

A KEY TO THE GENERA OF THE BRITISH SEAWEEDS

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INTRODUCTION

THIS key is developed from one used on various courses at the Marine Biology Station, Menai Bridge and at Dale Fort Field Centre. This was based on the excellent key in Knight and Parke's *Manx Algae* (1931), which was modified by the inclusion of genera not found on the Isle of Man and by the addition of a key to the Cyanophyceae. The key has been further modified in the light of experience gained during these courses and expanded to include all the genera in Parke's Check List (1953) and the later amendments (Parke 1956, -57, -59), apart from a few minor exceptions and with the major change that the classification of Drouet and Daily (1956) has been adopted for the non-filamentous Cyanophyceae.

The basic pattern of the key remains that of Knight and Parke and I am very grateful for their generous permission to make use of it here. I should also like to thank Dr. M. W. Parke and Mr. J. H. Barrett for valuable suggestions and criticism.

Few keys have been made without faults and I should like to hear of any difficulties experienced by users of this one or any suggestions they may care to make.

Notes on the key and its use

The term "Seaweeds" is used in the limited sense of the four classes in Newton's Handbook (1931) (Chlorophyceae, Phaeophyceae, Rhodophyceae and Cyanophyceae)—and from these the motile Chlorophyceae (Volvocales) are omitted.

Sizes are given for guidance only and should not be taken too literally.

A few entries are given specific names where a character identifies one species of a genus. In these and in all other cases the identification must be completed by reference to the works in the list at the end. If possible, specimens should be compared with properly identified herbarium specimens.

In some genera (e.g. *Enteromorpha*, *Cladophora*, *Callithamnion*, *Ceramium*) expert advice must be sought as no adequate treatment is easily available (in some cases, in fact, it does not exist).

It is always advisable to preserve specimens found for future examination.

Many of the characters given in the key can be observed only with a microscope. While a good hand lens will help considerably, it is unfortunate that many seaweeds cannot be identified with certainty in the field.

Some genera are less likely to concern the beginner because of their scarcity or for other reasons, and branches of the key which lead to them are set in italic type. In identifying the commoner algae, therefore, these branches can be given less attention but it should be remembered that quite rare plants may occur in large quantities in limited areas.

GLOSSARY AND ABBREVIATIONS

Unfamiliar words have been used in this key as sparingly as possible: where their inclusion has been unavoidable they have been used in the sense given in the list below.

μ (micron)—a unit of length = 0.001 mm.

Assimilatory—containing chromatophores and presumably the site of photosynthesis

Axial—longitudinally down the centre of the thallus

Axis—the main stem-like part of a thallus

Bisporos—spores produced in pairs by the division of the contents of a cell (Bisporangium)

Branching—can be of several types (Fig. 1)

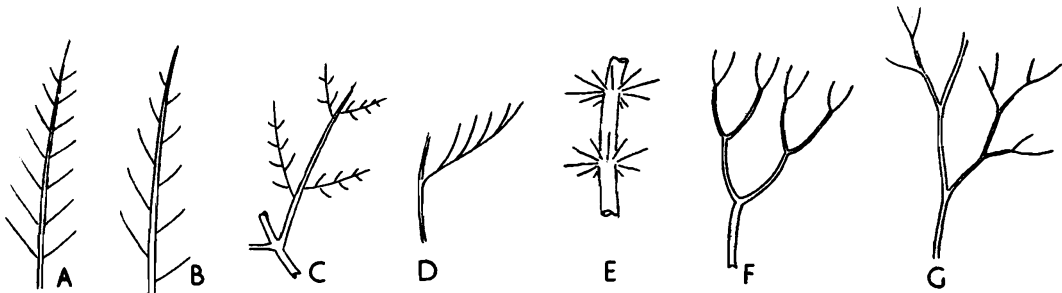


FIG. 1

Branching: A. Pinnate—opposite; B. Pinnate—alternate; C. Axis with tripinnate branching; D. Secund; E. Whorled; F. Dichotomous; G. Subdichotomous.

Carpogonium—term for oogonium in Rhodophyceae

Carpospore—in Rhodophyceae—a diploid spore produced after fertilization

Channelled—shaped like a shallow U in T.S. (Fig. 2)

Chromatophore (plastid)—body within a cell which contains chlorophyll and other pigments. Shape and number often characteristic (Fig. 3)

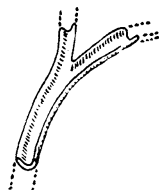


FIG. 2

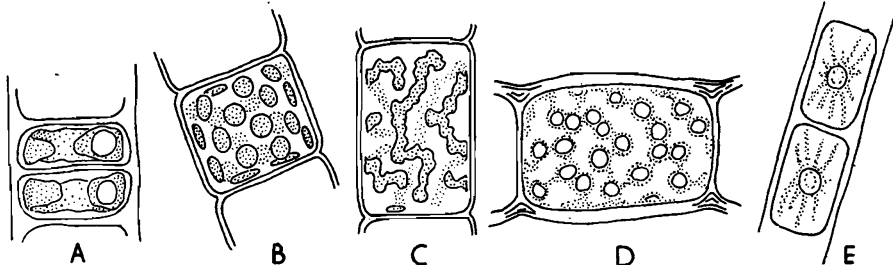


FIG. 3

Chromatophores: A. Band shaped (*Ulothrix flacca*) ($\times 800$); B. Discoid (*Giffordia*) ($\times 350$); C. Linear (*Ectocarpus*) ($\times 350$); D. Reticulate (*Cladophora*) ($\times 400$); E. Stellate (*Erythrotrichia*) ($\times 800$).

- Coenocyte**—a plant whose thallus contains numerous nuclei but is not divided into separate cells
- Conceptacle**—chamber within a thallus opening to the exterior through a pore or pores and containing reproductive organs
- Cortex**—the outer layers of a thallus, often of small cells
- Cortication**—the building up, on the surface of a thallus, of a layer of small cells either by corticating filaments which creep over it or by cells cut off from the surface cells (Fig. 12)
- Cruciate**—see Tetraspore and Fig. 6
- Cystocarp**—in the Rhodophyceae—the carpospores and the diploid cells which bear them (Carposporophyte) together with any protecting structure formed by the haploid cells of the parent female plant (Fig. 15)
- Dia.**—diameter
- Dichotomous**—see Branching and Fig. 1
- Discoid**—see Fig. 3
- Distal**—towards the outermost extremity
- Ecorticate**—without cortication
- Endolithic**—living within rock
- Endophytic**—living within the body of a plant, generally without penetration into the cells
- Endospore**—in the Cyanophyceae—spores formed within a cell by the division of its entire contents
- Endozoic**—living within the body of an animal (including the shell etc.)
- Epilithic (saxicolous)**—living attached to rock, stone, etc.
- Epiphytic**—living attached to the surface of a plant
- Epizoid**—living attached to the surface of an animal
- Exospore**—in the Cyanophyceae—spore budded off from the exposed protoplast of a cell
- False branching**—mainly in the Cyanophyceae. Branching by outward growth of ends of trichomes after a breakage (Fig. 16)
- Filament**—a single or multiple linear series of cells (Fig. 5). In the Cyanophyceae, “filament” means a mucilage sheath together with the trichome(s) it contains
- Filiform**—thread-like; narrowly cylindrical
- Forcipate**—incurved like the jaws of pincers (Fig. 12)
- Fron**—a leaf-like portion of a thallus
- Hair**—elongated colourless cell or series of cells projecting from a thallus
- Heterocyst**—a cell of a Cyanophycan trichome either intercalary or basal and differing from the other cells; often thicker walled and yellowish (Fig. 16)
- Hormogone (Hormogonium)**—in the Cyanophyceae—a short section of a trichome which becomes detached and moves away out of the sheath to act as an organ of vegetative propagation
- Hypothallium**—basal layers of cells in the encrusting Corallinaceae (*Lithothamnium* etc.) which can be differentiated from the upper region (Perithallium) of upwardly directed filaments (see Fig. 11)
- Intercalary**—inserted at a point along a thallus (Figs. 4 and 16); not terminal or basal
- Lamina**—flat expanded portion of a thallus
- Linear**—long and narrow (Fig. 3)
- L.S.**—longitudinal section
- Medulla**—the inner cells of a thallus; usually colourless
- Midrib**—thickened region extending longitudinally down the middle of a flat frond
- Monosiphonous**—a filament composed of a single row of cells (Fig. 5)
- Monospore**—a non-motile spore borne singly in a cell (Monosporangium) which is usually enlarged

Multiseriate—composed of more than one row of cells (Fig. 4)

Nematecium—reproductive organ consisting of a closely packed mass of parallel filaments, bearing spores and forming a pustule on the thallus

Node—a joint: in this key, the junction between adjacent cells of a monosiphonous or segments of a polysiphonous filament or between articulations in a plant like *Lomentaria* (Fig. 12)

Oogonium—a cell whose contents form one or more non-motile female gametes (ova)

Opposite—see Branching

Ostiole—a pore opening into a conceptacle, cystocarp etc.

Papillary—nipple-like

Parasite—organism living upon or within a plant or animal and obtaining nourishment from its host. Parasitic algae often colourless

Paraphyses—short filaments or branches associated with sporangia

Parenchyma—an undifferentiated tissue of thin walled cells

Pericentral—cells in a polysiphonous filament surrounding a central one and originating by division from it (Fig. 5)

Periostracum—thin outer horn-like layer of a mollusc shell

Perithallium—see Hypothallium

Pinnate—see Branching

Plurilocular sporangium—a sporangium formed from a cell or series of cells subdivided by walls into small chambers each containing a single zoospore (Fig. 4)

Polarity—a distinct difference between opposite ends (e.g. between base and apex)

Polysiphonous—a multiseriate filament derived from a monosiphonous one by longitudinal division of the cells (Fig. 5)

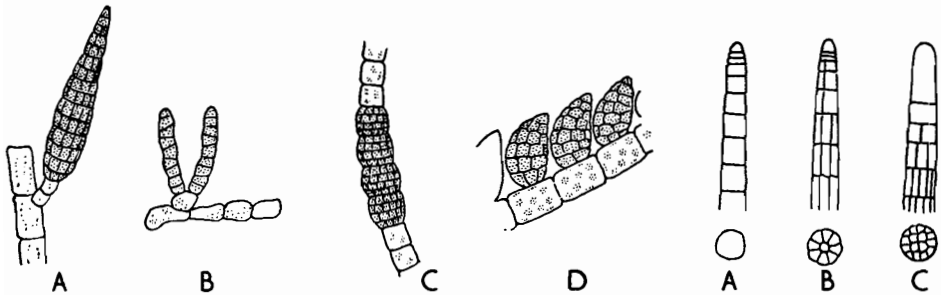


FIG. 4 (above, left)

Plurilocular sporangia: A. Stalked, lateral, elongated (*Ectocarpus*, etc.); A, C, D. Multiseriate; B, Uniseriate (*Myrionema*); C. Intercalary (*Pylaiella*); D. Ovoid—pointed (*Giffordia*). (All $\times 100$).

FIG. 5 (above, right)

Monosiphonous and Polysiphonous organization: A. Monosiphonous filament; B. Polysiphonous filament with central siphon (=cell) surrounded by a ring of pericentrals (e.g. *Polysiphonia*); C. Polysiphonous filament without an obvious central siphon (e.g. *Sphacelaria*).

Propagule (Propagulum)—portion of a thallus specially developed which, becoming detached, acts as an organ of vegetative propagation (Fig. 10)

P.S.—plurilocular sporangium (—a)

- Pseudoparenchyma**—mass of closely packed filaments giving the appearance of parenchyma
- Pyrenoid**—small, round or irregularly shaped, highly refractive body in a chromatophore; proteinaceous but enveloped in starch, staining darkly in iodine
- Pyriform**—pear-shaped
- Ramulus**—a small branch; normally refers to the smallest branches of a plant, especially when these are of uniform size, form or distribution
- Receptacle**—portion of a thallus in which conceptacles are concentrated
- Recurved**—bent back
- Reticulate**—net like, perforated (Fig. 3)
- Rhizoid**—root like outgrowth from a cell
- Rhizoidal**—root like; a rhizoidal filament is of irregular diameter, sinuous, often downwardly directed and frequently colourless
- Secund**—borne in a row on one side only of a branch etc., like the teeth of a comb (Fig. 1)
- Septum**—a cross wall
- Sessile**—borne directly on the thallus without an intervening stalk
- Sheath**—a layer of mucilage round a thallus, esp. round a trichome or trichomes of the Cyanophyceae. May be easily seen when dense or coloured but if tenuous can be demonstrated by mounting in water containing fine particles such as Indian ink
- Simple**—unbranched
- Sorus**—group of sporangia
- Sporangium**—cell in which spores are produced
- Stellate**—star-shaped (Fig. 3)
- Stipe**—stem-like portion of a thallus bearing a lamina
- Stipitate**—having a stipe
- Subdichotomous**—branching intermediate between alternate and dichotomous (Fig. 1)
- Tetrahedral**—see Fig. 6
- Tetraspore**—in Rhodophyceae (and Dictyotales)—spores produced by the meiotic division of a tetraspore mother cell (Tetrasporangium) to give four cells. Division is of three kinds, as shown in Fig. 6

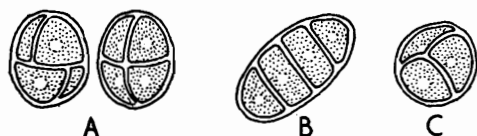


FIG. 6

Division of tetrasporangia:

- A. Cruciate
 B. Zonate
 C. Tetrahedral (All $\times 500$)

- Tetrasporophyte**—diploid plant in which tetraspores are produced
- Thallus**—a plant body not differentiated into root, stem, leaf etc.
- Trichome**—in the Cyanophyceae—a connected linear series of cells which may be multiserial or, more usually, uniserial (Fig. 16)
- T.S.**—transverse section
- Unilocular sporangium**—sporangium formed from a single cell, not divided by cross walls and containing one or more motile or non-motile spores. The site of meiosis in the Phaeophyceae
- Uniserial**—composed of a single row of cells
- U.S.**—unilocular sporangium
- Whorl**—a radiating ring of branches, sporangia etc. given off at the same level
- Zonate**—see Tetraspore
- Zoospore**—motile flagellated spore

RECOGNITION OF THE CLASSES

- CHLOROPHYCEAE** (Green Algae): cellular or coenocytic, the colour of the leaves of higher plants, cells with pigments in chromatophores.
- PHAEOPHYCEAE** (Brown Algae): cellular, golden brown to very dark brown, pigments in chromatophores. Filamentous or massive thalli.
- RHODOPHYCEAE** (Red Algae): cellular. In shade, in deep water (and, in winter, elsewhere), coloured from clear bright red to dark reddish purple, but bright sunlight bleaches the red pigments and colour then becomes light brown or straw yellow—lighter than Phaeophyceae. Plants with straw coloured upper parts and dark bases are very likely to be Rhodophyceae. Pigments in chromatophores.
- CYANOPHYCEAE** (Blue-green Algae): cellular, cells usually small. Colour dark blue-green, occasionally purple or reddish. No chromatophores—colour diffused through cell contents. Individual plants small but often present in large numbers covering extensive areas.

CHLOROPHYCEAE

1. Very small unicellular or filamentous plants, microscopic except when filaments are united into very thin sheets or into small (up to 2 mm. dia.) discs or cushions. Creeping filaments sometimes bearing erect branches up to a few mm. long. On or within plants or animals, less frequently on rock, shells etc. 2
- Plants of macroscopic size, individuals being visible to the naked eye or, if very small or very finely filamentous, then present in easily seen masses 20
2. Bearing bristle-like hairs on at least some cells (Fig. 7) 15
Without bristle-like hairs 3
3. On rock or similar substrata 4
Upon or within plants or animals 5
4. Plants uniseriate when young; becoming multiseriate, irregularly cylindrical and solid later. Cells in surface view embedded in a colourless matrix, in obvious groups, more or less rectangular and with their walls orientated longitudinally and transversely (Fig. 8). Attachment to the substratum always by means of rhizoids **Gayella**
Thallus a compact sheet or disc one cell thick formed of filaments growing closely together, the filamentous structure being obvious only at the periphery **Pseudoclonium**
Thallus a single large thick walled cell attached to the substratum by a long tapering colourless stalk **Codiolum pusillum***

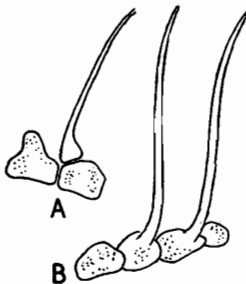


FIG. 7

Bristle-like hairs of Chaetophorales: A. *Bolbocoleon*;
B. *Ochlochaete*. (Both $\times 250$.)

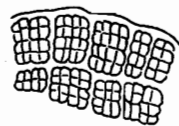


FIG. 8

Surface view of edge of thallus of
Prasiola and *Gayella* ($\times 300$).

5. Plants unicellular 6
Plants filamentous 9
6. Endophytic 7
Epiphytic 8
7. Thallus a single large spherical or ovoid cell embedded amongst the cells of various larger algae (e.g. *Dilsea*, *Polysiphonia*) or in *Zostera*
- Chlorochytrium**
- Thallus a single large ovoid cell growing amongst filaments of *Petrocelis* and attached to the substratum by an elongated, tapering, colourless stalk
- Codiolum petrocelidis***
8. *Plant a single elongated cell attached to the surface of various algae by a stalk expanding into a small disc at the base* Characium
Plant a single spherical cell sometimes slightly pointed at the base, sessile on algae (esp. Rhizoclonium) Sykidion
9. *Filaments creeping in the walls of polyzoa—Flustra, Membranipora etc.* Epicladia
- In the shells of molluscs* 10
Elsewhere 11
10. *Generally in empty shells. Filaments of irregularly shaped cells and all growing inside the substance of the shell, some penetrating deeply so that all the shell may be affected. Sporangia the only portions which are exposed* Gomontia
Filaments creeping in the periostracum of living marine snails and never penetrating the calcareous portion of the shell. Producing short, pointed branches which extend to the surface Tellamia
Filaments coenocytic with occasional septa. Growing within empty mollusc shells Ostrobium
11. *Epiphytic. Filaments united into definite discs, sheets or cushions* 12
Endophytic. Filaments occasionally united into masses in various red algae, Fucus and Zostera Entocladia
12. *Discs of creeping filaments whose cells give rise to erect filaments, producing a thallus several cells thick, at least in the central part. One pyrenoid in each cell* 13
Discs one cell thick throughout, up to 2 mm. in dia. Zoospores formed from cells in the centre 14
13. *Disc with rhizoids in the central part attaching it to the substratum. Zoospores produced in the end cells of erect filaments* Pseudopringsheimia
Disc without rhizoids below Pseudulvella
14. *Cells with more than one nucleus; without pyrenoids* Ulvella
Cells with one nucleus, 1-4 pyrenoids Pringsheimiella
15. *Thallus coenocytic, consisting of swollen multinucleate elements connected by rhizoidal filaments and bearing long hairs. Endophytic in Enteromorpha* Blastophysa
Filaments of cells, more or less united into discs or cushions 16
Filaments of cells, not united into discs etc. 18
16. *Filaments united into a disc, bearing closely packed erect filaments tapering to end in long hairs* Pilinia†
Cells not in obvious erect filaments; numerous hairs borne on the surface, not cut off from the parent cells 17
17. *Thallus an irregular disc (see Fig. 7)* Ochlochaete
Thallus hemispherical or globular Chaetobolus

* **Codiolum** now considered to be stages in the life histories of various members of the Cladophoraceae.

† recently shown to be identical with **Kolderupia** of the Phaeophyceae.

18. *Creeping filaments bearing hairs with swollen bases which are divided by a wall from the parent cells* (see Fig. 7) **Bolbocoleon**
Creeping filaments with short (often unicellular) erect branches which bear hairs without swollen bases and not cut off from the parent cells **Acrochaete**
Creeping filaments without erect branches, hairs arising directly from cells of filaments without cross walls at their bases 19
19. *Never more than one hair on any cell* **Ectochaete**
Up to 3 hairs on any cell, hairs often twisted and intertwined **Phaeophila**
20. *Thallus flat or cylindrical, consisting of 1 or 2 layers of cells* 21
Thallus filamentous, consisting of numerous cells 27
Thallus of coenocytic filaments which may be simple or branched or built up into massive spongy structures. Epiphytic or epilithic 25
21. *Thallus flat, at least in part, and 1 cell thick* 22
Thallus flat, 2 cells thick 23
Thallus tubular, wall of tube 1 cell thick, branched or unbranched, cylindrical or flattened 24
22. *Thallus tubular when young, splitting to form a delicate membrane 1 cell thick, cells irregularly arranged* **Monostroma**
Thallus often stipitate. Cells of thallus in groups, more or less rectangularly arranged, resembling the street plan of a modern city. (Fig. 8). Upper littoral plant—often in nitrogen-rich places **Prasiola**
23. *Thallus broad, flat throughout, the 2 cell layers quite inseparable* **Ulva**
Thallus much longer than broad, tubular at the extreme base and sometimes the edges, the 2 cell layers being separable (with some difficulty!)
24. *Thallus gelatinous, usually unbranched; composed of rounded cells separated by thick walls and occurring singly or in groups of 2 or 4, and arranged in longitudinal, well separated rows* **Capsosiphon**
Thallus branched or unbranched, cylindrical or compressed; cells in surface view 10μ to 30μ long, arranged irregularly or sometimes in longitudinal rows, closely packed together **Enteromorpha**
Thallus small (less than 10 cm. long) branched or unbranched. Cells in surface view not arranged in any regular pattern and from 3μ to 7μ long **Blidingia minima**
25. *Thallus 30μ to 350μ thick (often about 100μ) and sparingly branched. Not organized into a more complex thallus—frequently forming a dark green, velvety layer on mud etc.* **Vaucheria***
Massive spongy plants formed of interwoven coenocytic filaments which bear club-shaped branches which, closely packed, form the outer layer of the thallus. Either much branched or, very occasionally, forming cushions on rock **Codium**
26. *Thallus obviously filamentous to the naked eye* 26
Thallus consisting of main axes bearing lateral, more or less pinnate branches and arising from creeping basal filaments. Cross walls forming only at the bases of branches when reproduction occurs **Bryopsis**
Thallus of very thin filaments in tufts, sparingly branched. Occasionally septate at branch bases. Sporangia swollen and borne laterally on short stalks **Derbesia**
27. *All filaments uniseriate, branched or unbranched* 28
At least some filaments more than 1 cell thick 34

* Actually a member of the class Xanthophyceae but included here for convenience.

28. Separate filaments visible to the naked eye, branched or unbranched.
 Composed of large "cells" (actually coenocytic segments) with reticulate chromatophores and having a 3-layered cell wall, the outer layer taking no part in septum formation (see Fig. 9) 29
 Filaments microscopically fine, unbranched, slimy to the touch, cell walls not as in Fig. 9. 1 undivided chromatophore in each cell 33
29. Filaments branched 30
 Filaments unbranched 32
30. Filaments contorted and intertwined, forming unattached masses. Branches short (up to 3 cells) hooked, generally thinner than the rest of the filament and sometimes very scarce **Rhizoclonium**
 All branches of similar form without rhizoidal branches and not forming spongy masses. Epiphytic or epilithic. Growth apical **Cladophora**
 With some branches, especially in the lower parts of the plant, recurved, twisted and pale coloured and serving to bind the filaments into a spongy mass. Intercalary growth frequent 31
31. Light green, tufted, seldom as much as 5 cm. long, usually epiphytic **Spongomorpha**
 Dark green, each plant forming a number of separate tufts, composed of intertwined filaments bound together by rhizoidal branches, rope-like at the base and spreading distally **Acrosiphonia centralis**
32. Filaments firm to the touch, either very stiff and attached by a basal cell to rock (singly or in clumps of a few filaments) or intertwined in unattached masses. Individual cells regularly cylindrical or barrel shaped and often visible to the naked eye **Chaetomorpha**
 Filaments soft to the touch, attached to rock or other algae in dense clumps. "Cells" often irregular in length, some being shorter than broad **Urospora**
33. Each cell with a single band shaped chromatophore partially encircling the cell (Fig. 3A). Cells often shorter than broad **Ulothrix**
Each cell with a single plate-like chromatophore. Filaments short and very prone to fragmentation into component cells **Stichococcus**
34. Filaments of uniform width, sparingly branched or unbranched consisting of 2, occasionally 4 rows of cells formed by the longitudinal division of the cells of an originally uniseriate filament and so placed regularly side by side **Percursaria**
 Filaments branched, several cells thick, rather variable in width, cells in longitudinal rows but not placed regularly side by side **Enteromorpha**

PHAEOPHYCEAE

- A. Filamentous plants, macroscopic or microscopic, filaments creeping or erect and entirely monosiphonous 1
- B. Filamentous plants at least partly polysiphonous, with cells in the polysiphonous parts regularly arranged in transverse rows, except where covered by subsequent cortication 2
- C. Forming easily seen crusts or cushions on rock 32
- D. Thallus entirely or largely hollow, distended into spherical or irregular sacs or tubular 38
- E. Thallus not organized in any of the above ways. If filiform or filamentous, then not as in A, B or C 43
1. Plants macroscopic with erect filaments obvious and the dominant part of the thallus 18
 Plants small, often of microscopic size, erect filaments not more than a few mm. long, sometimes absent. Epiphytic, endophytic or endozoic 3

Plants with numerous unbranched assimilatory filaments (not colourless hairs) visible to the naked eye, but usually less than 2 cm. long. Epiphytic, in tufts like small shaving brushes or occasionally in more extensive cushions (as on *Himantalia*)

2. Plants much branched and rather stiff. Branches and filaments mostly ending in large apical cells. Longitudinal division of cells behind the apex producing a very regular polysiphonous thallus with regular branching. Corticating filaments may obscure the structure in the older parts, when it can still be seen in the branches. Sometimes with propagules (Fig. 10)
- Plants branched or unbranched, partly monosiphonous or almost entirely polysiphonous except for extreme ends of filaments (Fig. 5), in which case without large apical cells

14

29

25

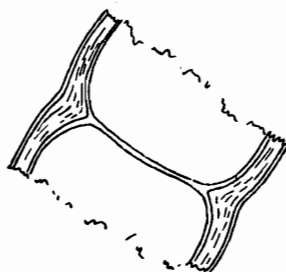


FIG. 9

Cell wall structure of Cladophorales, showing layering and a cross wall formed only from the inner layer ($\times 500$).

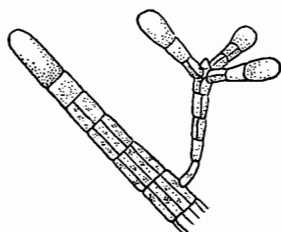


FIG. 10

Propagule on *Sphacelaria* ($\times 200$).

3. *Creeping filaments entirely or mainly endophytic or endozoic*

11

Creeping filaments epilithic or epiphytic, sometimes with some penetration into the host, often aggregated into discs, cushions or patches up to 2 mm. in diameter

4. Creeping filaments with chromatophores, either separate or aggregated into discs (Fig. 3) never more than 2-3 layers thick, and bearing erect filaments. *Forming globular gelatinous cushions up to 2 mm. across on Chondrus composed of branched filaments with inner cells elongated and outer ones broader and ovoid. P.S. and U.S.*

4

5

Forming gelatinous cushions on Chorda, Sauvageaugloia and Ascophyllum with tufts of unbranched assimilatory filaments arising from a central mass of branched filaments. P.S. in tufts, uniseriate (Fig. 4); U.S. absent

Microcoryne

Microscopic tufts of unbranched filaments and hairs arising from a mass of colourless cells from which rhizoidal filaments penetrate the host. P.S. and U.S. basal and lateral

Myriactula

Forming brown spots on Gracilaria compressa and G. foliifera; with a mucilaginous mass of branched external filaments and deeply penetrating endophytic filaments without obvious basal layer at the surface

Cylindrocarpus microscopicus

5. *Erect filaments with 1 plate-like chromatophore in each cell. Creeping filaments forming a more or less compact disc never more than 1 cell thick. P.S. multiseriate (Fig. 4). Usually epilithic*

Componema

- Creeping filaments united into a disc bearing numerous short closely packed erect filaments which end in apical hairs* **Kolderupia**
- Creeping filaments very straight and radially arranged. Bearing large, transparent elongated cells ("ascocysts") on both creeping and erect filaments* **Ascocyclus**
- Without ascocysts, several chromatophores in each cell 6
6. *Chromatophores linear* (Fig. 3); *creeping filaments forming a basal layer at least in part two or more cells thick. P.S. multiseriate* 7
- Chromatophores discoid* (Fig. 3), basal layer usually 1 cell thick 8
7. *Erect filaments branched; hairs and sporangia lateral* (Fig. 4) or *terminal on these branches but occasionally on the basal layer* **Hecatonema**
- Erect filaments unbranched. Hairs and sporangia not lateral, but arising from the basal layer on short stalks of 1 or more cells* **Chilionema**
8. *Creeping filaments bearing erect branches, P.S. uniseriate or multiseriate* (Fig. 4), sessile or stalked 9
- Basal creeping filaments without erect branches other than colourless hairs. P.S. formed from single, slightly enlarged vegetative cells. Epiphytic on various algae* **Pheostroma**
9. *P.S. usually uniseriate* 10
- Erect branches 1-3 mm. long. P.S. multiseriate, ovoid or somewhat elongated, sessile, lateral on erect branches or basal filaments* **Kützingiella**
10. *Basal layer of radiating filaments closely packed and with a short erect branch from every cell, the longest branches in the centre of the thallus. Epiphytic, not penetrating host* **Myrionema**
- Cells of basal layer each bearing either an erect branch or a downward-growing rhizoidal branch which penetrates the host, Dumontia incrassata* **Ulonema**
11. *Creeping filaments endophytic in Carpomitra. U.S. ovoid, terminal or lateral on irregularly branched erect filaments 1-2 mm. long with a few discoid chromatophores in each cell. P.S. not recorded* **Sphacella**
- Creeping filaments endozoic in Alcyonidium or Flustra* **Endodictyon**
- Endophytic in various algae often with erect branches emerging from the surface of the host* 12
12. *Endophytic in Laminaria saccharina, with branched erect filaments up to 1 cm. long bearing uniseriate P.S. (Fig. 4). 2 or 3 band shaped chromatophores (Fig. 3) in each cell* **Laminariocolax**
- Creeping filaments with 1 or 2 plate-like chromatophores in each cell. P.S. of up to 5 cells sessile on creeping branches. U.S. little larger than vegetative cells terminal on short erect branches. Epiphytic, forming small brown spots on Porphyra or Polysiphonia* **Microsyphar**
- Creeping filaments bearing erect branches. P.S. multiseriate* (Fig. 4) 13
13. *Creeping filaments of irregular cells bearing erect branches of similar cells which seldom penetrate the surface of the hosts or have a few cells only emerging, as do hairs and sporangia* **Streblonema**
- Creeping filaments of irregular cells bearing branches of more regularly cylindrical cells which emerge from the surface of the host to a distance of a few mm.* **Herponema**
14. *Erect filaments arising from a pseudoparenchymatous hump of cells. P.S. uniseriate, basal, never intercalary* (Fig. 4) 15
- Erect filaments in tufts attached by branched basal filaments. P.S. intercalary* (Fig. 4) 16
15. *Basal mass bearing unbranched assimilatory filaments (up to 2 cm. long) of uniformly cylindrical cells and also short, branched filaments (paraphyses) of rounded cells which become larger towards the tips. Sporangia at the base of the clump, on both kinds of filament. In dense tufts on Fucus etc. and dense patches on receptacles of Himanthalia* **Elachista**

- As above but with few paraphyses; with assimilatory filaments not more than 5 mm. long; in gelatinous hemispherical tufts on Arthrocladia etc.* **Symphoriococcus**
16. Erect filaments with some cells near the tips developing completely into P.S. (as in *Pylaiella*). U.S. terminal on short branches near the base of the clump 17
P.S. very small, developing in bands encircling some cells of the erect filaments, increasing the diameter and leaving sterile axial cells in the centre. U.S. not known **Halothrix**
17. Epiphytic on *Laminaria*, *Alaria* etc. at LWM and sublittoral **Leptonema**
Epilithic, well up-shore, in caves etc. **Waerniella**
18. P.S. intercalary (Fig. 4), U.S. intercalary or sometimes lateral, but if so, very much larger than vegetative cells 19
 Sporangia never intercalary, always lateral, sessile or stalked. (n.b. P.S. sometimes ending in a colourless hair) 21
Plants up to 2 cm. long, sparsely branched and growing by means of an obvious apical cell. Numerous discoid chromatophores in each cell (Fig. 3). U.S. and P.S. sessile, lateral **Choristocarpus**
19. Both P.S. and U.S. intercalary (see Fig. 4), in series, a little larger than the vegetative cells from which they are formed. Chromatophores numerous, discoid (Fig. 3). Occasionally with a single longitudinal division in vegetative cells **Pylaiella**
P.S. intercalary (Fig. 4), U.S. (=oogonia or monosporangia) very much larger than vegetative cells, borne singly or in pairs, intercalary or lateral on short stalks 20
20. *Branching opposite, regular, all sporangia intercalary* **Tilopteris**
Branching irregular, oogonia and monosporangia intercalary or lateral **Haplospora**
21. *P.S. in clusters at the bases of branches. Several discoid chromatophores in each cell* **Sorocarpus**
 P.S. not in clusters 22
22. Chromatophores of linear form (Fig. 3), branching irregular or alternate 23
 Several discoid chromatophores (Fig. 3) in each cell 24
23. Several linear chromatophores in each cell. P.S. multiseriate (Fig. 4), usually elongated and tapering, sometimes ending in a colourless hair **Ectocarpus**
 A single spiral linear chromatophore in each cell (sometimes broken). Filaments interwoven and with recurved branches binding them together into woolly cords **Spongonema**
24. Branches often opposite or with second minor branches (Fig. 1). P.S. sessile, ovoid or pointed ovoid, with the apex leaning sideways (Fig. 4), often in second series. Often with corticating filaments (Fig. 12) at the base. Epiphytic **Giffordia**
 Small plants, usually less than 4 cm. tall—occasionally up to 10 cm. Branched mainly near the base. Sporangia usually stalked and never in series, usually borne near the base. Arising from creeping filaments, forming tufts or more extensive carpets. Epiphytic or sometimes partly endophytic **Feldmannia**
25. Plant almost entirely polysiphonous, monosiphonous only at extreme ends of filaments, unbranched, sometimes hollow when old 26
Plants large, much branched, monosiphonous in branches and parts of main axes 27
 Small plants with tuft of filaments which bear more or less numerous short monosiphonous branches giving the whole thallus a club-shaped appearance 28
26. *Filaments up to 15 mm. long in dense tufts, monosiphonous at the base, becoming polysiphonous, tapering and hair-like towards the apex. P.S. in clusters, sessile or terminal on small branches at the base of the filaments. U.S. not recorded* **Giraudia**

- Filaments up to 10 cm. long (often less), of uniform diameter, sometimes hollow when old, blunt tipped. U.S. and P.S. formed from vegetative cells at the surface of the filament. Epiphytic, in dense patches on *Chorda* or small tufts (seldom over 1 cm. long) on *Alaria* **Litosiphon**
27. Plants polysiphonous in older parts but with monosiphonous branches, opposite or sometimes whorled. Large globular U.S. sessile, in opposite pairs, sometimes whorled. P.S. intercalary **Isthmoplea**
- Filaments polysiphonous in older parts, occasionally hollow, sometimes with interrupting monosiphonous regions. Numerous branches, often attenuated at the tips. U.S. and P.S. partially sunk into the surface of the thallus and formed from surface cells **Stictyosiphon**
28. Tufts of a more or less polysiphonous filaments, each with many monosiphonous simple branches arising from surface cells and bearing long hairs. Branches usually shortest near the base, gradually lengthening distally so that thallus appears club-shaped. U.S. sessile, ovoid; P.S. ovoid, sessile, single and clumped. Epiphytic on *Scytosiphon* and other algae **Myriotrichia**
- Filaments polysiphonous, bearing dense covering of monosiphonous dichotomous branches and some hairs. U.S. ovoid, sessile or stalked. P.S. stalked. Epiphytic on *Asperococcus* and other algae and *Zostera* **Leblondiella**
29. Thallus branched, covered by corticating filaments and bearing large number of short secondary branches all round, resembling a bottle-brush, sometimes in distinct separate whorls. Epilithic **Cladostephus**
- Branches more or less pinnate, never whorled (Fig. 1)
30. Thallus irregularly pinnate, corticating filaments (Fig. 12) only on basal parts of main axis. Sporangia borne laterally on branches, never axillary **Sphacelaria**
- Corticating filaments (Fig. 12) covering most of main axes and major branches **Sphacelaria plumosa**
31. Plants very stiff, branching in 1 plane, secondary branches very regularly opposite, unbranched and without corticating filaments. Sporangia borne laterally on these secondary branches. (= *Chaetopteris*) **Sphacelaria plumosa**
- Plants branched in 1 plane or radially and very bushy, in each case with pinnately branched secondary branches. Branches arising by division of the apical cell and broadly inserted. Sporangia borne in the axils of branches **Halopteris**
32. Thallus a membranous plate attached to rock etc. by rhizoidal filaments **33**
- Thallus adhering directly to rock, not attached by rhizoidal filaments **34**
33. Thallus up to 20 cm. across, of several layers, with largest cells in the centre. Edge of thallus diverging into numerous filaments. Upper surface smooth, bearing sessile, cylindrical U.S. and narrow, stalked P.S. **Zanardinia**
- Thallus up to 2 cm. across, parenchymatous, with cortical tissue of large cells and surface layer of small regular cells. U.S. cylindrical, P.S. absent
34. More or less hemispherical, gelatinous cushions composed of dichotomously branched filaments. U.S. lateral, stalked, irregularly shaped **Aglaozonia stage of Cutleria**
- Cylindrocarpus**
- Massive parenchymatous crust up to 4 cm. thick, layered and without easily separated erect filaments. U.S. in superficial sori terminal on short branched filaments **Battersia**
- With a basal layer of closely packed filaments from which unbranched erect filaments arise

35. *With 1 chromatophore in each cell. Basal layer several cells thick, bearing closely pressed erect filaments on which U.S. and P.S. develop apically. Usually sublittoral* **Lithoderma**
- With several chromatophores in each cell 36
36. *Thallus up to 10 cm. across, with parenchymatous basal plate bearing closely crowded erect filaments, separable under pressure, at the bases of which sporangia are borne. Fertile regions causing swellings in thallus* **Ralfsia**
Very small, basal plate 1 cell thick. Sporangia borne on creeping filaments **Chilionema**
Sporangia terminal on erect filaments 37
37. *Sporangia pyriform, 15 μ -20 μ wide* **Sorapion**
Sporangia straight sided, wider at the tip, up to 12 μ wide **Petroderma**
38. *Thallus elongated and tubular* 40
Thallus rounded, irregularly lobed or sub-spherical. Epiphytic on various algae 39
Thallus forming a stalked "button", frequently hollow, from the centre of which arise (in summer) forked thongs bearing conceptacles of oogonia and antheridia **Himanthalia**
39. *Thallus at first solid, but soon becoming hollow, showing 2 layers of tissue, the outer of radially arranged, monosiphonous assimilatory filaments. Gelatinous, separating into irregular lumps when squeezed* **Leathesia**
Thallus hollow, of 2 layers of tissue, the outer of which is apparently parenchymatous. Membranous, easily torn but not separating when squeezed **Colpomenia**
40. *Thallus unbranched or branching only at the base* 41
Thallus branched 42
41. *Thallus branched only at the base, cylindrical, tapering distally, usually constricted at intervals. Small cells on surface transformed into sporangia which are not localized into sori* **Scytosiphon**
Thallus more or less cylindrical, often irregularly distended and often wider towards the apex. Dotted all over with sori of colourless hairs and sporangia **Asperococcus**
Thallus unbranched, cylindrical, often open at the apex, 1 cell thick, cells regularly arranged in rows. Zoospores produced singly in cells of thallus **Phaeosaccion**
In tufts or patches on Chorda; up to 10 cm. long (often less). Cells arranged in transverse rows, thallus a few cells thick or solid in the younger parts. Blunt ended. U.S. and P.S. scattered, superficial **Litosiphon**
42. *Thallus large. Up to 50 cm. long; 1-5 mm. in dia. Branches opposite or whorled, tapering at each end. U.S. in patches or whorls appearing to the naked eye as a succession of rings round the thallus* **Striaria**
Branching dichotomous, at least in the smaller branches. Thallus at first solid, later hollow in older parts 73
Plants with or without a definite main axis; irregularly branched 72
43. *Small, gelatinous, irregularly lobed thalli epiphytic on various algae with an inner mass of dichotomous branches and an outer layer of radially arranged assimilatory filaments* **Leathesia**
Thallus smooth, unbranched, solid, resembling a leather bootlace up to 2 m. or more long **Chorda**
Thallus branched, very slippery with a core of large-celled colourless filaments more or less closely packed and an outer layer of radially arranged, crowded monosiphonous assimilatory filaments 44
Thallus not organized as above 49

44. Thallus up to 3 mm. in dia., of firm texture, with a central axis and numerous long simple branches. Core of closely packed elongated cells with a compact cortex of very small assimilatory filaments, not easily separable under pressure. P.S. absent **Chordaria**
Thallus soft, narrow (1-3 mm. broad), very profusely branched with many small ramuli, main axes not obvious, with assimilatory filaments each ending in a large globular cell.
 P.S. absent **Sphaerotrachia**
 Thallus irregularly branched, soft and gelatinous, radially arranged filaments easily separable under pressure 45
45. Central core of longitudinally elongated cells not interwoven with transverse filaments. Both P.S. and U.S. present 46
 Central core of longitudinal filaments interwoven with fine filaments running in all directions, surrounded by cortex of cells decreasing in size outwards and bearing assimilatory filaments in groups 48
46. P.S. terminal on assimilatory filaments which bear U.S. laterally at their bases 47
 P.S. and U.S. lateral at the bases of the assimilatory filaments **Liebmannia**
47. Epilithic **Eudesme**
Epiphytic on Zostera **Cladosiphon**
48. Diameter of thallus irregular, 5 mm. or more in places **Mesogloia**
 Diameter of thallus more regular; up to 2 or 3 mm. **Sauvageaugloia**
49. Reproductive organs (oogonia and antheridia) sunk in conceptacles localized in fertile regions (receptacles) at tips of fronds or borne on special lateral branches 50
 Reproductive organs not as above, or plant without receptacles 53
50. Lower part of thallus in form of stalked leathery button with (in summer) long forked strap-shaped receptacles springing from its centre **Himanthalia**
 Strap or ribbon-like thallus; flat, much branched; air bladders, if present, in the course of the frond 52
 Thallus cylindrical, or often somewhat flattened 51
51. Thallus with large oval air-bladders borne singly along the main axes; ovoid receptacles on short lateral deciduous branches, arranged in groups **Ascophyllum**
 Thallus cylindrical, 2-3 mm. in diameter. Dichotomously branched. Receptacles terminal, cylindrical, base expanded and knobby **Bifurcaria**
 Thallus pinnately branched, slightly flattened in the plane of the branches; long pod-like air-floats divided by septa; small, elongated receptacles on narrow forked branches **Halidrys**
 Thallus finely divided, usually narrow (1-3 mm.), though thicker at the base, and cylindrical, frequently covered with spines; air bladders small, not very distinct, arranged in chains distending the finer branches **Cystoseira**
52. Small plants, up to 15 cm. long, without air-bladders, growing at high water mark; channelled thallus irregularly dichotomous, no midrib **Pelvetia**
 Larger algae, with or without air-bladders, not channelled; with a midrib; receptacles terminal on divisions of the thallus **Fucus**
53. Plant a stalked leathery button 3 cm. or less in diameter **Himanthalia**
 Small plant, up to 15 cm. long, without air-bladders, growing at high water mark; channelled thallus irregularly dichotomous, without a midrib **Pelvetia**
- Plants provided with definite air-floats 54
 Plants not provided with definite air-floats 56
54. Thallus flat, strap or ribbon-like with a midrib, much divided, air-floats in the course of the frond **Fucus**
 Thallus cylindrical, or often more or less flattened 55

55. Thallus with large ovoid air-bladders borne singly along the main axis
Ascophyllum
 Thallus pinnately branched; long pod-like air-floats divided by septa **Halidrys**
 Thallus finely divided, cylindrical, usually narrow, 2-3 mm. in dia., thicker
 at base, frequently covered with spines; air-bladders small, not very
 distinct, arranged in chains distending the finer branches **Cystoseira**
 Thallus cylindrical, 2-3 mm. in dia., stiff, dichotomously branched; incon-
 spicuous air bladders just below the upper dichotomies. Base expanded and
 knobably **Bifurcaria**
56. Thallus expanded into a membrane, a lamina or a ribbon more than 1 cm.
 wide; branched or unbranched; with or without a stem-like portion 57
 Thallus cylindrical or flattened, branched or unbranched, not exceeding 6 mm.
 in width 69
57. Thallus usually more than 40 cm. long when mature 58
 Thallus usually less than 40 cm. long when mature 61
58. Thallus provided with a midrib 59
 Thallus without a midrib, consisting of a broad flattened lamina arising from
 a narrow cylindrical or flattened stipe 60
59. Thin membranous papery frond with conspicuous yellow midrib and, if re-
 producing, a bunch of tongue-like branches arising from the stipe below
 the frond **Alaria**
 Thallus strap-like, much branched, with serrated margins and marked midrib;
 thallus covered with groups of mucilage hairs **Fucus serratus**
60. Large leathery fronds without midrib; stipe circular or slightly oval in
 section; no mucilage hairs on the lamina **Laminaria**
 Large leathery fronds with flattened stipe which sometimes has frilled lateral
 wings; base irregularly bulbous and covered with short tubercles; mucilage
 hairs on lamina **Saccorhiza**
61. Thallus undivided, often pointed at the apex 62
 Thallus dichotomously or otherwise divided 63
62. Sori of U.S. and P.S. (either or both) forming flecks or spots on the thallus;
 substance somewhat delicate in texture **Punctaria**
 U.S. absent; P.S. formed without much distention of surface cells over large
 areas of the thallus; substance of the thallus tough **Petalonia**
63. *Thallus without midrib, more or less dichotomously divided, narrowing markedly
 towards the tips which end in tufts of monosiphonous filaments. Thallus heavily
 spotted with sori of stalked P.S.* **Cutleria**
 Thallus dichotomously divided (sometimes almost undivided). Sporangia
 sessile, if present 64
64. With a midrib 65
 Without a midrib 66
65. *Frond narrow (less than 2 mm. wide), sporangia on conical expansions at the apices
 of branches; sublittoral* **Carpomitra**
Frond wider (1-2 cm.), papery, sporangia generally distributed on the surface; sublittoral
Dictyopteris
 Thallus leathery, either with obvious midrib and lamina (near HWM) or, on
 exposed shores, with lamina much reduced **Fucus**
66. Frond regularly dichotomously branched, branches not becoming wider
 distally 67
 Frond irregularly dichotomous or fan shaped, branches widening distally and
 with sporangia in lateral rows 68
67. T.S. in lower part of thallus shows a single central layer of large cells with a
 single layer of small cells on either surface **Dictyota**

- T.S. in lower part of thallus shows a central tissue of large cells more than 1 cell thick with a single layer of small cells on either surface* **Dilophus**
68. Frond much divided, up to 25 cm. long, not lime-encrusted **Taonia**
 Frond little divided, 10 cm. or less long, distal margin inrolled and rounded; with a chalky deposit **Padina**
69. *Small plants less than 5 cm. long, thin and wiry, epiphytic on Zostera. P.S. formed from surface cells* **Petalonia zosterifolia**
 Plant dichotomously branched, solid thallus 2-3 mm. in dia. attached by expanded knobby base **Bifurcaria**
 Thallus generally large—up to 2m. in length; very much branched, cylindrical or flattened, firm textured, parenchymatous, with a distinct central axial row of cells, seen in T.S. as a thick walled central cell, not necessarily large. Often with tufts of filamentous branches in summer **Desmarestia**
- Thallus filiform or filamentous 70
70. *Small unbranched cylindrical thalli (less than 3 cm. long and 1 mm. in dia.) epiphytic on Sauvageaugloia. Outer layer of short radial assimilatory filaments and uniseriate P.S.* **Buffhamia**
 Thallus with main axis and branches opposite or whorled 71
 Thallus with main axis, but branches irregular (not opposite or whorled) or with main axis indistinct 72
 Branching dichotomous, at least in smaller branches 73
71. *Thallus hollow, up to 5 mm. in dia., branches attenuated at both ends, sporangia superficial, in whorls visible to the naked eye as transverse rings* **Striaria**
 Thallus about 1 mm. in dia., with a very large thick walled, axial filament. Bearing tufts of branched, monosiphonous ramuli in whorls. U.S. in chains on the ramuli **Arthrocladia**
72. Thallus hollow in older parts or solid and parenchymatous throughout. Without assimilatory filaments. Main axis with long branches. U.S. formed from superficial cells not projecting from thallus **Dictyosiphon**
 Main axis thin with long alternate branches bearing U.S. in ovoid masses at the ends of short monosiphonous branches, with a distal tuft of hairs **Sporochnus**
 Branching irregular, plant bushy with long branches less than 2 mm. wide. Hollow in older parts, central cavity small. With a single axial cell row surrounded by a few layers of cells and an outer layer of short, radial assimilatory filaments bearing sporangia at their bases **Acrothrix**
 Branching irregular, sparse. Thallus tubular at least in older parts. Outer layer of branched assimilatory filaments with monosiphonous ramuli bearing intercalary P.S. Lower parts of thallus mucilaginous **Myriocladia**
73. Plants dichotomously branched, soft, up to 50 cm. long, 1 mm. thick at base. Outer layer of closely packed radial assimilatory branches of 2-3 cells each. Tips of branches without longer assimilatory filaments **Stilopsis**
 Plants dichotomously branched, firm, up to 40 cm. long, 1-2 mm. thick in older parts which may be hollow but have a persistent central filament. Outer layer of small cells, 1 cell thick. With assimilatory filaments near the tips of branches standing out from the surface but soon lost. P.S. rare; U.S. in small sori well separated and often in whorls or spirally arranged **Spermatochnus**
 Plants irregularly branched or dichotomous, firm, up to 60 cm. long, 1 mm. thick at base, older parts hollow. Outer layer of small cells; assimilatory filaments up to 150 μ long near the tips of branches, P.S. rare, U.S. in large hemispherical sori, often touching each other and giving the thallus a distinctly warted appearance **Stilophora**

RHODOPHYCEAE

1. Thallus encrusted with lime 2
Thallus not encrusted with lime 8
2. Thallus expanded horizontally, encrusting rock or other algae; attached by the whole surface, or with free margins, or attached at 1 point only; irregular coral-like branches without regular constrictions may arise from horizontal portion 3
Thallus not expanded horizontally, but erect, branched and regularly constricted 7
Endophytic in Corallina and Jania. Branched filaments between cells of host producing, on the surface, ovoid conceptacles with an apical ostiole **Choreonema**
3. Thallus a very thin plate—1 cell thick at the margins, several (1-5) layers thick in the central parts. Tetraspores in conceptacles; cystocarps raised. Tetraspores zonate (Fig. 6) 4
Thallus many cells in thickness, sometimes differentiated into distinct strata 5
4. Surface view shows cells arranged in concentric rows; some cells bearing long hairs, tetrasporangial conceptacles opening by a single pore **Melobesia**
Cells not in concentric rows, hairs absent, tetrasporangial conceptacles opening by a number of small pores. Epiphytic, epilithic, on shells etc. **Epilithon**
5. Encrusting, overlapping or sometimes vertically arranged plates. Tetraspores in conceptacles with domed roofs, opening by a single ostiole and with a central mass of sterile filaments surrounded by tetraspores. Basal cells in concentric rows **Lithophyllum**
Encrusting or forming coral-like growths. Tetrasporangial conceptacles with several openings 6
6. Thallus encrusting or knobby or branched and coralloid. Vertical section shows a hypothallium with the lowermost 2 or more layers of cells parallel with the substratum, upper ones in rows curving upwards (Fig. 11) **Lithothamnium**
Thallus encrusting, smooth, never with coralloid branches. Vertical section shows a hypothallium of cells in concentric rows (Fig. 11) **Mesophyllum**
7. Thallus pinnately branched (Fig. 1) **Corallina**
Thallus dichotomously branched (Fig. 1) **Jania**

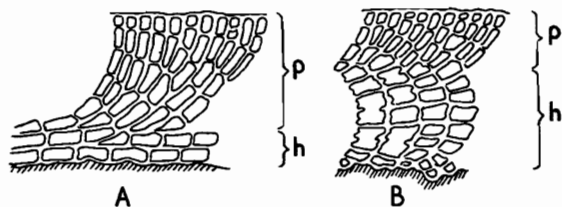


FIG. 11

Vertical sections through encrusting thalli: A. *Lithothamnium*; B. *Mesophyllum* (Both $\times 300$).

p=perithallium, h=hypothallium.

8. Minute filamentous algae creeping in or on the walls or shells, of animals or other algae, rarely giving off upright free filaments except when reproducing 9
Minute plants forming discs, plates or stain-like patches on rock or other algae; thallus an expanded basal plate either very thin or giving off vertical filaments of uniform height separable under pressure or forming a solid pseudoparenchymatous mass 12
Thallus of various forms but neither encrusting nor endophytic, or if endophytic (parasitic) then with reproductive organs in external outgrowths 17

9. *Endozoic in the walls of Alcyonidium with monosporangia on short erect emergent filaments* **Acrochaetium endozoicum**
Endozoic in Sertularia or epiphytic on various algae, shells or stones, tetraspores in erect emergent branches, cruciate; chromatophores linear, sometimes spirally arranged **Audouinella**
Endophytic in Cladophora pellucida. Zonate tetrasporangia in sori formed under the surface of the host wall, sometimes emergent. Bispores common **Schmitziella**
Irregular filaments endophytic in mollusc shells, often colouring them red. Bearing monospores **Conchocelis** stage of **Porphyra**
Endophytic in Bonnemaisonia and Asparagopsis between cortical cells, monospores lateral on creeping filaments **Acrochaetium bonnemaisoniae**
Endophytic in the walls of various algae (Polysiphonia etc.) with emergent branches up to 5 mm. long bearing monospores **Acrochaetium**
Endophytic in outer layers of Desmarestia ligulata, often with filaments growing side by side in contiguous pairs **Colacodictyon**
Minute epiphyte on Sporochnus and Carpomitra. Filaments under 2 mm. long, arising from a hemispherical basal cell and often bearing apical hairs **Kylinia**
Microscopic epiphytes forming discs or patches on or in Flustra, on the surface of other algae etc. Reproducing by monospores cut off within ordinary cells of the thallus 10
10. *Thallus consisting, at least at the margin, of easily recognized separate filaments* 11
Thallus consisting of a disc made up of closely aggregated filaments with an entire margin **Erythropeltis**
11. *Cells with definite individual walls, filaments traceable back to the centre of the thallus. Epizoid* **Erythrocladia**
Filamentous part with cells in uniseriate rows, well separated and embedded in mucilage, filamentous nature not obvious in central part of the thallus. Endozoic **Neevia**
12. *Erect filaments more than 5 mm. high* 28
Erect filaments less than 5 mm. high 13
Erect filaments absent, thallus a disc a few mm. in dia. formed of dichotomous creeping branches which may become a few layers thick in places. Tetraspores cruciate, in sori, borne in short filaments of a few cells, each of which becomes a tetrasporangium **Erythrodermis**
13. *Erect filaments easily separable under pressure* 14
Erect filaments not easily separated by pressure 15
14. *Forming extensive very dark red crusts on rock or Laminaria stipes. Erect filaments closely crowded, bearing intercalary cruciate tetrasporangia (Fig. 4 and 6)* **Petrocelis**
Small discs less than 1 cm. in dia. on shells. Sublittoral. Erect filaments short. Cruciate tetrasporangia in sori, each at the apex of an erect filament **Rhodocelus**
Forming discs up to 10 cm. or more in dia. on Laminaria stipes. Erect filaments bearing lateral, zonately divided tetrasporangia **Cruoria**
Small discs less than 2 cm. in dia. Erect filaments bearing lateral cruciate tetrasporangia. On shells etc.; sublittoral **Cruoriopsis**
Disc a few cm. in dia., attached by rhizoids to other algae, rock or shells. More or less calcareous; tetrasporangia cruciate, in nemathecia of numerous paraphyses raised above the surface of the thallus **Peyssonelia**
15. *Forming extensive dark red crusts. Tetrasporangia zonate or irregularly divided, borne below the level of the thallus surface in conceptacles with large pores* **Hildenbrandia**
Forming crusts on rock. Cruciate tetraspores not in sori, scattered amongst the erect filaments just below the surface of the thallus **Haematocelis**

- Forming crusts with tetrasporangia in sori raised slightly above the surface of the thallus 16
16. *Tetrasporangia zonate*, unaccompanied by paraphyses. Crusts up to 2.5 cm. wide on rock
Porphyrodiscus
 Tetrasporangia cruciate, accompanied by numerous paraphyses. Crusts sometimes extensive, varying from 2 to 30 cells in thickness; directly on rock and *Laminaria* stipes, without rhizoids **Rhododermis**
 Tetrasporangia cruciate, accompanied by numerous paraphyses. More or less calcareous. Crusts a few cm. in dia. attached to rock, shell, or algae by short rhizoidal filaments **Peyssonelia**
17. Thallus of very fine unbranched filaments attached singly to the substratum 18
 Thallus of fine branched filaments, monosiphonous throughout, sometimes with delicate, irregular corticating filaments growing over the surface of the main axis 19
 Thallus of branched filaments, originally monosiphonous but soon either becoming polysiphonous by longitudinal division of the main axis or with monosiphonous structure obscured by cortication of various kinds so that it can be seen only in the young growing apices or ultimate branches 33
 Thallus of various forms (cylindrical, compressed, laminate) but never obviously of monosiphonous structure even when the youngest parts are examined externally 46
18. Filaments monosiphonous, occasionally with additional rows of cells near the base **Erythrotrichia**
 Filaments polysiphonous, of irregular width, with groups of cells arranged in bands across the thallus. Forming dark slippery strata on upshore rocks and woodwork **Bangia**
19. Thallus cylindrical, a few mm. in dia., branched at least at the base, very gelatinous and worm-like, composed of numerous longitudinal monosiphonous filaments bearing others radially arranged in tufts. More or less separable under pressure 48
 Thallus filamentous, not gelatinous and worm-like. Branches opposite or whorled, or with some branches opposite and some alternate 20
 Thallus filamentous, not gelatinous or worm-like. Branches alternate (regular or irregular) or dichotomous; never opposite 26
20. Branches whorled or main branches arising irregularly and bearing whorled ramuli 21
 Branches opposite, or sometimes in whorls of three, or main branches alternate and ultimate branches opposite 23
21. Plants ecorticate, or corticate in older parts with large cells bearing numerous whorled ramuli at each node, giving the plant a shaggy or beaded appearance 22
 Plants very delicate, in dense tufts, usually small but occasionally 10 cm. or more long. All cells of microscopic size; profusely branched, each whorl of a few branches only **Antithamnion**
Plants corticate in the older parts, branches mostly irregularly alternate but the ultimate branches bearing whorls of small ramuli at the nodes **Atractophora**
22. Plants up to 25 cm. long, texture rather stiff, main branches irregular. Cells very large with numerous whorled branches at the nodes which curve upwards and overlap those of the next node, giving the plant a shaggy "bottle-brush" appearance. Epilithic **Halurus**
Plants up to 5 cm., soft, with main branches irregular and with dense whorls of dichotomous ramuli at the nodes, whorls overlapping in the smaller branches, separate in the older parts so that the thallus appears beaded. **Crouania**

- Plant with distinct main axis bearing very long, usually opposite branches.
Cells large. Ramuli borne in whorls which are obviously widely separated to the naked eye. Ramuli in the smallest branches often opposite rather than whorled
Sphondylothamnion
23. Small plants forming cushions. With creeping filaments attached to the substratum by unicellular disc-ended rhizoids. With erect branched filaments up to 1 cm. long. Branching irregular or main branches alternate and ultimate branches opposite. Tetraspores lateral
Plants with definitely pinnate or whorled branches
24
25
24. *Filaments with occasional colourless cells, much smaller than the normal ones and placed between them to one side of the filament. Tetrasporangia immersed in the branches singly or in series*
Trailiella (tetrasporophyte of **Bonnemaisonia**)
Filaments without occasional small colourless cells. Tetrasporangia in groups, lateral on branches
Spermothamnion
25. *Erect filaments up to 2 cm. long, arising from creeping filaments attached to the substratum by disc-ended rhizoids. Branches bearing regularly opposite ramuli. Tetrasporangia tetrahedrally divided (Fig. 6), borne singly, terminally on the ramuli*
Ptilothamnion
Filaments with pinnate, usually opposite or whorled branches. Tetrasporangia cruciate (Fig. 6), lateral
Antithamnion
26. *Plants very small (1 cm. or less), branched. Filaments composed of well-separated rounded cells in gelatinous cylinders. Each cell containing 1 stellate chromatophore (Fig. 3) with a pyrenoid*
Plants in small tufts or forming a dense fluffy covering over other algae, rock etc. Sometimes binding sand on rock. Length 2 cm. or usually less
Plants profusely branched, 2 to 10 cm. or more in length
27
28
29
27. *Light red coloured, more or less dichotomously branched, epiphytic on Sphacelaria and other algae*
Goniotrichum
Blue-green colour, cells oval, branching irregular. Epiphytic—in brackish water
Asterocytis
28. One chromatophore in each cell, usually with a pyrenoid. Monospores or occasionally cruciate tetraspores. Epiphytic or endophytic
Acrochaetium
More than 1 chromatophore in each cell—linear or stellate or irregular.
Cruciate tetraspores. Epilithic, commonly binding sand on littoral rocks, or occasionally elsewhere
Rhodochorton
29. Plants bright crimson, ecorticate; with profuse dichotomous branching; rather stiff. Composed of very large cells visible to the naked eye, at least in the older parts. Spores in groups surrounded by whorls of ramuli at the ends of short branches
Plants not of this form
30
31
30. Cells much longer than broad in the older parts, cylindrical or pyriform, ends of branches tapering to a fine point (see Fig. 15)
Griffithsia
Cells cylindrical, 2-4 times as long as broad in the older parts, ends of branches blunt
Bornetia
31. *Plant up to 10 cm. long, ecorticate except near the base. Branching irregularly alternate, ultimate ramuli subdichotomous (Fig. 1), bearing monospores (occasionally tetraspores) with a single stalk-cell in their axils*
Corynospora
Plants 10 cm. or more long, densely tufted. Branching alternate; final branches with lower half bare, distal part bearing pinnate, alternate ramuli. Tetraspore mother cells dividing to give numerous small spores
Pleonosporium

Plants up to 10 cm. long, older parts corticate, main axes clearly defined, branches often arising spirally; bearing, alternately, subdichotomous ramuli with lateral tetrahedrally divided tetraspores and terminal dichotomous chains of undivided spores **Seirospora**
 Plants up to 10 cm. long. Branched mainly in 1 plane, smaller branches and ramuli very regularly alternately branched. Tetraspores tetrahedral, terminal on the ramuli

Composhamnion

Plants up to 10 cm. long. Much branched, branching irregular, or alternate, ultimate branches alternate, or dichotomous. Tetraspores tetrahedral, lateral. Carpospores in paired groups on either side of the filaments, with a mucilage envelope but no protecting whorl of branches

32

32. Ultimate branches with alternate or dichotomous ramuli. Cells multinucleate.

Callithamnion

Ultimate branches bearing very regularly alternate ramuli. Cells uninucleate.

Aglaothamnion

33. Plant fundamentally of a polysiphonous axis with a central row of cells, each of which is surrounded by a varying number of pericentral cells of equal length (Fig. 5B); the polysiphonous axis may be hidden by small corticating cells

34

Plant cylindrical, or dorsoventrally flattened, but fundamentally of a monosiphonous axis, partially covered by bands of small cells, or completely enveloped in a sheath of irregular corticating cells

38

34. Plant with polysiphonous main axes but with persistent monosiphonous lateral branches

35

Plant polysiphonous throughout except for terminal groups of colourless hairs sometimes shed at maturity

36

35. Plant very definitely dorsoventrally flattened. Polysiphonous parts corticate, ultimate ramuli monosiphonous, with cells about as long as broad. Tetraspores in lateral rows in special swollen, conical branches **Heterosiphonia**

Plant with obvious main axis bearing alternate branches which become shorter towards the apex. Ecorticate. Minor branches bearing finely filamentous, dichotomously branched, ramuli. Polysiphonous parts with 7 pericentral cells. Tetraspores borne singly immersed in the branches, often in longitudinal rows

Brongniartella

Plant much branched, polysiphonous except for apices. Branches with incurled tips. Seldom fertile. Salt marsh plant tangled round stems of e.g. *Halimione*

Bostrychia

Plant profusely branched, minor branches bearing finely filamentous dichotomously branched ramuli whose cells are much longer than broad. Corticate. Tetraspores in transverse rows in swollen conical ramuli

Dasya

36. Thallus cylindrical, branched, with at least the minor branches ecorticate; frequently with groups of colourless hairs at the apices of branches

37

Thallus branched in 1 plane, with at least the minor branches regularly alternate. Cylindrical or flattened; corticate throughout, except sometimes near the growing apices, but with polysiphonous axis visible through the corticating cells

Pterosiphonia

Thallus cylindrical, T.S. showing a central cell and 5 pericentrals, corticate throughout; with numerous branches bearing many secund ramuli with incurling tips and tapering at both ends

Halopitys

Thallus cylindrical, T.S. showing a central cell and 5 pericentrals (occasionally 6), with several layers of corticating cells throughout. Branches attenuated towards the base, and either blunt-ended or occasionally attenuated distally

Chondria

- Plants small, much branched. Corticate except for the tips of branches which are curled inwards. Tangled round stems of plants (e.g. *Halimione*) in salt marshes **Bostrychia**
- Thallus cylindrical, much branched; L.S. showing a few rows of elongated cells around a central cell and with several layers of small corticating cells; structure not obviously regularly polysiphonous—central and pericentral cells not of uniform length with their cross walls in the same plane. Sometimes with main axes bearing numerous short, equal branches **Rhodomela**
37. Branching variable, ecorticate or with cortication at the base only or corticate except for the apices and minor branches. Pericentrals 4-24 (Figs. 5 and 15) **Polysiphonia**
- Small plant, sparsely branched, up to 3 cm. high. Erect branches arising from a creeping system fixed to the substratum by unicellular rhizoids. Pericentrals up to 18* **Lophosiphonia**
38. Thallus cylindrical 39
Thallus flattened in 1 plane 40
39. *Main axis and branches covered with short evenly spaced, pinnate, spine-like ramuli. Cystocarps terminal on the ramuli* 41
Plant cylindrical, main axis never flattened. Not as above 42
40. Thallus irregularly pinnately branched, texture firm; more or less flattened branches of various widths, covered to the tips with small cells 88
Thallus with regular opposite branching, at least in the smaller branches, obviously monosiphonous at the apices 56
41. *Branched mainly in 1 plane, main axis sometimes flattened. Hooked branches absent* **Bonnemaisonia**
- Branched irregularly in all planes. Main axis never flattened. Bearing occasional short, thickened, hooked branches* **Asparagopsis**
42. Axial row of cells easily observed, either showing through the corticating cells or giving the axes a "beaded" appearance. Often with forcipate apices (Fig. 12) 43
Axial row of cells not easily seen except in young branches 45
43. Axis consisting of large cells, cylindrical or barrel shaped corticated either at the nodes or, if entirely, then with axial cells giving the thallus a beaded outline 44
Axis and branches consisting of large axial cells with several layers of corticating cells. Outline not beaded, central cells visible through the cortex, equal to only half the dia. of the filament **Microcladia**
- Gelatinous, much branched thallus. at first ecorticate, bearing whorls of fine, dichotomous ramuli. Later becoming covered by downward growing corticating filaments and with a close packed investment of whorled ramuli* **Dudresnaya**
44. Main axes and branches of similar form—corticate at the nodes (Fig. 12) or entirely. Tetrasporangia immersed in the thallus, often in whorls, sometimes singly in each articulation, causing local swellings **Ceramium**

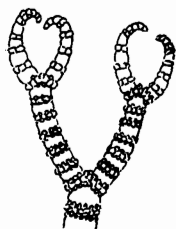


FIG. 12

Forcipate apices ($\times 150$) on a species of *Ceramium* corticated at the nodes.

- Main axes and branches corticate with small corticating cells at the nodes and long ones between. Bearing monosiphonous, ecorticate ramuli, several at each node. Tetrasporangia sessile on the branches* **Spyridia**
45. *Plant cylindrical, rather gelatinous, much branched, bearing numerous ramuli attenuated at either end. Central siphon not easily identified. T.S. shows 5-8 large cells surrounded by small corticating cells. Carpospores on locally swollen ramuli* **Naccaria**
- Plant cylindrical, much branched, substance firm, central siphon not easily seen. T.S. shows central cell surrounded by many others decreasing in size towards the periphery. Cystocarps flask-shaped, stalked. Tetraspores in 1 or 2 longitudinal rows immersed in special branches* **Rhodomela**
- Very gelatinous, cylindrical, much branched thallus with a single axial filament at least in the younger parts giving off whorls of branches uniting to form a cortex, at the periphery, of radially arranged, closely crowded equal branches, separable under pressure. Thallus sometimes hollow when old* **Gloiosiphonia**
46. *Thallus a thin membrane, 5 cm. long or more, 1 cell thick, yellow, brown or purple. Similar in texture to thin polythene sheet. Cells small (up to 25 μ across) in small groups, well separated* **Porphyra**
- Thallus a gelatinous mass in which small cells are embedded without apparent order, well separated from each other* **Porphyridium**
- Thallus membranous when mature, 4 cm. long or less, 1 cell thick, cells 4-7 μ across. When young a dome of cells in a mucilaginous matrix* **Porphyropsis**
- Plant a minute parasite with filaments endophytic and producing colourless pustules or leafy tufts on the surface of the host which contain the spores* 47
- Plants very gelatinous and worm-like, built up of longitudinal filaments giving off radially arranged filamentous branches all held together by mucilage* 48
- Plants not as above* 51
47. *Parasitic and producing pustules on Rhodomela confervoides* **Harveyella**
- Parasitic and producing pustules on Polysiphonia lanosa* **Choreocolax**
- Parasitic and producing pustules on Gracilaria verrucosa* **Holmsella**
- Parasitic and producing small leafy tufts on Cryptopleura* **Gonimophyllum**
48. *Thallus obviously monosiphonous in the younger parts with whorls of very fine dichotomous ramuli; older parts covered by corticating filaments and dense growth of radial ramuli (distinguished from Nemalion by this whorled arrangement)* **Dudresnaya**
- Thallus hollow in older parts; with a central axial filament, visible at least in the younger parts, giving off dichotomous, radially arranged branches whose end cells are small and closely packed to form the outer layer of the thallus* **Gloiosiphonia**
- Thallus never hollow. With a number of longitudinal filaments intertwined, giving off radial filaments, without a distinct axial row* 49
49. *Thallus simple or branched only at the base or with a few dichotomies. Cortex of radially arranged branches, not in whorls, dichotomously branched and all embedded in mucilage. Separable under pressure. End cells of branches not closely united into a continuous outer layer. Carpospores in small clumps amongst the outer branches, without special protecting filaments* **Nemalion**
- Thallus cylindrical, dichotomously branched, sometimes with slight constrictions in the branches; with outer cells of cortical branches large, colourless and united into a continuous outer layer. Carpospores within this, reaching the exterior through a pore* **Scinaia**
- Thallus with a distinct main axis and lateral branches; carpospores in clumps surrounded by special protecting filaments*

50. *Thallus with an inner axis of a number of intertwined filaments bearing radial, dichotomous branches in which the cells are largest towards the periphery* **Helminthocladia**
Thallus with a central axis of large cells, longitudinally elongated and not obviously composed of separate filaments, bearing a cortex of radial dichotomous branches which end in long colourless hairs in the younger parts **Helminthora**
Thallus more or less cylindrical, much branched. T.S. shows single central cell with 4 widely spaced radial cells each giving off dichotomous branches, the ultimate branches of which meet in an outer cortex **Callosiphonia**
51. *Thallus cylindrical or somewhat flattened but, if so, less than 1 cm. wide and more than 1 cell thick* 52
Thallus, at least in part, a flattened lamina 53
52. *Axis of smooth outline, or articulated into segments, hollow or solid, branching irregular and sometimes whorled or dichotomous* 75
Axis much branched in 1 plane, basically pinnate, never dichotomous 55
53. *Thallus cylindrical in the lower parts, expanding distally into a more or less flattened blade. Texture firm, always more than 1 cell thick* 83
Thallus almost entirely flattened, sometimes with an inconspicuous stalk, or, if with a more definite rounded stripe, then with a lamina mainly 1 cell thick
54. *Thallus very thin—1 cell thick except in the thicker midrib, if this is present* 54
More than 1 cell thick 68
55. *Branches opposite, tri- or quadri-pinnate (see Fig. 1), very narrow with a single axial row of cells visible in the young apices* 56
Thallus rather soft and gelatinous, branching usually irregularly pinnate from a main axis, sometimes dichotomous. Central tissue of longitudinal filaments, interconnected and surrounded by a cortex of cells becoming smaller outwards **Grateloupia**
Branching opposite or whorled—axial cells seen only with difficulty when tips are examined externally. Thallus cylindrical, substance firm, rather brittle, branch tips blunt. Tetraspores in groups in ramuli. Cystocarps flask-shaped, sessile. Epiphytic on algae in pools **Laurencia obtusa**
Branching alternate 57
56. *Thallus rigid, usually stiff enough to maintain its shape out of water, regularly pinnate with alternate long and short branches. Corticate throughout. Usually epiphytic on *Laminaria* stipes* **Ptilota**
Thallus much branched, a few cm. long, soft, clinging to the fingers. Branches of unequal length but not regularly long and short. Youngest branches monosiphonous **Plumaria**
Thallus with obvious main axis, with irregular branching, all branches bearing numerous short spine-like opposite ramuli. Cystocarps terminal on short ramuli **Bonnemaisonia**
57. *Plants up to 20 cm.—usually less. Dark colour; L.S. shows central axis of longitudinal filaments surrounded by cortex of small cells* 88
Thallus up to 20 cm. long but very narrow, flattened in the upper parts, where thicker in the middle and becoming very thin at the edges **Pantoneura**
Thallus of solid texture, flattened, with a poorly defined midrib, dark red in colour, 6-12 mm. in width; ultimate branches with several sharply marked teeth **Odonthalia**
Thallus narrow (1 mm. wide or less). Main branches irregularly alternate in 1 plane, the ultimate ones arising in secund groups (Fig. 1); zonately divided tetraspores in special marginal clusters of branches **Plocamium**
Thallus narrow (1-4 mm.), branching irregularly and profusely. Branches fringed with numerous short, lateral, spiny ramuli, sometimes distended into globular swellings **Sphaerococcus**

- Substantial fronds with blunt-ended lateral branches but not conspicuously narrow insertions; circular or oval in T.S. Sometimes very stunted and turf-like on exposed rocks **Laurencia**
58. Macroscopic midrib present 59
Midrib absent or ill defined 63
59. Plant with 1 to numerous leaf-like laminae, 1-5 cm. or more wide, with midribs and secondary ribs; borne on a stiff cylindrical stipe 60
Plants with narrow laminae a few mm. wide and much branched 61
Plant with lamina almost entirely absent except in the distal parts where it is poorly developed **Pantoneura**
60. Thallus branched in the plane of the lamina, edge of lamina deeply lobed, as in an oak leaf. Stipe short **Phycodrys**
Lamina simple, edges not deeply indented (more like a beech leaf). Usually with several laminae arising from a thick cylindrical stipe **Delesseria**
61. Thallus branched dichotomously in the plane of the lamina (as in *Fucus*) **Membranoptera**
Thallus with branches arising from the midrib, attenuated at their bases, not in the plane of the lamina 62
62. Apices of branches attenuated to a point, midrib the only "vein" **Hypoglossum**
Apoglossum
63. Apices blunt, secondary "veins" present **Apoglossum**
Thallus small (up to 5 cm. long), much divided, with a midrib more or less clearly defined **Erythroglossum**
Thallus 6-7 cm. long: epilithic, with a stipe 5-10 mm. long. Lamina bears additional branched filamentous attachment organs at its margin and tetraspores in small out-growths from its surface **Drachiella**
64. Thallus up to 25 cm. or more long, with no trace of a midrib 64
Microscopic veins absent, apical cell indistinct (as in Fig. 14B) **Nitophyllum**
Microscopic veins present (Fig. 13) 65

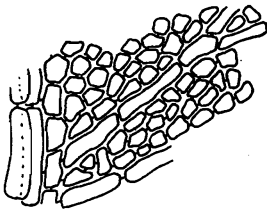


FIG. 13

Microscopic vein ($\times 300$).

FIG. 14

Growing apices: A. *Polyneura*; B. *Cryptopleura*. (Both $\times 300$.)

65. Apical cells clearly defined at apex of frond and elsewhere on its margin (Fig. 14A) 66
Apical cells indistinct (Fig. 14B) 67
66. *Small (5 cm. or less) thallus much divided, with marginal rhizoids attaching it to other plants* **Rhizoglossum**
Plant up to 25 cm. long, variously divided, with a very short stipe at the base.
Rhizoids absent. Tetrasporangia in sori on the thallus surface or marginal **Polyneura**

67. Plants variously divided, up to 25 cm. long, sometimes with blue iridescence under water; veins spreading from the base. Tetrasporangia in sori on marginal proliferations or on the thallus surface. Sometimes with hooked branches **Cryptopleura**
Plants irregularly divided, tetrasporangia borne in curved sori with surface of the thallus near the apices **Acrosorium**
68. *Dichotomously branched with spores in longitudinal streaks in places giving the appearance of an interrupted midrib* **Stenogramme**
 Without a midrib 69
69. *Thallus 1-5 cm. long consisting of a flattened ovoid frond from the margins of which spring a few (6-12) similar branches* **Lomentaria orcadensis**
 Thallus laminate—undivided or very little divided and with a smooth outline. Cystocarps in central layers, not producing swellings 70
 Thallus completely laminate; variously lobed or branched, with or without veins 71
70. Plant extremely leathery, dark crimson in colour, forming spoon shaped blades attenuated at the base, 5-15 cm. long, singly or in clumps of a few **Dilsea**
Plant up to 10 cm. long, bright red, soft, with a single layer of small cells on either side joined by a medulla of very sparse filaments **Halymenia**
Plant up to 30 cm. long, soft, the colour of raw liver **Schizymenia**
71. Thallus tough or fleshy, entirely or almost opaque, variously branched, lobed or frilled, without veins 72
 Thallus a delicate membrane, usually translucent, with or without veins, sometimes frilled at the margin 73
72. *Thallus broad and irregularly lobed, lobes often narrow at their bases. Medulla of longitudinally elongated and interwoven filaments covered by a cortex of 2 or more layers of cells, the outermost being smallest. Cystocarps forming raised bumps* **Callymenia**
Thallus thick and brittle. With narrow, more or less dichotomous branches, without marginal proliferations. Cystocarps forming raised warts on the surface with a central ostiole. Medulla of large cells, not elongated, with a cortex of small cells **Gracilaria foliifera**
 Thallus broad and fan shaped, with irregular lobes and branches. Central tissue of large and small cells with cortex of small cells. Tetrasporangial sori and cystocarps in small marginal proliferations **Callophyllis**
Thallus bright red, soft, up to 30 cm. long, strap shaped, irregularly branched and usually with marginal proliferations. A single layer of cells on either side, joined by sparse filaments **Halarachnion**
Thallus usually small, fleshy and gelatinous, branching irregular, sometimes dichotomous, with medulla of longitudinal filaments bearing radial, dichotomous branches ending in rows of small cells which are united into a cortex several cells in thickness **Platoma**
 Thallus tough, dark red, attenuated at the base, with rounded ends and usually with marginal proliferations of the same shape. On rocks and a common epiphyte on *Laminaria* stipes etc. **Rhodymenia**
73. Thallus bright red, fan shaped, more or less dichotomously branched, usually numerous marginal proliferations in which tetrasporangia and cystocarps occur **Callophyllis**
Thallus very delicate, 2 or 3 cm. long, pale in colour, very finely divided into narrow branches. Large marginal cystocarps, tetrasporangia near the tips. L.S. shows inner tissue of dichotomously branched filaments of large cells **Euthora**

- Thallus delicate, frequently dichotomously branched in almost spherical masses 5-15 cm. in dia. Tetrasporangia zonate, mostly near the tips. Cystocarps marginal. L.S. shows central filament of elongated cells giving off alternate branches* **Rhodophyllis**
- Thallus with elongated narrow blades, firm and tough, giving off numerous tongue-like marginal branches. Attached by a mass of cylindrical interwoven branches **Calliblepharis**
- Thallus membranous and firm, attached by a small disc, undivided and irregularly lobed 74
74. *Central tissue of longitudinally elongated and interwoven filaments with cortical layers of small cells* **Callymenia**
- Central tissue of large rounded colourless cells visible through the cortex of small cells **Rhodymenia**
75. Thallus hollow, or stem solid and branches hollow 76
Thallus solid throughout 79
76. Thallus, at least its main branches, not obviously constricted into articulated joints; branched in 1 or in all planes 77
Thallus, both main stem and branches, definitely constricted into articulated joints 78
77. Thallus branched sparingly at the base, forming clumps of tubular, irregular and sometimes twisted branches, slightly flattened; up to 30 cm. in length by up to 1 cm. in width; dark purple-red or brownish in colour; built up of longitudinally running threads giving off short peripheral branches and covered by a layer or two of very small branches **Dumontia**
- Thallus 5-15 cm. long, much branched; finely divided, usually in 1 plane only, but sometimes in all planes; bi- or tri-pinnate; branches attenuated at both ends **Lomentaria clavellosa**
- Thallus 1-4 cm. long, consisting of flattened ovoid frond, from the margins of which spring a small number (6-12) of similar branches* **Lomentaria orcadensis**
- Main axis cylindrical, often naked in the lower parts, with distended ovoid branches near the apex, on which or in which reproductive organs may occur **Gastroclonium ovatum**
78. Very small plant, about 2 cm. in height; usually very dark; found in crevices of rock in upper littoral; thallus not completely hollow but traversed by a wide-meshed network of interlacing filaments; (resembling a miniature Prickly Pear plant;) tetraspores zonately divided **Catenella**
- Plant 5-10 cm. long, clearly and definitely articulated into bead-like joints, often bushy; main branches irregularly dichotomous, smaller branches often in whorls; articulations of main axis about 5 mm. in length (sometimes more than this, the whole plant then being about twice as large) **Lomentaria articulata**
- Plant up to 30 cm. long, of pyramidal outline; branches arising in whorls of 3-6, secondary and tertiary branches similar; articulations of main axis 1-2 cm. in length **Chylocladia**
- Plant 2-10 cm. long, forming a dense tuft of spreading branches whose segments, though definitely articulated, are not conspicuously swollen in their middle region **Champia**
79. Thallus less than 2 cm. long, articulated into bead-like joints; black or dark purple in colour. In crevices in upper littoral rocks on less exposed shores **Catenella**
- Thallus cylindrical or slightly compressed but not articulated into bead-like joints

80. Thallus with sturdy cylindrical axes, up to 5 mm. in diameter, up to 20 cm. long, repeatedly dichotomously branched, reaching a uniform height and giving a very regular appearance to the plant 81
 Thallus irregularly branched, very wiry; almost black in colour **Ahnfeltia**
 Plant not rigid, cylindrical, much branched, forming bushy tufts up to 50 cm. long, or less branched up to 2 m. long 82
81. Plant attached to the substratum by a group of claw-like branches; reproductive organs in swollen apices; tetrasporangia zonately divided **Furcellaria**
 Plant attached by compact basal disc; reproductive organs in nemathecia **Polyides**
Thallus dichotomously branched in 1 plane, stiff and wiry, forming compact tufts 5-10 cm. high; tetraspores cruciately divided, in nemathecia **Gymnogongrus**
82. Much branched plant with medulla composed of longitudinally elongated filaments; attachment by a basal group of claw-like branches to rock or other algae; tetrasporangia zonately divided (Fig. 15) **Cystoclonium**
 Plant with medulla of large colourless cells not elongated longitudinally; attached by a small basal disc to rock or stones; tetrasporangia cruciately divided (Fig. 15) **Gracilaria**
83. Thallus dark crimson, thick and leathery, forming spoon-shaped blades, 5-15 cm. long and attenuated towards the base, singly or in small groups **Dilsea**
 Thallus more or less pinnately branched or with flattened blades with marginal proliferations 84
 Thallus dichotomously branched without pinnate branches or marginal outgrowths 85
84. Thallus with long flattened blades bearing filiform or flattened marginal proliferations up to 2 cm. or more long. Attached by a basal mass of interwoven cylindrical branches. Tetraspores zonate **Calliblepharis**
 Thallus pinnately branched; branches blunt ended. Basically polysiphonous, T.S. shows medulla of close packed cells. Cystocarps ovoid (Fig. 15, F.), sessile; tetraspores tetrahedral **Laurencia**

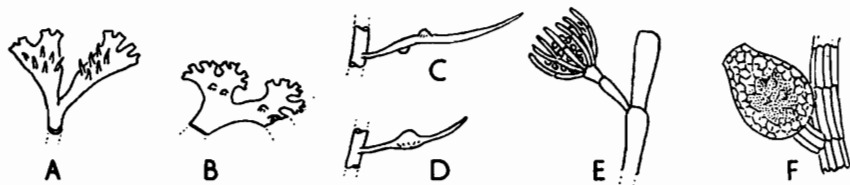


FIG. 15

Cystocarps: A. *Gigartina stellata* ($\times \frac{1}{2}$); B. *Chondrus crispus* ($\times \frac{1}{2}$); C. *Gracilaria verrucosa* ($\times \frac{1}{2}$); D. *Cystoclonium purpureum* ($\times \frac{1}{2}$); E. *Griffithsia flosculosa* ($\times 20$); F. *Polysiphonia* sp. ($\times 50$).

85. Thallus, at least in the lower parts, channelled. Cystocarps papillary, spiny, on the surface of the upper parts (Fig. 15) **Gigartina stellata**
 Thallus flat to almost cylindrical but never channelled 86
86. Thallus very variable in thickness, from almost cylindrical to very flattened, cystocarps forming a small dome-like projection on one side of the frond (and a slight dent on the other in thin thalli) (Fig. 15). Sections show a medulla of interwoven filaments giving off others radially to form a small-celled cortex. Tetraspores not in nemathecia **Chondrus**

- Thallus with medulla of large closely packed cells and cortex of small cells in close packed radial filaments. Tetraspores in strings in nemathecia 87
87. *Thallus flat, stipe small. Freely dichotomously branched, branches with parallel sides and rounded apices. Cystocarps in wart like projections from the surface*
- Gymnogongrus norvegicus**
- Thallus with lower part cylindrical and bearing fan shaped, dichotomously branched, flattened laminae distally, or almost all flattened with few divisions and sometimes a poorly defined midrib towards the base. Sometimes with marginal proliferations similar to the parent laminae. Cystocarps sessile or stalked
- Phyllophora**
88. *Thallus with a medulla of interwoven filaments from which others arise radially to form a cortex. Cystocarps spherical, sessile or stalked, often in pairs* **Gigartina**
- Medulla of large, longitudinally elongated cells with smaller interlacing filaments. Cystocarps immersed in the branches and causing slight swellings 89
89. *Cystocarps with 2 ostioles, 1 on either side of the thallus; interlacing filaments mostly at periphery of medulla* **Gelidium**
- Cystocarps with 1 ostiole only; interlacing filaments mainly in centre of medulla* **Pterocladia**

CYANOPHYCEAE

1. Plants non-filamentous or with poorly defined filaments which are, at least partially, packed closely together in a gelatinous whole 2
- Plants distinctly filamentous, filaments branched or unbranched. Trichomes with or without mucilage sheath. Reproduction by spores or hormogones 4
2. No differentiation between base and apex of cells. Cells solitary or in colonies, never filamentous. Reproduction by vegetative division 3
- Plants always attached to substratum. Cells solitary or colonial, showing polarity, particularly in solitary cells. Thalli encrusting, one cell thick or, if more, then composed of radially arranged irregular filaments. Sometimes with filaments penetrating the substratum. Reproduction by endospores and exospores **Entophysalis***
3. Cells ovoid or cylindrical, dividing in 1 plane only, perpendicular to the long axis of the cell. Cells solitary or in colonies embedded in solid mucilaginous masses which may be visible to the naked eye **Coccochloris†**
- Cells spherical to cylindrical, in flat plate-like colonies, dividing in 2 planes perpendicular to each other and to the surface of the colony. Cells regularly arranged in rows at right angles to each other **Agmenellum‡**
- Cells spherical to cylindrical, in mucilaginous masses. Division in 3 perpendicular planes so that cells may lie in rows orientated in 3 directions perpendicular to each other. Mucilaginous matrix homogeneous or in layers round the cells **Anacystis§**
4. All cells of trichomes similar 5
- Cells of more than 1 kind in trichomes 13
5. Trichomes in a sheath, more than 1 trichome in 1 sheath. Sheaths closed at the ends. Filaments often branched 6
- Trichomes naked or with a single trichome in each sheath; sheaths open at the ends 8

* Includes *Chaemosiphon*, *Chlorogloea*, *Dermocarpa*, *Oncobyrsa*, *Pleurocapsa* and *Xenococcus*† Includes *Aphanothece*, *Gloeothece* and *Synechococcus*‡ Includes *Merismopedia* and *Holopedia*§ Includes *Aphanocapsa* and *Gloeocapsa*

6. Sheaths mucilaginous with numerous trichomes in each; filaments creeping, usually unbranched **Microcoleus**
7. Sheaths mucilaginous, colourless, cells of the trichomes always shorter than wide, trichomes tapering at the ends usually with the end cell enlarged, giving the appearance of a cap (see Fig. 16), occurring in sheets **Hydrocoleum**
8. Trichomes in sheaths; filaments occasionally branched, united into pointed tufts, which may be erect, 2-3 cm. high, or prostrate **Schizothrix**
- Trichomes naked or in sheaths, not united into tufts **Symploca**

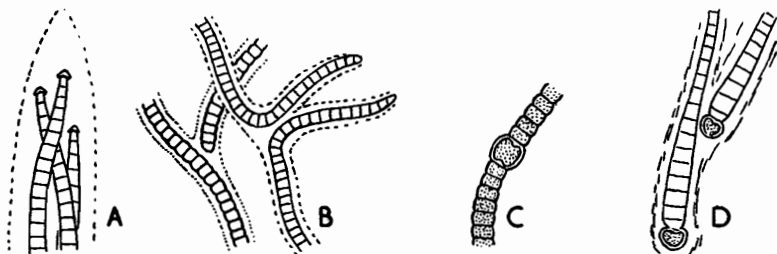


FIG. 16

A. Trichomes ending in calyptras (*Hydrocoleum*); B. False branching; C. Intercalary heterocyst (*Nodularia*); D. Basal heterocyst (*Rivularia*). (All $\times 250$).

9. Filaments with delicate, colourless sheaths, interwoven into sheets which are often strong enough to withstand handling. Filaments never of regular spiral form **Phormidium**
- Filaments not interwoven into sheets
10. Sheaths present 10
- Sheaths absent 11
11. Filaments showing frequent false branching (Fig. 16), heterocysts absent 12
- Filaments unbranched, trichomes are capable of gliding motion, often moving out of their sheaths (look carefully!) **Plectonema**
- Trichomes wound in a spiral of constant diameter, motion screw-like. Individual cells often small and hard to distinguish **Lyngbya**
12. Trichomes straight or irregularly bent but not of spiral form, free, usually showing rapid gliding motion **Spirulina**
- Oscillatoria**
13. Vegetative division mainly transverse, trichomes uniseriate. Filaments unbranched or with false branching 14
- Vegetative divisions both transverse and longitudinal to form multiserial trichomes with true branching. Endolithic in calcareous rock and with some branches attenuated and hair-like **Mastigocoleus**
14. Trichomes distally attenuated and hair-like 15
- Trichomes not, or only slightly, tapering at their ends 20
15. Without heterocysts, filaments arising from an encrusting basal mass of closely packed cells. Epiphytic or epilithic **Amphithrix**
- With heterocysts 16
16. Filaments united in a macroscopic mucilaginous mass 17
- Filaments not united in a mucilaginous mass 19

17. Heterocysts intercalary (Fig. 16). Filaments with profuse false branching, in black or brown mucilaginous colonies which are solid at first and later hollow **Brachytrichia**
- Heterocysts basal (Fig. 16) 18
18. Thalli flat, encrusting; filaments unbranched, with a single heterocyst at the base of each, uniformly arranged perpendicular to the substratum. Epiphytic on various algae, stones etc. **Isactis**
- Thalli globose or cushion-like. Filaments with false branching, with a heterocyst at the base of each branch, well separated from the parent trichome **Rivularia**
19. One trichome in each sheath, filaments unbranched or with false branching which never appears dichotomous. Heterocysts basal and intercalary. Epiphytic, epilithic (or endophytic in *Nemalion*) **Calothrix**
- Sheaths containing 2-6 trichomes or at least their bases. False branching appearing dichotomous **Dichothrix**
20. Trichomes all of the same form, not differentiated into basal and erect portions, unbranched 21
- Trichomes differentiated into basal and erect portions, with false branching 23
21. Trichomes much twisted, in a mucilaginous mass with a distinct outer envelope more deeply coloured than the rest. Heterocysts intercalary and sometimes terminal **Nostoc**
- Trichomes free or in an indefinite mucilaginous mass with no distinct outer envelope 22
22. Filaments free, with sheaths. Cells of trichomes shorter than broad, numerous intercalary heterocysts **Nodularia**
- Filaments either free, or sometimes in mucilaginous masses with no clear limits, sheaths absent or very delicate. Heterocysts intercalary. Cells of trichomes longer than broad **Anabaena**
23. Filaments unbranched, 1 trichome in each sheath with basal heterocysts and cells larger towards the base. (Distinguished from *Calothrix* by trichomes not attenuated into hairs) **Fremyella (Microchaete)**
- Filaments branched, with false branches borne singly, sheaths delicate **Tolypothrix**

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