

THE CLASSIFICATION OF PLANTS. XII.*

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Eleven papers have been published previously by the writer, giving a preliminary survey of the phyletic classification of plants, and covering the whole ground except the Algæ. The first paper was published in the OHIO NATURALIST, 5: 298-301, 1905, and subsequent papers appeared from time to time in that journal. The present paper completes the series, but it is the intention of the writer to continue the studies in a more detailed manner, dealing with the phylogeny and taxonomy of the various classes and subclasses.

The term Algæ has reference to a physiological group and is of the same convenience in dealing with the lower plants in a practical way as the terms, trees, parasites, herbs, etc. It has no taxonomic value. An alga may be defined as a thallophyte with chlorophyll. The algæ are largely aquatic organisms but some species are able to endure aerial conditions as their normal habitat.

The algæ apparently belong to at least six distinct phyla and a number of the classes have closely related fungi. Our knowledge of the morphology and life histories of the algæ is still very imperfect, so any arrangement must be regarded as more or less tentative. The writer has not been able to follow those authors who divide the green algæ primarily into Akontæ, Isokontæ, and Heterokontæ. Such a procedure seems decidedly artificial. The Peridiniæ are regarded as more animal-like than plant-like and are thus removed to the Protozoa. Following Oltmanns and others, the Diatomeæ are placed near the Conjugatæ but only as a subphylum, since the relationship can, at best, be only very remote. The agreement with desmids in certain characters is nevertheless striking and both diatoms and desmids may be regarded as derivatives from some primitive filamentous group without zoospores, but which discharged its isogamous sexual cells into the water with little change from the vegetative character. Although the Oedogoniales are

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peculiar in many respects they are nevertheless plainly related to the other filamentous green algæ and the same is true of the Siphoneæ and related forms which according to the writer's views do not warrant segregation into a distinct phylum as was done by Bessey. On the other hand, the Charales are so aberrant that their origin is very obscure and they have, therefore, been placed in a distinct phylum.

SYNOPSIS OF THE ALGAL PHYLA

- I. Cells typically with poorly differentiated nuclei and chromatophores, reproducing by fission, motile and nonmotile, never with a pure chlorophyll-green color, but containing phycocyanin; unicellular or filamentous, apparently without sexuality. The most primitive of the algae and along with the bacteria the most primitive of all organisms. Marine and mostly freshwater, some species growing in very hot springs. Phylum, SCHIZOPHYTA.
- II. Cells with well differentiated nuclei and usually with definite chromatophores; green or variously tinted by coloring matters.
 - A. Unicellular or filamentous plants containing chlorophyll, either of a brownish or yellowish color and with silicified, two-valved walls, or green with complex chromatophores or fantastic cells, the walls not silicified; sexual or apparently nonsexual by degeneration; conjugating cells not ciliated, isogamous. Phylum, ZYGOPHYTA.
 1. With silicified, valved cell walls, usually with fantastic forms and markings, and usually of a yellowish or brownish color. Marine and fresh water plants. Subphylum, DIATOMEAE.
 2. Cell walls not silicified; plants filamentous or unicellular, green, the unicellular often with fantastic forms and markings. Fresh water plants. Subphylum, CONJUGATAE.
 - B. Plants not with silicified two-valved walls; usually with zoospores when green, or with heterogamous sexuality, sometimes nonsexual, the isogamous green forms usually not with fantastic chromatophores nor with a constriction in the middle of the cell.
 1. Antheridium when present not consisting of a globular structure containing sperm-bearing filaments; sometimes with an alternation of generations.
 - a. Plants mostly green, nearly all producing nonsexual zoospores, the sexual forms isogamous or heterogamous. Characteristic water plants, but also numerous marine species.
Phylum, GONIDIOPHYTA.
 - b. Plants with the chlorophyll usually hidden by a brown, red, or purple pigment always with a multicellular body and with sexuality or apparently from sexual ancestors.
 - (a) Mostly marine, often large, brown algae with phycophaein; isogamous or heterogamous or sexuality unknown, with ciliated sperms, both gametes discharged from the gametangium. Phylum, PHAEOPHYTA.
 - (b) Mostly marine red or purple algae with phycoerythrin; heterogamous, with stationary eggs and non-ciliated sperms.
Phylum, RHODOPHYTA.
 2. Filamentous, green algae with globular antheridia containing sperm-bearing filaments, the sperms being biciliated; nonsexual spores absent. In fresh or brackish water. Phylum, Charophyta.

SYNOPSIS OF THE SEVERAL PHYLA

Phylum, SCHIZOPHYTA. Fission Plants.

- I. Without a definite nuclear membrane and with a low type of chromatophore. Class, CYANOPHYCEÆ. Blue-green Algae. 1000 species.
- A. Not filamentous; cells free or in masses or plates (superficial aggregates); or the cell individuals with definite base and apex, in fruiting sometimes forming a row of cells. **Chroococcales**. Chroococcaceæ, Chamaesiphonaceæ.
- B. Cells arranged in definite filaments.
1. Filaments without hair-like tips, sometimes narrowed at the ends.
- a. Without heterocysts; free filaments commonly massed into flat layers, sometimes several filaments enclosed in one common sheath. **Oscillatoriales**, Oscillatoriaceæ.
- b. With intercalary heterocysts. **Nostocales**. Nostocaceæ, Scytonemataceæ, Stigonemataceæ.
2. Filaments with hair-like tips at one or both ends. **Rivulariales**. Campotrichaceæ, Rivulariaceæ.
- II. With nuclear membrane and highly differentiated chromatophores; unicellular or in colonies. Class, GLAUCOCYSTEÆ. 20 species. **Glaucocystales**, Glaucocystaceæ.

Phylum, ZYGOPHYTA. Conjugate Algae.

- I. Cell walls impregnated with silica, composed of two valves; chromatophores yellow or brown, rarely green, containing chlorophyll and diatomin and a variable number of pyrenoids. Subphylum and class, DIATOMÆ. Diatoms. 5700 species.
- A. Valves without a raphe or pseudo-raphé, with a concentric or radiating symmetry around a central point; valve view usually circular, polygonal, or broadly elliptical in outline, rarely boat-shaped or irregular; conjugation unknown; cells without spontaneous movement. Mostly marine plants. **Eupodiscales**. Round Diatoms. Eupodiscaceæ, Soleniacæ, Biddulphiaceæ, Rutilariaceæ.
- B. Valves with a raphe or pseudo-raphé or with a sagittal line, with a zygomorphic or isobilateral or sometimes irregular symmetry; never centric; valve view mostly boat-shaped or elliptical in outline; motile or nonmotile; conjugation known in most groups. Mostly fresh water plants. **Naviculales**. Long Diatoms. Fragillariaceæ, Surirellaceæ, Achnanthaceæ, Naviculaceæ.
- II. Cell walls without silica, but with abundant development of gelatinous pectose causing the plants to be slimy to the touch; chromatophores green, with chlorophyll and one or more pyrenoids. Subphylum and class CONJUGATÆ. 2300 species.
- A. Thallus a filament, or commonly separating into single cells, mostly flattened, the cell wall usually divided into two symmetrical halves; cells mostly constricted at the middle, often of fantastic and beautiful forms; cell contents mostly divided into symmetrical halves; conjugation by the breaking open of the cell walls or by the formation of a primitive conjugation tube. **Desmidiiales**. Desmids. 2100 species. Spirotaeniaceæ, Desmidiaceæ.
- B. Thallus a simple filament, occasionally slightly branched, of cylindrical cells, the cells not constricted in the middle, but sometimes the contents divided into symmetrical halves; these latter forms distinguished from the preceding order by the definite filament and prominent conjugation tube; some species forming aplanospores. **Zygnemates**. Pond-scums. 200 species. One family, Zygnemaceæ.

Phylum, GONIDIOPHYTA. Zoospore Plants.

SYNOPSIS OF THE CLASSES OF GONIDIOPHYTA.

- I. Plants unicellular or colonial, not truly filamentous.
- A. Nonsexual, unicellular or colonial algæ without zoospores, commonly with autospores; cells normally with one nucleus. **AUTOSPORÆ.**
 - B. Isogamous or heterogamous, sexual algæ or probable derivatives from them, with zoospores.
 1. Unicellular or colonial algæ, usually with one nucleus in each cell, rarely cenocytic; the colonial forms not produced by the symmetrical aggregation of free zoospores into a definite colony; vegetative stage nonmotile or active. Isogamus or heterogamous. **CHLOROCOCCEÆ.**
 2. Cenocytic algæ consisting of colonies of peculiar form, new colonies being produced by the definite arrangement of daughter cells developed in the parent cenocyte; isogamous, aquatic. **HYDRODICTYÆÆ.**
- II. Green algæ with a filamentous or massive body and with 1, 2, 4, or many cilia on the zoospores and gametes.
- A. Cenocytic, septate or nonseptate, isogamous or heterogamous.
 1. Vegetative body usually septate, consisting of a series of cenocytes; chloroplasts forming a net, rarely in separate plates. **SIPHONOCLADEÆ.**
 2. Vegetative body usually nonseptate, with distinct lenticular, oval or plate-like chloroplasts. **SIPHONÆÆ.**
 - B. Algæ having normal cells with one nucleus, with a conjugation of free swimming gametes or with motile sperms and stationary eggs. **CONFERVEÆ.**

Class, AUTOSPORÆ. 200 species.

- I. Reproduction by autospores, the protoplast dividing within the mother cell, and the daughter cells escaping singly or in colonies. In fresh, brackish, or sea water, or on moist rocks, etc.; some endozoic in water animals. **Selenastrales.** Selenastraceæ, Oocystaceæ, Chlorellaceæ, Tetraedraceæ, Scenedesmaceæ, Sorastraceæ.
- II. Reproduction by vegetative division and separation by splitting of the daughter cells. (Doubtfully placed in the Autosporæ). Aerial, on damp stones, trees, etc., or in fresh or salt water. **Protococcales.** Protococcaceæ.

Class, CHLOROCOCCEÆ. 250 species.

- I. Cells ciliated and motile in the vegetative state; unicellular or in definite colonies. **Volvocales.** Chlamydomonadaceæ, Volvocaceæ.
- II. Cells not active in the vegetative stage.
 - A. Vegetative cell divisions absent, cells separate or somewhat cenocytic. **Chlorococcales.** Chlorococcaceæ, Chloretheciaceæ, Ophiocytaceæ.
 - B. Colonies increasing by vegetative cell division. **Tetrasporales.** Botryococcaceæ, Tetrasporaceæ.

Class, HYDRODICTYÆÆ. 30 species.

One order, **Hydrodictyales.** Pediastraceæ, Hydrodictyaceæ.

Class, SIPHONOCLADEÆ. Lower Tube Algæ. 450 species.

- I. Plants isogamous or slightly heterogamous; filaments branched. **Cladophorales.** Valoniaceæ, Cladophoraceæ, Siphonocladaceæ, Dasycladaceæ.
- II. Plants heterogamous, with stationary eggs and motile spermatozoids; filaments separate, unbranched, free-floating. **Sphaeropleales.** Sphaeropleaceæ.

Class, SIPHONÆ. Higher Tube Algæ. 200 species.

- I. Sexual reproduction unknown or isogamous.
 - A. Small globular terrestrial plants with branched rhizoids penetrating the ground; zoospores with cilia of unequal lengths. **Botrydiales. Botrydiaceæ.**
 - B. Mostly large marine or sometimes endophytic algæ; zoospores if present not with unequal cilia. **Bryopsidales. Derbesiaceæ, Bryopsidaceæ, Caulerpacæ, Phyllosiphonacæ, Codiaceæ.**
- II. Sexual reproduction by highly specialized stationary eggs and motile spermatozooids; thallus tubular, branched or unbranched; growing in fresh or brackish water or on moist soil. **Vaucheriales. Vaucheriaceæ.**

Class, CONFERVÆ. Confervas. 650 species.

- I. Isogamous, or the free-swimming gametes sometimes of unequal size.
 - A. Thallus unbranched.
 - 1. Chloroplasts reticulate, without pyrenoids; fresh water plants. **Microsporales. Microsporaceæ.**
 - 2. Chloroplasts central or parietal, with one or more pyrenoids.
 - a. Chloroplast single, central, stellate, with one pyrenoid; no zoospores known; aerial in habit. **Prasiolales. Prasiolaceæ.**
 - b. Chloroplast parietal, with one to many pyrenoids.
 - (a) Unbranched filaments; chloroplasts with one to many pyrenoids. **Ulotrichales. Ulotrichaceæ, Tribonemaceæ.**
 - (b) Thallus expanded, a 1-2-layered plane or tube; chloroplast single, with 1 pyrenoid; mostly marine. **Ulvales. Ulvaceæ.**
 - B. Thallus filamentous, branched, usually abundantly so, the branches often attenuated or hair-like tips. **Chaetophorales. Chaetophoraceæ, Trentepohliaceæ, Harposteiraceæ.**
- II. Heterogamous, the egg stationary in the oogonium; sometimes with a primitive alternation of generations.
 - A. Oogonium not developing a cortical layer after fertilization. **Oedogoniales. Cylindrocapsaceæ, Oedogoniaceæ.**
 - B. Oogonium with a trichogyne-like tip, covered after fertilization by a cortical layer; thallus disk-like or cushion-like. **Coleochaetales. Coleochaetaceæ.**

Phylum, PHAEOPHYTA. Brown Algæ.

- I. Zoospores present; sexual reproduction by motile, biciliate gametes produced in external gametangia, occasionally by heterogametes, and in extreme cases by nonmotile eggs. Class, PHAEOSPORÆ. Kelps. 550 species.
 - A. Zoospores and isogametes similar and motile.
 - 1. Frond various, simple or branched, but never differentiated with definite root-like and leaf-like parts. **Ectocarpales. Ectocarpaceæ.**
 - 2. Frond large, leather-like, usually stalked, differentiated with root-like and leaf-like parts; with zoospores only. The largest marine plants. **Laminariales. Laminariaceæ. Giant Kelps.**
 - B. Zoospores and heterogametes dissimilar.
 - 1. Gametes large and small, but both motile. **Cutleriales. Cutleriaceæ.**
 - 2. Gametes consisting of small active spermatozooids and nonmotile eggs; frond filiform. **Tilopteridales. Tilopteridaceæ.**
- II. Zoospores absent; sexual reproduction by means of motile sperms and nonmotile eggs which are discharged from the oogonium; nonsexual reproduction absent or by means of nonmotile spores.
 - A. Sperms biciliate; without nonsexual spores; gametangia in sunken conceptacles. Class, CYCLOSPORÆ. Rockweeds. 350 species. One order **Fucales. Durvillaeaceæ, Himanthaliaceæ, Fucaceæ, Sargassaceæ.**
 - B. Sperms with one flagellum; nonsexual spores nonmotile; reproductive organs external; with a regular alternation of sexual and nonsexual generations. Class, DICTYOTÆ. 130 species. One Order, **Dictyotales. Dictyotaceæ.**

Phylum, RHODOPHYTA. Red Algæ.

- I. Nonsexual reproduction by single thallus cells; trichogyne imperfectly developed; no pits between the thallus cells. Class, MONOSPORÆ. 50 species. One order, **Bangiæles**. *Bangiaceæ*, *Rhodochaetaceæ*, *Compsopogonaceæ*.
- II. Nonsexual reproduction by tetraspores usually developed in groups of four; trichogyne well developed; cells protoplasmically connected through large pits in the walls. Class, FLORIDÆÆ. 3000 species.
 - A. Sporophores ("gonimoblasts" or branches bearing the carpospores) of the sporocarp produced directly from the fertilized oogonium; mostly plants with filiform fronds. Fresh water or marine. **Nemalionales**. *Lemaneaceæ*, *Helminthocladiaceæ*, *Chaetangiaceæ*, *Gelidiaceæ*.
 - B. Sporophores produced by auxiliary cells after these conjugate with the fertilized oogonia or their branching processes ("ooblastema").
 1. Sporophores produced by nearby auxiliary cells; marine plants.
 - a. Sporophores produced by nearby auxiliary cells and growing outward in the plant body; filiform, foliaceous or massive plants. **Rhodymeniales**. *Sphaerococcaceæ*, *Rhodymeniaceæ*, *Delesariaceæ*, *Bonnemaisoniaceæ*, *Rhodomelaceæ*, *Ceramiaceæ*.
 - b. Sporophores produced by the nearby auxiliary cells and branching copiously in the surrounding tissues of the plant body; fronds parenchymatous, flattened or leaf-like. **Gigartinales**. *Acrotyleaceæ*, *Gigartinaceæ*, *Rhodophyllidaceæ*.
 2. Sporophores produced by remote auxiliary cells after these have conjugated with the branched "ooblastema" filaments arising from the fertilized oogonium; fronds filiform, branched, often flattened. Mostly marine, but a few fresh water species. **Cryptonemiales**. *Gloiosiphoniaceæ*, *Grateloupiaceæ*, *Dumontiaceæ*, *Nemastomaceæ*. *Rhizophyllidaceæ*, *Squamariaceæ*, *Corallinaceæ*.

Phylum, CHAROPHYTA. Stoneworts.

One class and one order, CHARÆÆ. 160 species. **Charales**.

- I. Crown of the oogonium with ten cells. *Nitellaceæ*.
- II. Crown of the oogonium with five cells. *Characeæ*.

KEY TO THE ORDERS OF ALGÆ

1. Nonsexual fission algæ, unicellular, colonial or filamentous, blue-green or brownish, never with a pure chlorophyll-green color, usually with gelatinous walls; filaments often with heterocysts; never with cilia or flagella, but sometimes motile; chromatophores usually poorly defined. 2.
1. Mostly sexual algæ, but sometimes nonsexual, with a pure chlorophyll-green color or often red, purple, yellow, or brown; plants not propagating by fission; unicellular, colonial, filamentous, or massive; chloroplasts usually well defined; commonly with zoospores; some with silicious walls. 6.
2. With poorly differentiated nuclei, without a definite nuclear membrane, and with a low type of chromatophore. (*CYANOPHYCEÆ*). 3.
2. With well developed nuclei, with a nuclear membrane, and with highly differentiated chromatophores. (*GLAUCOCYSTEÆ*). **Glaucocystales**.
3. Not filamentous; unicellular or colonial, free or attached. **Chroococcales**.
3. Cells arranged in definite filaments. 4.
4. Filaments without hair-like tips, sometimes narrowed at the ends. 5.
4. Filaments with hair-like tips at one or both ends, with or without heterocysts. **Rivulariales**.
5. Without heterocysts. **Oscillatoriales**.
5. With heterocysts. **Nostocales**.
6. Cells covered with two silicious, usually ornamental valves, mostly brown or yellowish in color; unicellular, or simple filaments, sometimes on gelatinous stalks. (*DIATOMEÆ*). 7.
6. Cells not covered with two silicious valves. 8.

7. Valves without a raphe or pseudo-raphé; usually with a concentric or radiating symmetry around a central point, rarely isobilateral or zygomorphic; valve view usually circular; polygonal, or broadly elliptical in outline. **Eupodiscales.**
7. Valves with a raphe or pseudo-raphé, or with a sagittal line; with an isobilateral or zygomorphic symmetry, never centric; valve view mostly boat-shaped, needle-shaped, rod-shaped, or elliptical in outline. **Naviculales.**
8. Unicellular or simple free filaments, chlorophyll-green, with complex chromatophores containing prominent pyrenoids, reproduction usually by conjugation of the cell contents either through a conjugation tube or by the breaking open of the cell walls; cells and gametes never with cilia; unicellular forms usually of fantastic shapes, usually divided into two symmetrical halves. (**CONJUGATÆ**). 9.
8. Sexual process if present by typical isogametes, or heterogamous; plants commonly branched filaments or massive, the unicellular forms or simple filaments rarely corresponding to the above description. 10.
9. Thallus a filament or mostly unicellular, the cell wall usually divided into two symmetrical halves, cells mostly constricted at the middle; conjugation by the breaking open of the cell walls or by the formation of a primitive conjugation tube. **Desmidiiales.**
9. Thallus a simple filament of cylindrical cells not constricted in the middle, but sometimes the contents divided into symmetrical halves; these latter forms distinguished from the preceding order by the definite filament and the prominent conjugation tube. **Zygnemales.**
10. Antheridia when present not consisting of a globular structure containing sperm-bearing filaments. 11.
10. Filamentous green algæ with globular antheridia containing sperm-bearing filaments, erect, branches in whorls; rhizoids thread-like; sperms biciliate, non-sexual spores absent; plants more or less incrustated with lime. (**CHAREÆ**). **Charales.**

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11. Plants green, rarely with a red or brown color and then unicellular; nearly all producing zoospores except the lowest; largely fresh water algæ, but some marine. 12.
11. Plants usually with the chlorophyll hidden by a brown, red, or purple pigment, always with a multicellular body, often massive; sperms motile or non-motile; mostly marine algæ. 29.
12. Plants unicellular or colonial, not truly filamentous. 13.
12. Plants filamentous or massive. 18.
13. Nonsexual unicellular or colonial algæ without zoospores, commonly with autospores or merely splitting apart; cells normally with one nucleus, not forming net-like or fantastic, radially symmetrical plate-like union colonies (**AUTOSPORÆ**). 14.
13. Isogamous or heterogamous sexual algæ usually with zoospores. 15.
14. Reproduction by autospores, the protoplast dividing within the mother cell and the daughter cells escaping singly or in colonies. **Selenastrales.**
14. Reproduction by vegetative division and separation by the splitting apart of the daughter cells. **Protococcales.**
15. Unicellular or colonial algæ with cells normally having one nucleus; the colonial forms not produced by the symmetrical aggregation of free zoospores. (**CHLOROCOCCÆ**). 16.
15. Cenocytic algæ consisting of net-like or symmetrical plate-like colonies of peculiar form, produced by the definite arrangement and union of daughter cells in the parent cenocyte; (**HYDRODICTYÆ**). **Hydrodictyales.**
16. Cells ciliated and active in the vegetative state; unicellular or in definite colonies, commonly spherical. **Volvocales.**
16. Cells not active in the vegetative stage. 17.
17. Vegetative cell division absent, cells separate or somewhat cenocytic. **Chlorococcales.**
17. Colonies increasing by vegetative division. **Tetrasporales.**

18. Cenocytic algæ, septate or nonseptate. 19.
 18. Not cenocytic, but with normal cells having a single nucleus. (*CONFERVEÆ*). 23.
 19. Vegetative body usually septate, consisting of a series of cenocytes; chloroplasts forming a net, rarely in separate plates. (*SIPHONOCLADEÆ*). 20.
 19. Vegetative body usually nonseptate, with distinct lenticular, oval, or plate-like chloroplasts. (*SIPHONÆ*). 21.
 20. Filaments branched; plants isogamous. **Cladophorales.**
 20. Filaments unbranched, free-floating; plants heterogamous with stationary eggs. **Sphaeropleales.**
 21. Isogamous, or sexual reproduction unknown. 22.
 21. Sexual reproduction by highly specialized stationary eggs and motile spermatozooids; thallus tubular, branched or unbranched. **Vaucheriales.**
 22. Small globular terrestrial plants with branched rhizoids penetrating the ground; zoospores with cilia of unequal lengths or with only one. **Botrydiales.**
 22. Mostly large marine or sometimes endophytic algæ; zoospores if present otherwise. **Bryopsidales.**
 23. Isogamous, or the free-swimming gametes of unequal size. 24.
 23. Heterogamous, the egg stationary in the oogonium; oogonium developing a cortical layer after fertilization, or if not then certain cells of the filament with peculiar striate rings around the top. 28.
 24. Thallus unbranched. 25.
 24. Thallus filamentous, branched, usually abundantly so, the branches often with hair-like attenuated tips. **Chaetophorales.**
 25. Chloroplasts reticulate, without pyrenoids; growing in fresh water. **Microsporales.**
 25. Chloroplasts central or parietal, with one or more pyrenoids. 26.
 26. Chloroplast single, central, stellate, with one pyrenoid; no zoospores known; aerial in habit. **Prasolales.**
 26. Chloroplasts parietal with one to many pyrenoids. 27.
 27. Unbranched filaments; chloroplasts with one to many pyrenoids. **Ulotrighales.**
 27. Thallus expanded, a 1-2-layered lamina or tube; chloroplast single with one pyrenoid; mostly marine plants. **Ulvales.**
 28. Oogonium not developing a cortical layer after fertilization; zoospores with a crown of cilia; certain cells with striate rings at the upper end. **Oedogoniales.**
 28. Oogonium with a trichogyne-like tip, covered after fertilization by a cortical layer; thallus disk-like or cushion-like; zoospores biciliate. **Coleochaetales.**
- 29—
29. Mostly marine brown algæ; isogamous or with ciliated sperms, and large eggs, both gametes discharged from the gametangia; or with zoospores only. 30.
 29. Mostly marine red algæ, with stationary eggs and non-ciliated sperms; mostly with tetraspores; zoospores absent; usually with cystocarps. 35.
 30. Zoospores present; sexual reproduction by motile biciliate gametes produced in external gametangia; occasionally heterogamous, the extreme cases with non-motile eggs. (*PHÆOSPORÆ*). 31.
 30. Zoospores absent; sexual reproduction by means of motile sperms and non-motile eggs which are discharged from the oogonium; gametangia sunken or external; non-sexual reproduction absent or by means of nonmotile spores. 34.
 31. Zoospores and isogametes similar and motile. 32.
 31. Zoospores and heterogametes dissimilar. 33.
 32. Frond various, simple or branched, but never differentiated with definite root-like and leaf-like parts. **Ectocarpales.**
 32. Frond large, leather-like, usually stalked, differentiated with root-like and leaf-like parts; with zoospores only; plants usually very large. **Laminariales.**
 33. Gametes large and small but both motile; plants medium to large, flat, branched, or orbicular, attached by rhizoids. **Cutleriales.**
 33. Gametes a small active spermatozoid and a nonmotile egg; fronds filiform, tufted, attached by rhizoids. **Tilopteridales.**

34. Sperms biciliate; nonsexual spores absent; gametangia in sunken conceptacles; plants usually flat or flattish, branched, attached below, medium to large in size. (CYCLOSPORÆ). **Fucales.**
34. Sperms with one flagellum; nonsexual spores (tetraspores) nonmotile, reproductive organs external; fronds erect, flat, leaf-like, attached by rhizoids. (DICTYOTÆ). **Dictyotales.**
35. Nonsexual reproduction by single thallus cells, monospores; trichogyne imperfectly developed; no pits between the thallus cells; plants red or purple, mostly filamentous or sometimes stratose. (MONOSPORÆ). **Bangiales.**
35. Nonsexual reproduction by tetraspores, usually developed in groups of four; trichogyne well developed; carpospores developed on filaments after fertilization; cells of the thallus protoplasmically connected through large pits in the cell walls. (FLORIDEÆ). 36.
36. Sporophores ("gonimoblasts" or branches bearing the carpospores) of the sporocarp on the sexual plant produced directly from the fertilized oogonium; mostly plants with a filiform frond; fresh water or marine. **Nemalionales.**
36. Sporophores produced by auxiliary cells after these conjugate with the fertilized oogonia or their branching processes ("ooblastema"). 37.
37. Sporophores of the sexual plant produced by nearby auxiliary cells; marine plants. 38.
37. Sporophores produced by remote auxiliary cells after these have conjugated with the branched "ooblastema" filaments arising from the fertilized oogonia; fronds filiform, branched, often flattened; mostly marine, but a few fresh water species. **Cryptonemiales.**
38. Sporophores produced by nearby auxiliary cells and growing outward in the plant body; filiform, foliaceous, or massive plants. **Rhodymeniales.**
38. Sporophores produced by nearby auxiliary cells and branching copiously in the surrounding tissues of the plant body; fronds parenchymarous, erect or spreading, branching, cylindrical, flattened, or leaflike. **Gigartinales.**

PHYLA, SUBPHYLA, CLASSES AND SUBCLASSES OF PLANTS.

A general table of the classification of the plant kingdom on a phyletic basis is given below. At present the writer recognizes 50 classes, a class being defined as a group of plants in a subkingdom or division whose members show an evident relationship. A class may also be defined as the largest, definitely determined, monophyletic group in a subkingdom. A phylum consists of one or more classes showing a probable relationship. It might be mentioned that a subkingdom is one of the seven progressive stages into which living plants may be divided, each stage being separated from the next higher by a more or less prominent hiatus.

Phylum I. SCHIZOPHYTA. Fission Plants.

- Class 1. Cyanophyceæ. Blue-green Algæ.
 Class 2. Glaucocysteeæ. Higher Blue-green Algæ.
 Class 3. Schizomycetæ. Fission Fungi.
 Class 4. Myxoschizomycetæ. Slime Bacteria.

- Phylum II. **MYXOPHYTA.** Slime Fungi.
 Class 5. Plasmodiophoreæ. Clubroot Fungi.
 Class 6. Acrasiææ.
 Class 7. Myxomycetæ. Slime Molds.
 Subclasses.
 a. Ceratiomyxææ.
 b. Myxogasterææ.
- Phylum III. **ZYGOPHYTA.** Conjugate Algæ.
 Class 8. Diatomeæ. Diatoms. (Subphylum A).
 Class 9. Conjugatææ. Conjugates. (Subphylum B).
- Phylum IV. **GONIDIOPHYTA.** Zoospore Plants.
 Class 10. Autosporææ.
 Class 11. Archemycetææ. Primitive Fungi.
 Class 12. Chlorococceææ. Green-slimes.
 Class 13. Hydrodictyeææ.
 Class 14. Siphonocladææ. Lower Tube Algææ.
 Class 15. Siphoneææ. Higher Tube Algææ.
 Class 16. Monoblepharideææ.
 Class 17. Confervææ. Confervas.
- Phylum V. **PHÆOPHYTA.** Brown Algææ.
 Class 18. Phæosporææ. Kelps.
 Class 19. Cyclosporææ. Rockweeds.
 Class 20. Dictyoteææ.
- Phylum VI. **RHODOPHYTA.** Red Algææ.
 Class 21. Monosporææ.
 Class 22. Florideææ. Red Seaweeds.
- Phylum VII. **CHAROPHYTA.** Stoneworts.
 Class 23. Chareææ.
- Phylum VIII. **MYCOPHYTA.** True Fungi.
 Subphylum A. **Phycomycetææ.** Algal Fungi.
 Class 24. Zygomycetææ.
 Class 25. Oomycetææ.
 Subphylum B. **Mycomycetææ.** Higher Fungi.
 Class 26. Ascomycetææ. Sack Fungi.
 Subclasses.
 a. Hemiascææ. Intermediate Sack Fungi.
 b. Exoascææ.
 c. Aspergilleææ. Tuber Fungi.
 d. Discomycetææ. Disk Fungi.
 e. Pyrenomycetææ. Black Fungi.
 f. Deuteromycetææ. Imperfect Fungi.
 Class 27. Laboulbeniææ. Beetle Fungi.
 Class 28. Teliosporææ. Brand Fungi.
 Class 29. Basidiomycetææ. Basidium Fungi.
 Subclasses.
 a. Protobasidiææ.
 b. Hymenomycetææ.
 c. Gasteromycetææ.
- Phylum IX. **BRYOPHYTA.** Mossworts.
 Class 30. Hepaticææ. Liverworts.
 Class 31. Sphagneææ. Bog Mosses.
 Class 32. Schizocarpææ. Granite Mosses.
 Class 33. Musci. True Mosses.
 Class 34. Anthocerotææ. Hornworts.

Phylum X. PTENOPHYTA. Fernworts.

Class 35. Filices. Ferns.

Subclasses.

a. Eusporangiatae. Primitive Ferns.

b. Leptosporangiatae. Modern Ferns.

Class 36. Hydropteridae. Water-ferns.

Class 37. Isoetæ. Quillworts.

Phylum XI. CALAMOPHYTA. Calamite Plants.

Class 38. Sphenophylleæ. (Fossil). Wedge-leaf Calamites.

Class 39. Equisetæ. Horsetails.

Class 40. Calamariæ. (Fossil). Calamites.

Phylum XII. LEPIDOPHYTA. Scale-leaf Plants.

Class 41. Lycopodiæ. Lycopods.

Class 42. Selaginelleæ. Selaginellas.

Phylum XIII. CYCADOPHYTA. Cycad Plants.

Class 43. Pteridospermæ (Fossil). Seed Ferns.

Class 44. Cycadeæ. Cycads.

Class 45. Cordaitæ (Fossil). Cordaites.

Class 46. Ginkgoæ. Maiden-hair-trees.

Phylum XIV. STROBILOPHYTA. Strobilus Plants.

Class 47. Coniferæ. Conifers.

Class 48. Gnetæ. Joint-firs.

Phylum XV. ANTHOPHYTA. Flowering Plants.

Class 49. Monocotylæ. Monocotyls.

Subclasses.

a. Helobiae.

b. Spadicifloræ.

c. Glumifloræ.

d. Liliifloræ.

Class 50. Dicotylæ. Dicotyls.

Subclasses.

a. Thalamifloræ.

b. Centrospermæ.

c. Calycifloræ.

d. Amentiferæ.

e. Myrtifloræ.

f. Heteromeræ.

g. Tubifloræ.

h. Inferæ.