

THE CLASSIFICATION OF PLANTS, IV.

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The class concept is becoming fairly well established in botany even though one frequently finds groups of very unequal rank designated as classes in recent works. In the last article of the present series of papers, the writer defined a class as "A group of plants in a subkingdom, the members of which show an evident relationship to one another because of similarity of morphological and physiological characters." A diagram was also given showing the approximate relationships of the classes.

There are between forty and fifty plant classes. Of course, it will be recognized that the groups we call classes are of the same rank only in a general sense. In the following scheme forty-six classes, four of them fossil, have been established and are characterized by brief descriptions together with the approximate number of species. The endings of the fungus names have been changed to correspond to Saccardo's views. There should be a uniform system of class endings, but this will come probably only when the class becomes more definitely recognized as a plant group. It might be well in the future to revise some of the class names now in use. It is manifestly absurd to attempt to apply the law of priority in establishing class names. Until very recently the very idea of the class as a definite group from the modern point of view was lacking and our system of the larger groupings is still in its evolution. The arguments adduced for priority in establishing generic and specific names have no weight when applied to the higher groups. From time to time some botanist proposes an improvement and it is thus that a reasonable system will be developed.

In a future paper an attempt will be made to group the classes into proper phyla in harmony with the diagram already published.

I. PROTOPHYTA. 3000 species.*Protophyceae.***1. Cyanophyceae.** Blue-green Algae. 1000 species.

Nonsexual algae with phycocyanin, blue-green or brownish in color; unicellular, in plates or masses, or in simple or branched filaments; reproduction by simple fission or hormogones, sometimes with specialized resting cells; cell walls usually gelatinous. Typically freshwater plants, frequently occurring in hot springs, some growing in aerial conditions on moist soil, rocks and trees.

2. Pleurococceae. 200 species.

Simple nonsexual green algae, unicellular, filamentous, or in colonies; reproduction by fission, by internal division, or by zoospores. Typically freshwater or aerial plants.

*Protomycetae.*3. **Schizomycetae.** Bacteria. 1350 species.

Simple unicellular or filamentous fission fungi, parasitic, saprophytic, or holophytic; commonly with flagella or cilia, sometimes moving by means of cell contraction; often producing nonmotile spores which can endure great extremes of heat and cold; reproduction by simple fission, the divisions in one, two, or three directions; cells not naked or ameboid.

4. **Myxoschizomycetae.** Slime Bacteria. 20 species.

Unicellular fission fungi with a slight undulatory motion produced by the contraction of the cell, imbedded in a pseudo-plasmodium and moving about en masse; forming peculiar sporangium-like bodies when passing into the resting or spore stage; cells not amoeboid; saprophytes on decaying organic matter.

5. **Myxomycetae.** Slime Moulds. 400 species.

Unicellular nonsexual mostly terrestrial fungi showing some relationship to the Rhizopoda, occurring in plasmodial masses of more or less completely fused amoeboid cells which finally, with few exceptions, build up complex sporangia-like bodies containing the spores or encysted individuals; spores on germinating giving rise to flagellate naked cells; saprophytes or rarely parasites.

6. **Archimycetae.** 200 species.

Simple parasitic often aquatic fungi without or with a very imperfect mycelium; nonsexual, with zoospores or with thick-walled resting spores; zoospores usually penetrating and developing in a cell of the host plant.

II. NEMATOPHYTA. 57,000 species.

*Gamophyceae.*7. **Protococceae.** 230 species.

Simple sexual green algae, single celled or in colonies; usually with normal cells containing one nucleus; reproduction by division, by free swimming gametes, or by motile spermatozoids and stationary eggs.

8. **Hydrodictyae.** 26 species.

Green coenocytic algae consisting of colonies of peculiar form often very symmetrical; reproduction by the conjugation of equal motile gametes; nonsexual reproduction by zoospores which form new colonies in the parent coenocyte or are discharged in a delicate membrane.

9. **Diatomeae.** Diatoms. 3000 living species.

Single celled or somewhat filamentous algae usually of a brownish color, in which the cell wall becomes silicified and consists of two valves usually with fantastic markings; reproduction by division or by the conjugation of two cells.

10. **Conjugatae.** 1200 species.

Unicellular or filamentous, unbranched, unattached, green, mostly freshwater algae, with a single nucleus and with one or more highly specialized chloroplasts with pyrenoids in the cells; reproduction by division and by zygospores formed by the conjugation of two similar or nearly similar cells, often joined by the development of a special conjugation tube.

11. **Siphoneae.** 625 species.

Coenocytic terrestrial or aquatic green algae usually filamentous, more or less branched, and with or without transverse septa; reproduction by zoospores, by ciliated gametes, or by true sperms and eggs.

12. **Conferveae.** 600 species.

Simple or branched filamentous green algae, sometimes having the cells in discs or sheets, usually attached, having normal cells with one nucleus; reproduction by means of zoospores and by motile gametes or by heterogametes, the egg being stationary; commonly with a primitive alternation of generations; chloroplasts one or more, usually with pyrenoids.

Subclasses, *Isogamae*.

Heterogamae.

13. **Phaeosporeae.** 385 species.

Normally brown-colored marine algae ranging from rather simple filamentous forms to very large, highly developed organisms with a distinct conducting tissue whose cells contain sieve plates; usually attached, the frond often differentiated into stem and leaf-like structures; reproduction by zoospores produced in unilocular sporangia, and motile gametes produced in plurilocular sporangia; both types of sporangia exposed.

14. **Cyclosporeae.** 316 Species.

Medium to large, marine, brown algae, attached, branched, and usually flattish; reproduction by small biciliate sperms and large non-ciliated eggs which are discharged and fertilized in the water; reproductive organs sunken in conceptacles.

15. **Dictyoteae.** 82 species.

Erect, attached, marine, brown algae with flat leaf-like fronds; nonsexual reproduction by nonmotile tetraspores; sexual reproduction by means of non-ciliated eggs produced singly and finally discharged from the oogonium, and sperms with one flagellum produced in many-celled antheridia.

16. **Bangieae.** 46 species.

Marine or freshwater red or purple algae with filamentous or thalloid fronds; reproduction by single thallus cells and by the production of antheridia and oogonia from ordinary thallus cells, the antheridium developing nonciliated sperms, the oogonium which is without a distinct trichogyne usually developing a single stationary egg.

17. **Florideae.** 1835 species.

Mostly marine red or purple algae, often of considerable size, filamentous or thalloid; reproduction by means of non-ciliated sperms produced in antheridia consisting of definite groups of cells, and eggs produced singly in the base of an oogonium which is prolonged above into a slender trichogyne. Plants with a definite alternation of generations the fertilized egg having a complicated development but in the simpler cases giving rise to a juvenile sporophyte body from which one to many carpospores are produced which on germination develop into a second sporophyte stage on which tetraspores are produced from which the gametophyte is again propagated.

18. **Chareae.** Stoneworts. 160 species.

Green filamentous erect, mostly freshwater algae, attached at the base by means of rhizoids, with stems distinctly segmented into nodes and internodes, the nodes being marked by whorls of branches; plants usually with an incrustation of lime and the cells of the stem and branches often covered with a cortical layer of smaller cells; without an alternation of generations; oogonia rounded covered by a cortical layer of branches, antheridia compound and very complex composed of united branches to form a hollow globular structure containing sperm-bearing filaments; spermatozoids spirally coiled, biciliate; no nonsexual spores present.

*Eumycetae.*19. **Monoblepharideae.** 6 species.

Small coenocytic fungi with a nonseptate or nearly nonseptate mycelium, with unciliated zoospores and with a typical sexual reproduction; saprophytic and aquatic; eggs stationary in the oogonium which opens to admit the unciliated spermatozoids.

20. **Zygomycetae.** 180 species.

Saprophytic or parasitic fungi with a nonseptate or nearly nonseptate mycelium having a conjugation of equal or nearly equal branches, one of which does not penetrate the other to any extent, the result of conjugation being a simple or coenocytic zygospore; sometimes parthenogenetic; nonsexual spores usually non-motile.

21. **Oomycetae.** 185 species.

Mostly parasitic fungi with a nonseptate or nearly nonseptate mycelium, with conjugating branches, the one being much larger than the other which penetrates into its interior, the result being a simple or coenocytic sexual spore; sometimes parthenogenetic; nonsexual motile spores also produced which frequently develop in conidia.

22. **Ascomycetae.** 12,250 species, besides 8,250 Lichens and 13,500 Deuteromycetae.

Parasitic or saprophytic fungi with a septate mycelium and asci usually containing a definite number of ascospores, the asci often produced as the result of a conjugation of two branches of the mycelium, or sometimes by a more highly developed sexual process; conidiospores commonly developed, in many groups the conidial stage only being known.

Subclasses, *Hemiascae*
Exoascae
Discomycetae
Pyrenomycetae
Discolichenes
Pyrenolichenes
Deuteromycetae

23. **Laboulbenieae.** 150 species.

Minute fungi with a septate body parasitic upon insects, usually beetles, connected with the host by means of a dark-colored horny base serving as an organ of absorption and a hold-fast; oogonium with a slender projection, the trichogyne, to which the nonmotile spermatia become attached, finally fertilizing the oosphere below; as the result of fertilization a number of sacs or asci are produced which contain the nonsexual ascospores.

24. **Teliosporeae.** 2100 species.

Parasitic fungi with the septate mycelium developed in the tissues of the host, finally producing teliospores which give rise to septate or nonseptate basidia on which basidiospores are produced; some groups producing five kinds of spores, often heteroecious; especially abundant on plants of the Grass family.

25. **Basidiomycetae.** 10,000 species.

Mostly large saprophytic, rarely parasitic, fungi with a septate mycelium; developing septate or nonseptate basidia on the vegetative mycelium, no teleospores being produced; basidia usually with two or four spores.

Subclasses, *Protobasidiae*
Hymenomycetae
Gasteromycetae
Hymenolichenes.

III. BRYOPHYTA. 17,000 species.

26. **Hepaticae.** Liverworts. 3875 species.

Gametophyte thalloid or a stem-like frond with scales which are without a costa, mostly dorsiventral, usually with a sack-like envelope, the perigynium, around the archegona; rhizoids thread-like and unicellular; protonema usually small or only slightly developed, transient. Sporophyte either a spherical sporangium without foot or stalk, or differentiated into sporangium, foot and

elastically elongating stalk; sporangium without columella, usually with elaters, indehiscent, irregularly dehiscent at the top, or splitting into four valves from the summit, rarely developing an operculum.

27. **Sphagneae.** Bog-mosses. 250 species.

Gametophyte a stem-like, erect, light, gray-green frond without a true central strand but with large cortical cells, bearing numerous scales without a costa but with two kinds of cells, narrow ones with chlorophyll and large ones without, but with holes in the walls; rhizoids septate; protonema finally thalloid and flat; fruiting plant developing one or more pseudopodia which support the sporophytes. Sporophyte without a stalk but with an expanded foot; sporangium with a shallow dome-shaped spore cavity in the upper part and with an operculum but without a peristome, elaters, or air cavities. Growing in bogs and wet places.

28. **Andreaeae.** Granite-mosses. 105 species.

Gametophyte a stem-like, erect frond without a central strand, bearing numerous scales without or with a costa; rhizoids consisting of cylindrical masses or plates of cells; protonema more or less thalloid. Sporophyte without a seta but with a foot and finally carried upon a pseudopodium; sporangium without air cavities, splitting into four or more valves which are at first united at the top, spore cavity cylindrical dome-shaped with an upward projecting central columella; elaters none; calyptra present on the sporophyte. Caespitose plants of a dark brown color growing on rocks.

29. **Musci.** Mosses. 12,500 species.

Gametophyte a stem-like, erect or prostrate frond usually with a well-developed central strand and with costate scales; rhizoids filamentous, septate; protonema usually well-developed and filamentous, sometimes persistent; pseudopodium none. Sporophyte well-developed with sporangium, foot, and usually with a well-developed hypophysis and a seta with a central strand; sporangium usually with an operculum and a central columella extending entirely through the spore cavity, usually with a well-developed peristome and air spaces often communicating on the outside with stomata; venter of the archegonium enlarging and usually ruptured at the base, the upper part being carried on top of the sporangium as the calyptra.

30. **Anthocerotes.** Horned Liverworts. 103 species.

Gametophyte a dorsiventral thalloid frond without scales or with imperfectly developed scales but with unicellular rhizoids; sexual organs imbedded in the tissue of the thallus; protonema small and transient. Sporophyte with a slender horn-like or

pod-like sporangium and with a bulbous foot containing an irregular surface with wart-like projections; sporangium with a central columella, two-valved, with small irregular elaters among the spores; epidermis with or without stomata; cells with a single large chloroplast.

IV. PTERIDOPHYTA HOMOSPORAE. 4,500 species.

31. **Filices.** Ferns. 4,000 living species.

Sporophyte herbaceous or tree-like, usually with a horizontal rhizome, simple or branched; leaves usually large, alternate and mostly compound, rarely grass-like; sporangia borne on the under side of the leaves or on simple or branched sporangio-phores; eusporangiate or leptosporangiate; sporophylls not forming cones. Gametophyte comparatively large, tuber-like without chlorophyll and subterranean, or developed as a flat, simple or branched thallus, hermaphrodite or unisexual; spermatozoids multiciliate.

Subclasses *Eusporangiatae*
Leptosporangiatae.

32. **Equiseteeae.** Horsetails. 25 species.

Sporophyte perennial, herbaceous, with a rhizome, and with jointed, mostly hollow, simple or branched, aerial stems which are either annual or perennial; vascular bundles in a circle; leaves reduced to sheaths around the joints, the sheaths toothed; sporangia borne on small peltate sporophylls arranged in whorls on a terminal cone; eusporangiate; spores with four narrow, strap-like, hygroscopic appendages. Gametophyte a small green thallus, usually unisexual; spermatozoids multiciliate.

33. **Lycopodieae.** Lycopods. 155 species.

Sporophyte perennial, herbaceous, with or without a rhizome, the aerial stems upright or trailing; branching monopodial or dichotomous; leaves small, without a ligule, scattered on the stem, into two to many ranks; sporangia solitary on the upper surface of the leaves or in their axils, eusporangiate; sporophylls in bands alternating with the sterile leaves or arranged in spirals in terminal cones; spores small, not appendaged. Gametophyte small, sometimes subterranean, with or without chlorophyll, hermaphrodite; spermatozoids biciliate.

V. PTERIDOPHYTA HETEROSPORAE. 700 species.

34. **Calamariaceae.** Fossil.

Paleozoic plants, sometimes of tree-like aspect and dimensions, with hollow-jointed stems with a circle of collateral vascular bundles; stems increasing in diameter by a cambium zone; heterosporous, the sporophylls in cones.

35. Sphenophylleae. Fossil.

Paleozoic plants of tree-like aspect and dimensions, with solid jointed stems with a central triarch vascular bundle; leaves wedge shaped, comparatively small; probably heterosporous, the sporophylls in cones.

36. Hydropterides. Water-ferns. 75 species.

Sporophyte with a horizontal rhizome or floating on the surface of the water; leaves alternate or whorled; microsporangia and megasporangia borne together enclosed in sporocarps, leptosporangiate. Gametophytes developing entirely within the spore walls or protruding only slightly, very short lived; spermatozoids large, spirally coiled, multiciliate.

37. Isoeteae. Quillworts. 60 species.

Sporophyte with a short tuberous stem with a peculiar type of secondary thickening and with long, erect, grass-like leaves which have a ligule; roots dichotomous; microsporangia and megasporangia large, borne singly, sunken in the expanded bases of the leaves, eusporangiate. Gametophytes very much reduced; spermatozoids spirally coiled, multiciliate.

38. Selaginelleae. Selaginellas. 500 species.

Sporophyte dorsiventral or erect, with monopodial or dichotomous branching and dichotomous roots; leaves small, opposite or spirally arranged, ligulate; cells often with a single chloroplast; sporophylls in bisporangiate cones, the eusporangiate microsporangia and megasporangia single in the axils of the sporophylls. Gametophytes small and short-lived; spermatozoids very minute, biciliate. Some fossil species developed as large trees with secondary thickening by a cortical meristem.

VI. GYMNOSPERMAE. 500 living species.**39. Pteridospermae.** Fossil.

Paleozoic seed plants of fern-like aspect; stems short and erect, increasing in thickness, bearing compound leaves.

40. Cycadeae. Cycads. 90 species.

Sporophyte with erect, woody, simple or little-branched stems, bearing compound leaves; vascular bundles collateral concentrically arranged, increasing in thickness by their cambium; cortical meristem developed in which new bundles are produced; sporophylls in cones, or the carpels sometimes merely in whorls through which the stem grows; ovule with pollen-chamber; female gametophyte becoming large and fleshy; male gametophyte developing two or more large spirally coiled multiciliate spermatozoids.

41. Cordaiteae. Fossil.

Paleozoic branching trees bearing large, long, thick parallel-veined leaves spirally arranged.

42. **Ginkgoeae.** Maiden-hair-trees. 1 living species.

Sporophytes developing into large trees with a cambium layer from which annual rings of wood are produced, with numerous, large, wart-like dwarf branches on the ordinary branches; leaves deciduous, broad, with dichotomous venation, borne in clusters on the dwarf branches or alternate on ordinary branches; flowers monosporangiate, dioecious; ovule with pollen-chamber; cotyledons, 2, the embryo not developing until the seed falls to the ground; female gametophyte becoming large in the seed which has a bony inner and a fleshy outer coat; male gametophyte developing 2 large spirally coiled multiciliate spermatozoids.

43. **Coniferae.** Conifers. 350 species.

Sporophytes developing as shrubs or large trees, much branched, with or without dwarf branches; stems with a normal cambium, no vessels in the secondary wood; resin nearly always present; leaves mostly small, entire, linear, lanceolate, subulate, or scale-like; flowers monosporangiate, monoecious or dioecious; seeds and female gametophyte rather small, ovules without pollen-chamber, cotyledons 2-15, always free; sperm cells 2, not motile, no cilia being present.

44. **Gneteeae.** 50 species.

Sporophytes developing as shrubs, trees, or woody climbers, with branched or simple stems containing vessels in the secondary wood; leaves simple and opposite; flowers monoecious; seeds naked, orthotropous; cotyledons two; resin passages none; gametophytes various.

VII. ANGIOSPERMAE. 125,000 species.

45. **Monocotylae.** Monocotyls. 24,000 species.

Sporophytes developing as herbs or sometimes as woody plants of large dimensions, embryo usually with one terminal cotyledon and usually with a lateral plumule; stem with closed, usually scattered vascular bundles, without typical bark and annual rings of growth, rarely with secondary thickening; leaves mostly parallel-veined, sometimes netted-veined; flowers more commonly trimerous.

Subclasses, *Helobiae*
Spadiciflorae
Glumiflorae
Liliiflorae

46. **Dicotylae.** Dicotyls. 100,000 species.

Sporophytes developing as herbs or woody plants; embryo with two cotyledons, rarely with more or only one, and with a terminal plumule; stem with open vascular bundles, usually

arranged in a circle and developing a continuous cambium cylinder, forming annual rings of growth in the case of perennial stems, with bark on the outside; leaves usually netted-veined; flowers more commonly pentamerous or tetramerous.

Subclasses, *Choripetalae*
Centrospermae
Apetalae
Heteromerae
Sympetalae Hypogynae
Sympetalae Epigynae
