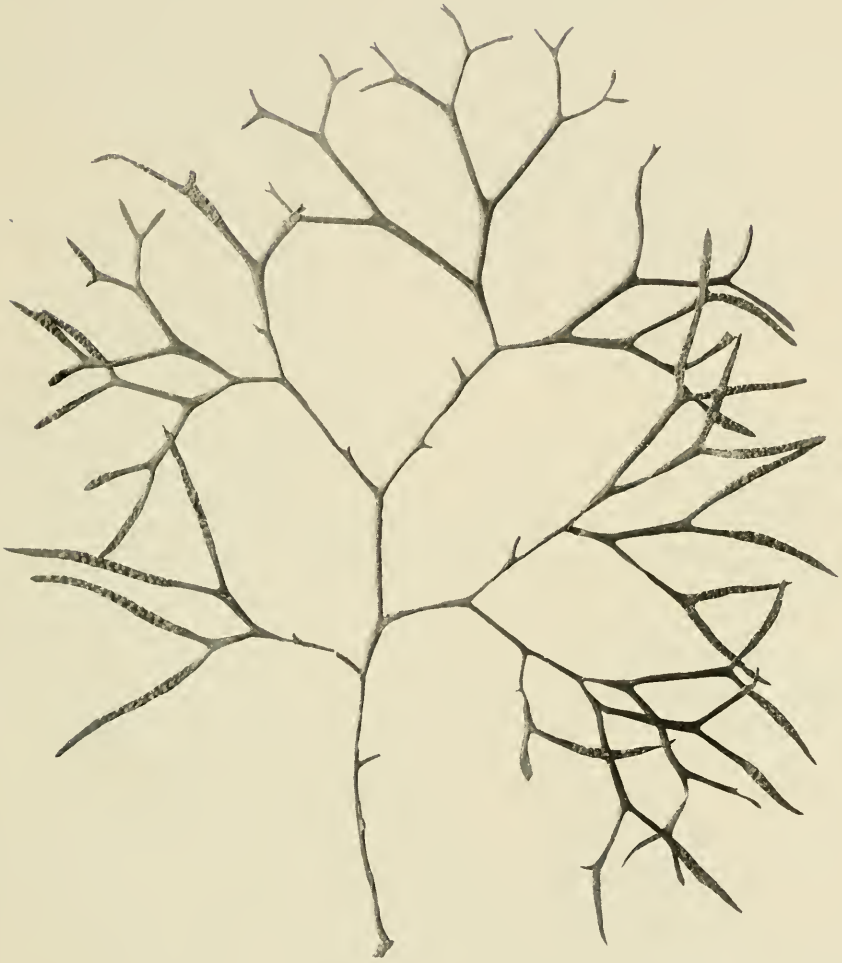


PLATE 105

Fucus membranaceus f. *latissimus* Gardner

From a photograph of the type specimen. One-third natural size.

PLATE 106

Fucus evanescens f. *oregonensis* Gardner

From a photograph of the type specimen. One-half natural size.

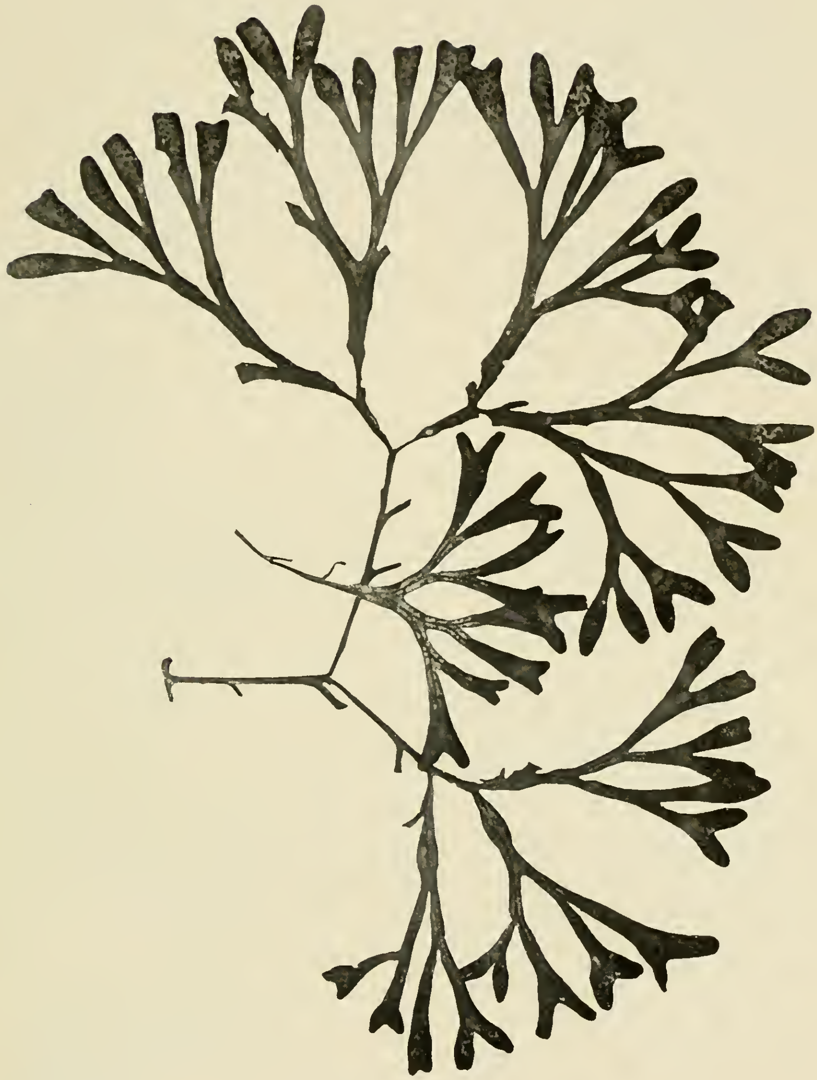


PLATE 107

Fucus evanescens f. *robustus* S. and G.

From a photograph of a portion of a fresh plant. One-third natural size.

INDEX

Univ. Calif. Publ. Bot., vol. 8, part III

Titles of papers, and names of **new taxonomic units**, also **pages where diagnoses appear** are in **boldface**.

ERRATA

Page 515, line 31. *For* tenuissimum *read* tenuissima.
Page 518, line 33. *For* glaciale *read* glacialis.
Page 565, line 7. *For* aculeae *read* aculeata.
Page 576, line 1. *For* Rupreclatiella *read* Ruprechtiella.
Page 610, line 33. *For* Dictyoneuron *read* Dictyoneurum.
Page 638, line 22. *For* Aguarum *read* Agarum.
Page 646, line 36. *For* Andersonia *read* Andersonii.