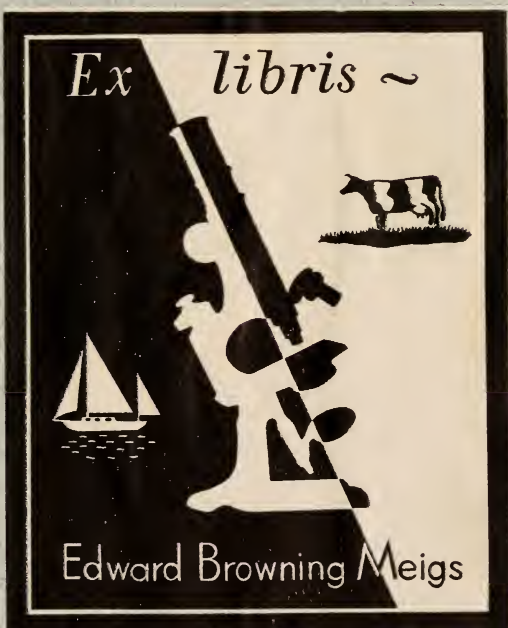
Arthur V. Meigs
March 23, 1891



FRESH-WATER ALGÆ

OF THE

UNITED STATES;

(EXCLUSIVE OF THE DIATOMACEÆ)

COMPLEMENTAL TO

DESMIDS OF THE UNITED STATES;

WITH

2300 ILLUSTRATIONS,

COVERING ONE HUNDRED AND FIFTY-ONE PLATES, A FEW COLORED,
INCLUDING NINE ADDITIONAL PLATES OF DESMIDS.

BY THE REV. FRANCIS WOLLE,

Member of the American Society of Microscopists.

BETHLEHEM, PA.:
THE COMENIUS PRESS,
1887.

TO

DR. ANTON HANSGIRG,

OF THE ROYAL-IMPERIAL UNIVERSITY

OF PRAGUE, BOHEMIA,

IN RECOGNITION OF HIS EARNEST RESEARCHES

AND VALUABLE CONTRIBUTIONS TO THE

LIFE-HISTORY OF FRESH-WATER ALGÆ,

THIS VOLUME IS RESPECTFULLY

DEDICATED

BY HIS FRIEND AND CORRESPONDENT,

THE AUTHOR.

PREFACE.

IN presenting the following memoir on the Fresh-water Algæ of the United States, we are keenly sensible of the great task we have undertaken. The subject-matter is in an unsettled state, passing through a period of transition. There is an Old School and a New School. The former accepts all forms as distinct plants, and the latter rejects a large portion of the forms, mostly unicellular, as only conditions of development. Suggestions for a new nomenclature have been made. The latest by Dr. Anton Hansgirg, Professor in the Royal University of Prague; but they seem premature. There are too many questions of life-history remaining undetermined.

The most complete work representing the Old School, is *Rabenhorst's Flora Europaea Algarum* (1864–1868). An admirable work in its day, and indispensable for reference at the present time: but a very large number of forms therein described, making up many genera, some of which contain fifty or more species, are nothing more nor less than conditions of development.

Thuret of France has claims for later suggestions. He does not reject the unicellular forms as mere conditions, but proposes to reverse the order of arrangement by placing those more highly developed, or those most nearly allied to the larger marine algæ, first in rank; and then gradually descend to the lower forms. The idea meets with favor. Dr. O. Kirchner in preparing a prodomus of the Fresh-water Algæ of Silesia (1878) adopted the proposition. His work being imbued with the more modern ideas of the value, (or valuelessness) of many forms, and being quite in accord with my own observations and convictions, his volume has been a valued companion, and I am largely indebted to Dr. Kirchner for the order of arrangement followed in the preparation of the body of the present volume. Many genera are still preserved which have literally no worth, but they serve for reference. They will be noticed more fully under their various generic characters.

We have added nine additional plates of Desmids illustrating one hundred or more species and varieties mostly new to the United States.

In our ability to make this large addition we have had the kind co-operation of collectors and workers in various parts of the country. Rev. H. D. Kitchel and his son H. S. Kitchel continued with us; Miss E. Butler, of Minneapolis, Minn., made some good finds. Geo. B. Twitchel has been operating in a new field, Ohio. Professor F. W. Cregin is active in Kansas; W. N. Hastings is working up the vicinity of Rochester, N. H., and G. M. Rafter, that of Rochester, N. Y.; Mrs. Hanson and Miss M. S. Haggin, of San Francisco, Cal., have during the past Summer (1886) commenced opening up the Desmidial resources of that State; as pioneers they have done a good work. G. v. Lagerheim, of Stockholm, Sweden, has published a list of American Desmids, partly from the island of Cuba, but mainly from Massachusetts. Mr. W. B. Turner, of England, also added a few American forms from Nova Scotia and the United States, all duly noticed under their generic heads.

FRANCIS WOLLE.

Bethlehem, Pennsylvania,
December, 1886.

AUTHORITIES QUOTED,

Mostly in addition to those already noted in *Desmids of the United States;* also the *abbreviation* of names used in the preparation of this monograph.

Ag.—C. A. Agardh. Systema Algarum, 12 mo. Lund, 1824.

Ag.—J. G. Agardh. Species genera et ordines Algarum. Lundæ, 1848–1863.

Allm.—George James Allman. On a new genus of Algæ, belonging to the family Nostochaceæ. Annals and Magazines of Natural History, 1843, etc.

Arch.—W. Archer. Various communications in Quarterly Journal of Microscopic Science. London, 1857–1880.

Bail.—John W. Bailey. Microscopic observations in South Carolina, Georgia and Florida. Smithsonian Contributions, Vol. II.

Berk.—Rev. M. J. Berkley. Gleanings of British Algæ, supplement to English Botany, 1833.

Bor.-Thur.—Ed. Bornet, et G. Thuret. Notes Algologiques. Paris, 1876–1880.

Borzi.—Antonino Borzi. Studi Algolgici:
Note alla morfologia e biologia. Messina, 1883–1885.

Bory.—Bory de St. Vincent. Memoir sur les genres de confervis nommes Thorea, Lemanea, Batrachosphērmum et Draparnaldia. Paris, 1808.

Br.—A. Braun. 1. Ueber Chytridium, 1856.
2. Rejuvenescence in Nature.
3. Algarum unicellularum genera nova, etc.

Breb.—A. Brebisson. Algues des environs de Falaise, 1835.

Ces.—Vincenzo barone Cesati.—Ueber die Vermehrung von Hydrodictyon. Hedwigia, 1852.

Cienk.—L. Cienkowski Ueber Sphaeroplea, etc., Botanische Zeitung, 1865. Ueber meinen Beweis für die Generatio primaria, 1858.

Cleve.—P. T. Cleve. Monograph ofver de Svenska arterna af Algen, Fam. Zygnemaceæ. Upsal, 1868; Fam. Vaucheria.

Cohn.—Dr. Ferd. Cohn.—Beiträge zur Biologie. Breslau, 1870–1884.
On Protococcus pluvialis; translated and published by Ray Society, 1853.

Cooke.—British Fresh-water Algæ, 1885.

Corda.—A. K. J. Corda. Die Algen. Sturm's Deutschlands Flora, 1829–1832.

D. C.—MM. Lamarck et de Candolle. Flore Française, 1805.

D. By.—A. de Bary. Ueber die Conjugaten, 1858.
Ueber der Algengattung Oedogonium, 1864.

Dick.—Dr. G. Dickie. The Botanists' Guide to the Counties of Aberdeen, etc., 1860.

Dill.—J. J. Dillenius, M.D. Historia muscorum. Oxford, 1741.

Dillw.—L. W. Dillwyn. British Confervæ. London, 1809.

Ducluz.—M. Ducluzel. Essai des Conferves de Montpellier.

Ehrb.—Dr. C. G. Ehrenberg. Die Infusionsthierchen als vollkommene Organismen, 1838, etc.

Flotow.—J. v. Flotow. Beobachtungen über Hæmatococcus pluvialis, 1844.

Fres.—Dr. G. Fresenius. Sphaeroplea in Bot. Zeitung, 1851.

Gay.—Fr. Gay. Essai, monographie locale des Conjugaceés. Montpellier, 1884.

Girod.—Girod—Chantrans. Recherches Microscopique sur les Conferves, etc., 1802.

Greva.—Grevillea. A quarterly record of cryptogamic Botany, 1872–1886.

Grev.—Algæ Britannicæ. R. Kaye-Greville, 1850.

Grun.—A. Grunow. Die Desmidaceen und Pediastreen einiger Oesterreichischen Moore, etc., 1858.

Harv.—Dr. W. H. Harvey. A manual of the British Algæ. London, 1841.
Phycologica Britannica, 1846–1851.

Hansg.—Dr. A. Hansgirg. Polymorphismus der Algen, 1885.
Bemerkungen zur Systematik einiger Süsswasser Algen, 1884; and other papers.

Hass.—Dr. A. H. Hassall. British Fresh-water Algæ. London, 1845.

Hicks.—John B. Hicks. On Fresh-water Algæ; Sundry papers in Royal Mic. Journal.

Hilse.—Dr. Hilse. Beiträge zur Algen und Diatomeen-Kunde Schlesiens, 1860.

Hill.—Franz Hillebrandt. Ueber ein Chroolepus mit Zoosporenbildung. Bot. Zeitung, 1861.

Hob.—J. Hobson. Notes on Indian Desmideæ. Mic. Journal, 1863.

Hook.—Sir W. J. Hooker.—English Cryptogamia, 1833.

Huds.—Gulielmi Hudsoni. Flora Anglica, 1778.

Itz.—Dr. H. Itzigsohn. Skizzen zu einer Lebensgeschichte des Hapalosiphon Braunii. Also frequent papers in Bot. Zeitung; Hedwigia; Annal. des Science; Nova Acta, etc.

Josh.—W. Joshua. Burmese Desmidieæ with descriptions of new species.

Kirch.—Dr. O. Kirchner. Kryptogamen Flora von Schlesien. Breslau, 1878.

Kleb.—G. Klebs. Ueber die formen einiger Gattungen der Desmidiaceen, 1879.

Kg.—F. T. Kuetzing. Phycologia generalis; 1843.

2. Phycologia Germanica; 1845.

3. Species Algarum; 1849.

4. Tabulæ Phycologicæ, 1845–1869.

Lags.—Lagerstedt. Monographia om Algslägt Prasiola. Upsal, 1869.

Lagh.—G. Lagerheim. Bidrag till Kaennedomen om Stockholmstraktens Pediastreer, Protococcaceer, etc.

2. Algologiska och mykologiska anteckningar fran en botanisk resa i Lulea Lappmark.

3. Om Chlorochytrium Cohnii och dess foerhallande till naerstaende arter.

4. Ueber Phaeothamnion. Eine neue Gattung unter den Süsswasser-Algen, 1884.

5. Zur Algenflora der Wasserfälle von Lulea Elf.

6. Bidrag till Sveriges Algflora, 1883.

7. Bidrag till Amerikas Desmidieflora, 1885.

Lands.—D. Landsborough. British Seaweeds, with notices of some of the Fresh-water Algæ. London, 1849.

LeClerc.—Sur la fructification du genre Prolifere. Paris, 1817.

Linn.—Car. Linnaeus. Species Plantarum, 1753.

Lyngb.—H. C. Lyngbye. Tentamen Hydrophytologiae Danicae, 1819.

Menegh.—Prof. J. Meneghini. Monographia Nostochinearum Italicarum. Turin, 1841.

Meyen.—F. J. F. Meyen. Beiträge zur Physiologie und Systematik der Algen. Nova Acta Leop. Acad. 1828.

Mont.—J. F. Camille Montagne. Exploration Scientifique de l'Algerie. Paris, 1846, and occasional papers, 1845–1852.

Moug.—J. B. Mougeot et C. Nestler. Stirpes Cryptogamæ Vogeso-Rhenanæ. Spec. exsic. 1,500, 1810–1860.

Naeg.—C. Naegeli. Gattungen Einzelliger Algen. Zurich, 1849.

Nord. and Wittr.—O. Nordstedt et V. B. Wittrock. Algæ aquae dulcis exsiccatae. Upsal, 1877–1886.

Nord.—O. Nordstedt. Numerous Papers, v. Des. U. S. p. ix.

Nota.—Notarisia Commentarium Phycologicum. Redattori, G. B. de Toni, E. David Levi. Venezia, Italia.

Perty.—Max. Perty. Bemerkungen über die Bacillarieen. Bern, 1848.

Ueber die identitaet einiger Algen—und Infusoriensippen, 1863.

Petit.—Paul Petit. Spirogyra des Environs de Paris. Paris, 1880.

Pringsh.—Dr. N. Pringsheim. Beiträge zur Morphologie und Systematik der Algen. Berlin, 1858–1860.

Jahrbücher für Wissenschaftliche Botanik. 1858–1884.

Pritch.—Andrew Pritchard. A History of Infusoria, including the Desmidiaceæ and Diatomaceæ. London, 1861.

RAB.—Dr. Ludw. Rabenhorst. Algen Europa Exsiccati. Dresden, 1850–1867.
Flora Europæa Algarum Aqua dulcis et submarinae. Leipzig, 1864.
Kryptogamen Flora von Sachsen. 1863.

RALFS.—John Ralfs. The British Desmidieæ. London, 1848.

REINSCH.—F. Reinsch. Algenflora von Mittel-Franken. Nurnberg, 1867.
Contributiones ad Algologiam et Fungologiam. 1874.

RICH.—Paul Richter. Ueber die in den Entwickelungskreis von Beggiatoa rosea-persicina, Zopf, gehoerenden seitherigen algen-species. Leipzig, 1884.
Ueber den Wechsel der Farbe bei einigen Süsswasseralgen, insbesondere den Oscillaren. Bot. Central Blattes, 1880.
Zum Formenkreis von Glœocystis. Hedwigia, 1880.
Frage über die moeglichen genetischen Verwandtschafts-verhältnisse einiger einzelligen Phycochromaceen. Hedw., 1880.

ROSTAF.—J. Rostafinski u. M. Woronin. Ueber Botrydium granulatum. 1877.
Hydrurus i jego pokrewienstwo. 1882.

ROTH.—A. G. Roth. Catalecta Botanica. Leipzig, 1797.
Neue Beiträge zur Botanik. 1788–1800.

ROY.—John Roy and J. P. Bisset. Notes on Japanese Desmids, 1886.

SCHAAR.—Dr. Julio Schaarschmidt. Klausenburg, Austro-Hungary. A number of Papers on Hungarian Desmids, Diatomes and other Algæ. All in the Hungarian language, hence of little use to the general reader.

SIRO.—S. Sirodot. Sur le development des Algues d'eau douce du genre Batrachospermum. Paris, 1875.
De la familie des Lemaneacees.

STEIN.—F. Stein. Die Infusionsthiere. 1854–1882.

THUR.—Gustave Thuret. Sur la reproduction de quelques Nostochinees.
Note sur la synonymie des Ulva. 1854.
Recherches sur les zoospores des Algues.

THWAIT.—G. H. K. Thwaites. On an apparently undescribed state of the Palmelleæ with a few remarks on germination in the lower plants. 1848.
Mode of the formation of spores in a species of Vesiculifera. 1846.
On the early stages of development of Lemanea fluviatilis. 1851.

TURN.—W. Barwell Turner. On some new and rare Desmids. London, 1885.

VAUCH.—J. P. Vaucher. Histoire des Conferves d'eau douce. 1803.

VAUP.—J. P. Vaupell. Befrugtningen hos en Art af Slaegten Oedogonium. Copenhagen, 1859.

WART.—B. Wartmann. Zur Anatomie und Entwicklungsgeschichte der Algengattung Lemanea. St. Gall, 1854.

WEBER.—Weber and Mohr. Gross Britanniens Conferven: a reproduction in German of Dillwyn's Confervae. 1803–1805.

WILLS.—A. W. Wills. Life-History of Volvox globator, in Midland Naturalist. 1880.

WILLE.—N. Wille. Om en ny endophytisk Alge, 1880.

Om Hvileceller hos Conferva. 1881.

Om Svaermecellerne og deres Copulation hos Trentepohlia, Mart. 1878.

Om Slaegten Gongrosira, Kg. Stockholm, 1883.

WITTR.—V. B. Wittrock. Dispositione Oedogoniacearum Suecicarum. Stockholm, 1870.

Om Gotlands Soetvattens Alger. 1872.

On the spore formation of the Mesocarpeæ, especially of Gonatonema. 1878.

Prodomus Monographia Oedogoniearum. Upsal, 1874.

On the development and systematic arrangement of the Pithophoraceæ. 1877.

Oedogoneaceæ Novae, in Suecia lectae, 1872.

Om Snoens och Isens Flora.

WOOD.—H. C. Wood. Contributions to the History of the Fresh-water Algæ of North America. (Smithsonian Institution, 1872.)

WORON.—M. Woronin. Neuer Beiträge zur Kenntniss der Chytrideen, in Bot. Zeitung, 1867.

INTRODUCTION.

THERE is a period in the life-history of Fresh-water Algæ which has not received the consideration the subject deserves. We mean an intermediate period between the microgonidia or spore, or the first development from it, and the matured plant. It is a period unlike anything known among the higher forms of vegetation. The phænogamous plants blossom, and bear seed, some in edible masses known as fruits, some in hard-shelled envelopes as the nuts, others have the seeds in pods, and so on ; the seeds germinate and at once reproduce the original type. Cryptogamous plants are not usually so direct in the reproduction ; they propagate from spores which in many, perhaps most, instances divide into parts, two or four, and these redivide often many times over, and then develop a prothallus, a peculiar sort of filamentous growth, from which the true plant grows. In the case of the *Fungi* this ante-growth is called *mycelium*. Under circumstances not favorable to reproduction this mycelium will grow into large masses. It is found in dark cellars and in neglected mines often filling the galleries scores of feet in extent, sometimes to a depth of two or three feet, yet never producing a single plant ; on the other hand, under favorable circumstances, the true plant will develop rapidly with scarcely a visible sign of a mycelium.

Among the Mosses also, we find this prothallus, (ante-growth) ; sometimes it extends over many square yards of earth or moist rocks without an evidence of the plant that should be developed from it ; at other times the true plant abounds with scarcely an evidence of a prothallus.

This growth of prothallus, and of mycelium constitutes a peculiar or abnormal production ; they are the true plants arrested in their normal course of development.

In Fresh-water Algæ, perhaps more than in any other class of cryptogamous plants, is this peculiar, arrested character of plant-life observed. It is found everywhere either in immediate connection with or independent of the more fully developed plants. Usually it presents itself in unicellular forms, embracing the forms of such old genera as Protococcus, Pleurococcus, Chlorococcum, and others among the Chlorophyceæ, and Gloeocapsa, Aphanocapsa, Microcystis and many others among the Cyanophyceæ. The cells divide, and redivide many times over. To say that one single spore, or cell, will produce thousands of its own kind in the course of a few days, is no exaggeration, yet all of these, or nearly all, are merely single cells, serving apparently no purpose except to form a bed or stratum from which in due time, when the particular requirement of temperature and moisture are supplied, a plant, or plants, will develop, reproducing the original filamentous type.

When we consider that in all vegetation the process of cell multiplication takes place by division of cells, that this is the process of growth in every stem and leaf, but differing; in these the cells remain united to increase the size, whereas in algæ the cells separate—the process of multiplication and growth of the so-called unicellular forms is not so altogether singular. As in the growth of a leaf hundreds and even thousands of cells are evolved before a leaf is fully matured, so in algæ many thousands of cells are produced before the true plant is developed. There is at least an analogy between the two in principle of development.

P. H. Dudley, in a recent paper read before the New York Microscopical Society (see document of said Society Vol. II, No. I. p. 9), on *Protococcus viridis*, takes a philosophic view of this condition of plant-life. A few lines may be transcribed: "As humble as our plant may seem from its classification, modern science is still unable to solve its mysteries; it is one of the great manufacturing chemists among plants, converting crude materials into combinations which, upon decay, may be taken up by higher vegetation. Spread out upon trees and rocks, its gelatinous substance is ready to catch and imbed the floating dust and inorganic matter brought to it by the wind, some of which will be converted and used. The air also brings great carboys of carbon di-oxide and exchanges them for oxygen. Fumes of sulphuric, sulphurous, nitric and nitrous acids, and also ammonia come to be combined; the rain brings chlorides and other chemicals to be utilized. Each of the individual cells of *Protococcus viridis*, only measuring from two to ten Micro-

Millemeters in diameter, can do more in its small laboratory than our chemists with all the room and appointments that science has suggested—it builds its own cellulose walls from inorganic matter. Chemists are hardly agreed upon the composition of cellulose and the protein compounds, and if they were, they could not introduce the life-principle to produce them."

The polymorphism of Fresh-water Algæ is not a new thought. It has received varied attention during the past half of a century. C. A. Agardh (Swede) in the earlier part of the present century called attention to some peculiar observations made by himself. The ideas were new and called forth severe criticism. Turpin treated him severely as a false prophet. At the present day some of his notions appear crude, but others stood the test of later observations, and Agardh deserves commendation for the direction he gave to later studies. Later (1840) followed Kuetzing (Prussia) in high rank as an Algologist. He recognized a relation between some of the lower unicellular forms with more fully developed plants.

Dr. H. Itzigsohn (Prussia, 1850) made a bolder stride in the study of the life-history of Hapalosiphon, and after two years of close attention, published his observations in an exhaustive, illustrated prodomus, bringing out many new facts relating to the polymorphic character of this plant. Correctly and ably as his work was done' it was not accepted but quietly ignored, apparently for no other reason than that it struck too severe a blow at the hitherto accepted theories of classification. At the same time that Itzigsohn did so much to throw light on the life-history of the Cyanophyceæ (Schizosporeæ), I. B. Hicks did much in the study of some of the Chlorophyceæ. He called attention to the work of Itzigsohn and to the contributions of Meyen, but instead of awakening an interest of inquiry into the true character of the unicellular forms, and their relation to more highly developed plants, a lethargy appears to have seized upon the minds of Algologists; a calm prevails and more than a decade passes before other explorers enter the field more or less imbued with the spirit of the newer thoughts; from time to time larger or smaller contributions made their appearance.

At the present date we have valuable papers from Borzi, of Messina, Italy; from Cienkowski and Faminzin, of Russia; from Hansgirg, of Bohemia, and Schaarschmidt, of Hungary; from Kirchner, Klebs, Richter, Sachs, and others, of Germany; from Rostafinski, of Poland; from Sirodot, of France; from Wille, Wittrock, Lagerheim, and others, of Sweden. Valuable as these papers are, few appear to have traced the progress of growth in individual plants from their earliest germination through their cycles of transformation to full maturity. They relate mostly to snatches of observation, but all tending to illustrate the polymorphic features of Fresh-water Algæ, and the relation of unicellular forms to the fully developed filamentous algæ. There is no such thing as the changing of plants from one generic character to that of another. What we do see approaching the appearance of such transformation is simply an undeveloped condition changing to another condition before reaching maturity.

Dr. Hansgirg, of the Royal University of Prague, one of the latest observers noted above, who for five years has been gathering specimens in all parts of Bohemia, and made them a study at all seasons of the year, giving special attention to their process of development, sums up his observations in the following seven theses—freely translated from the German.

We may remark in advance, they are full of valuable hints, but need, in some instances, verification in as far as they relate to our species.

THESIS I. Most of the Schizophyceæ (Cyanophyceæ), if not all, are polymorphic algæ, which, in different stages of growth in the open air, assume unicellular vegetative forms, and often retain these forms through many generations, but their genetic relation may be readily traced.

THESIS II. Most, if not all, of the forms hitherto classed with Chroococcaceæ, as the genera Chroococcus, Naeg., Glœocapsa (Kg) Naeg, Aphanocapsa, Naeg., Synechococcus, Naeg., Glœothece, Naeg., Aphanothece, Naeg., and others, have a genetic connection with other more highly developed forms, that is, the most (if not all) of the so-called unicellular, æruginous algæ forms have their origin in, or result from, the decay, or separation and dividing of cells of filamentous *Schizophyceæ*.

THESIS III. Such genera of the Family Oscillariaceæ Rab., as Leptothrix Kg., Hypheothrix Kg., Spirulina Lk., Oscillaria Bosc., Phormidium Kg., Chthonoblastus Kg., Lyngbya Ag., Hydrocoleum Kg., Symploca Kg., Schizothrix Kg., and others, are often found intermingled with thinner and thicker filaments which are merely younger or older conditions of the same plant; among them are also forms of the families, Nostochaceæ Rab., and Chroococcaceæ Rab., and forms of the Family Rivulariaceæ Rab.; (Calotricheæ Thr.,) Scytonemaceæ Rab., and Sirosiphoniaceæ Rab., all of which are genetically connected.

THESIS IV. The genera Nostoc Vauch., Anabæna Bory., Cylindrospermum Kg., Sphærozyga Ag., and others of the Family Nostochaceæ Rab., embrace many heterogeneous algæ forms which like the many Chroococcaceæ forms, are arrested conditions of development resulting in many instances from sudden thermic and hygrometric changes, and should be treated as developing conditions of various species of the families Oscillariaceæ Rab., Rivulariaceæ Rab., and Scytonemaceæ Rab.

THESIS V. The forms of the genera Mastigothrix Kg., Mastigonema Swabe, Schizosiphon Kg., belonging to the Family Rivulariaceæ Rab., and of the more recently added genus Calothrix, and also the forms of the genera Diplocolon Naeg., Scytonema Ag., Arthrosiphon Kg., Tolypothrix Kg., Plectonema Thur., Glaucothrix Kirch., and others of the Family Scytonemaceæ Rab., are the higher, and the most highly developed Algæ forms.

THESIS VI. As the higher developed forms of Rivulariaceæ Rab., (Calothrix Thr.) and of Scytonemaceæ Rab., may be developed from forms of the Family Oscillariaceæ, so are, or may be, developed from the genus Glaucothrix Kirch., forms of Tolypothrix Kg., Scytonema Ag., or forms of the nearly related Family Sirosiphoniaceæ Rab., as the genera Hapalosiphon Naeg., Sirosiphon Kg., Stigonema Ag., Fischera, Schwabe, and others.

THESIS VII. As the most of the Schizophyceæ, so also many of the Chlorophyceæ are polymorphic algæ. Most of the Chlorophyl-green filamentous algæ as Microspora Thr., Conferva Link., Rhizoclonium Kg., Ulothrix Kg., Schizomeres Leib., and Schizogonium Kg., stand in close relation to the higher forms as of the Family Chætophoraceæ Rab., Siphonocladiaceæ Schmitz, Ulvaceæ Rab., and others, which forms are produced by the widening of the single filaments and the dividing longitudinally, thus gradually producing leaf-like forms; on the other hand, by the separation of the parts and division of the cells in one, two or three directions, the most of the so-called unicellular algæ are produced, embracing forms of Protococcus Ag., Palmella Lyngb., Pleurococcus Menegh., Gloeocystis Naeg., Palmagloea Kg., Schizochlamys A. Br., Palmodactylon Naeg., Dictyosphaerium Naeg., Apiocystis Naeg., Polyedrium Naeg., Characium A. Br., Hydrianum Rab., and others.

Dr. Hansgirg does not in every instance demonstrate the position taken, but he does take up several species and follows them minutely through various polymorphic changes which occur in the process of multiplication; he also describes phases which occur under the influence of different degrees of light, temperature, moisture and the character of the soil on which they grow. It would not accord with the design of this work to follow him in all of his observations, which cover about 50 pages. *Scytonema Hoffmanni*, Ag., is one of the plants which received special attention. It is found on old walls, damp mossy earth, old wood, and is not infrequent in green-houses. The plant in younger and older conditions was found to represent the following forms: first, *Lyngbya forms, viz.*, Lyngbya foveolarum Mont., [Oscillaria (Leptothrix) foveolarum, Rab.;] L. Calcicola (Kg.) Hansg. [Leptothrix calcicola Kg., Hypeothrix calcicola Rab.] Oscillaria Kuetzingiana Næg.; Oscillaria tenuis Ag.; Lyngbya vulgaris (Kg.) Kirch., (Phormid. vulgare, Kg.) Lyngbya antliaria (Jurg.) Hansg.; Symploca muralis Kg., Symploca melanocephala Kg., Microcoleus terrestris Desm. *Stigonema-forms*; Stigonema Bouteilli (Breb. et Desm.) Hansg. (Sirosiphon Bouteilli Breb. et Desm.) *Nostoc-forms;* Nostoc Sphæroides Kg., N. gelatinosum Schon., including N. Delphinii, Bor. *Unicellular-forms;* Chroococcus minor Naeg. Chr. pallidus Naeg. Chr. aurantio-fuscus (Kg.) Rab., Gloeocapsa æruginosa Kg., Gl. didyma Kg., Gl. quaternata (Breb.) Kg., Gl. sanguinea Kg., Aphanocapsa cruenta (Ag.,) Hansg. [Porphoridium cruentum (Ag.) Naeg.]

Some pages are devoted to an account of the development of Ulothrix flaccida Kg. The following are forms or conditions through which this plant passes. It is made to include U. nitens Menegh., Conferva antliaria Kg., Psichohormium antliarium Kg., Gloeotila caldaria Kg., and embraces the following unicellular forms, *viz.*, Stichococcus bacillaris Naeg., Dactylococcus caudatus, Hansg., D. bicaudatus A. Br., Dactylothece Braunii Lagh., Protococcus viridis Ag., Chlorococcum humicola Rab., Cystococcus humicola Naeg., Pleurococcus vulgaris (Grev.) Menegh., Pl. pulcher Kirch., Pl. miniatus (Kg.) Naeg., Pl. aureo-viridis (Kg.) Rab., Protococcus grumosus Rich., P. cinnamoneus (Menegh.) Kg., Gloeocystis fenestralis (Kg.) A. Br., (Gloeocapsa fenestralis) Gl. vesiculosa Naeg., Palmella heterospora, Rab., and P. botryoides Kg.

These two plants are quoted, the one a *Cyanophyceæ* and the other a *Chlorophyceæ* as instances of the multiform transformations to be observed in the development of Fresh-water Algæ. Many others might be cited from personal observation as well as from the notes of Dr. Hansgirg and others, all demonstrating the position assumed, and often referred to in the body of this work, that the algæ forms undergo many polymorphic changes before they come to a full development.

It is evident that sooner or later the whole system of classification must be changed. The present system is altogether too artificial, separating as it does many forms not only into different genera, but into different families, and orders, which are genetically connected. Our present knowledge is too imperfect for a complete rearrangement. It is important to understand the life-history of not only a few, but of all the generic forms.

Much as has been accomplished in the past few years by the studies of such men of prominence as Borzi, Cienkowski, Hansgirg, Richter, Rostafinski, Sachs, Schaarschmidt, Sirodot, Wittrock, Woronin and others, there remains much more to be done, and years may pass before the life-history of all the generic forms shall be fully understood.

To the names adopted for the plants described in this work, we have added the synonymous names, with the names of their authors, but have not every time quoted the titles of the works in which the names occur ; this plan to economize space, and because of secondary importance. The titles of the papers or works of the various authors referred to, may be found immediately preceding this Introduction.

As this volume is complemental to our *Desmids of the United States* and the first eight of the series of 150 plates represent additional Desmids, have made the numbering of them a succession of those of the first volume, commencing with number LIV.

DESMIDIEÆ.

APPENDIX TO DESMIDS OF THE UNITED STATES.

Genus, GONATOZYGON. V. Des. U. S. p. 22.

G. SEX-SPINIFERUM, Turner.

Joints variable in length, ten to thirty times the breadth; base swollen, apex either rotundo-truncate or quite rounded; spines, or rather setae, very short and arranged longitudinally in six linear series. Forming long filaments. Minnesota.

Length of joints 88–191 μ; diameter 6–8 μ.

Genus, HYALOTHECA. V. Des. U. S. p. 22.

H. DISSILIENS, Var. HIANS, n. var. Plate LIV, figs. 14–16.

Differs from the typical form in having the lateral margins of the cells arched with an acute notch in the middle.

Diameter 25–50 μ.

The larger form from Budd's Lake, New Jersey; the smaller from ponds near Maitland, Kissimme and other localities, Florida, sometimes occurring in large masses. It is nearly allied to a New Zealand species described by Nordstedt as *H. hians.* Often difficult to distinguish from partially developed forms of *Desmidium quadratum.* End view is circular; has no evidence of a thickened border or a twist.

Genus, BAMBUSINA. V. Des. U. S. p. 24.

B. GRACILESCENS, Nord. Plate LIX, figs. 13, 14.

This form is described as a variety of *B. Brebissonii.* Whether viewed as such or as a distinct species, it was an interesting discovery to find it fruiting freely in a pond near Winter Park, Florida.

Diameter of cells 14 μ; length 23 μ; zygospores 15 μ.

The plant conjugates not like one of the *Desmidieæ*, but more like a *Zygnemaceæ*, in longer or shorter series; often when the zygospores are nearly matured, the cells of one side separate and cause the other side to bend backward.

Judging by these specimens the correctness of the generic position of *Bambusina* may be questioned.

Genus, SPHAEROZOSMA. V. Des. U. S. p. 28.

S. PULCHRUM, Bail., var. CONSTRICTUM, Wolle. Plate LIX, fig. 12.

Cells half as long as wide with a decided constriction in each lobe between the axis and the apex.

Diameter 70–75 μ.

Lake near Kissimme, Florida.

S. PULCHELLUM (Arch.) Rab. Plate LIV, figs. 8, 9.

Cells in outline oblong with the middle much inflated, sharply incised and angles rounded; ends narrower because not at all or very slighted inflated; apices square; varying in length from one to nearly two diameters.

Diameter 9–10 μ.

Pond waters, not rare. Syn. Spondylosium bambusioides, Witt. S. pulchellum, Arch.

S. MONILIFORME, Lund. Plate LIX, fig. 11.

Series of cells often long, firm, somewhat twisted; usually included in a mucous envelope. Cells average one-half longer than broad, deeply constricted, sinus obtuse outwardly enlarged, back more or less produced; seen from the vertex triangular, sides somewhat retuse; angles rounded, isthmus sub-elongate, membrane smooth.

Diameter about 20 μ.

Not infrequent in quiet waters, Florida; less frequent in New Jersey, Minnesota and Pennsylvania.

Genus, PENIUM. V. Des. U. S. p. 33.

P. SPIROSTRIOLATUM, Barker. Plate LXI, fig. 17.

Large, elongated; single cells somewhat swollen in the center, and tapering slightly towards the rotundo-truncate ends; the cell walls possessing a number of superficial, conspicuous, rather coarse striae, running in a spiral direction; these somewhat interrupted at a number of annular rib-like projections varying in number; these projections most numerous towards the ends.

Mr. Turner of England who reports this form from Minnesota remarks, "As I do not know of the publication of any measurements or authentic figure of this species, I may possibly be in error in referring these American forms to it: the figures therefore must speak for themselves."

Diameter of cells 23–31 μ; length of double cell as figured 227–260 μ.

Another form, Plate LXI, fig. 19, which may for the present, be referred to this species, I found frequent in the Tocoi marshes, Florida. It is unlike the preceding in the absence of the transverse sutures or rib-like projections; in the variableness of diameter and proportionate lengths. Diameter of smaller forms 15–18 μ and of larger form 37 μ. The smaller are 10–14 and the larger 7 times longer than broad.

Chlorophyl usually thrice interrupted.

P. CRUCIFERUM, (D.BY.) Wittr. Plate LXI, figs. 9–11.

Cells cylindrical, nearly twice as long as wide, scarcely constricted, ends roundly truncate; seen from vertex orbicular; chlorophyl laminae arranged in form of a cross as seen in transverse section; cytioderm smooth.

Syn. *Cosmarium cruciferum*, D.By.

Marsh pools, Florida.

P. (Cylindrocystis) TUMIDUM, F. Gay. Plate LVI, figs. 7, 8.

Cells twice as long as broad; each semi-cell a broadly truncated cone. Cytioderm smooth.

Diameter 28 μ.

Frequent in Tocoi marshes, Florida.

Genus, CLOSTERIUM. V. Des. U. S. p. 37.

C. JUNCIDUM, (Des. U. S. p. 38,) forma GRACILLIMA-LOEVISSIMA, Breb. Plate LV, fig. 21.

Very much smaller than the type-form and destitute of striae.

Frequent in pond near Maitland, Florida.

C. ENSIS, Delp. Plate LV, figs. 13, 14.

Cell elongate about twenty times longer than broad, sublinear, or lightly attenuated from the middle to the apices; ends not curved; cytioderm smooth.

Diameter 36 μ.

Not rare in ponds, Minnesota, Pennsylvania and New Jersey.

C. Brebissonii, Delp. Plate LV, fig. 17.

Cells sublinear, ends attenuated, moderately curved, apices rounded; about thirty times longer than broad; cytioderm smooth.

Diameter 18 μ.

Observed occasionally, Minnesota and Pennsylvania.

C. lanceolatum, Kg. (V. Des. U. S. p. 39). Plate LV, figs. 18–20.

Found hundreds of specimens of this species in a gathering made by Prof. F. W. Cragin, Kansas.

Diameter 40–50 μ.

C. Lunula, (V. Des. U. S. p. 40,) var. striatum. Plate LV, fig. 12.

Differing from the ordinary form by having the cytioderm finely but distinctly striate.

C. acerosum. (V. Des. U. S. p. 41.) Plate LXI, figs. 1, 2.

Finely in fruit; presenting the peculiarity of two forms of zygospores, single and twin, oval, the longer axis at right angles with the axis of the cells. Cell walls finely but distinctly striate.

C. turgidum. (V. Des. U. S. p. 41.) Plate LV, figs. 3, 4.

A form differing somewhat from that figured Plate VI, fig. 15.

C. striolatum. (Comp. p. 42 Des. U. S.) Plate LV, figs. 5–8.

Distinct from forms heretofore illustrated, Plate VI, figs. 8 and 20. Fig. 8 may be considered of doubtful value.

C. prelongum, (Breb.) Delp. Plate LV, figs. 15, 16.

Cells somewhat linear, cylindrical, elongate, about thirty times longer than broad, slightly curved, apices obtusely rounded, sometimes slightly recurved; cytioderm striated.

Diameter 20–21 μ.

Ponds, Pennsylvania and Minnesota.

C. subcostatum, Nord. Plate LV, fig. 11.

Cells usually four to five times longer than broad; back rather high arched, below nearly straight, may be either slightly concave or convex; apices obtusely rounded. Membrane usually yellowish brown with 9–12 longitudinal costae.

Diameter 50–60 μ.

Found this species most frequent in smaller pools in Florida. By specimens seen from Brazil, S. A., it is evident that this form is liable to great variation in size, having some as large as 125 μ diameter.

C. Delpontii, Klebs. (*C. crassum*, Delp.) Plate LV, fig. 9.

Cells cylindrical, somewhat inflated in the middle, gradually tapering to an obtusely rounded apex; distinctly striate with one, two or three sutures about the middle; cell twenty times (more or less) longer than broad.

Diameter 35–45 μ.

Delponte's name of *Crassum* having been previously applied to another species by Rabenhorst, Klebs changed it.

C. lineatum, var. costatum, Wolle. (Comp. Des. U. S. p. 43.) Plate LXI, fig. 3.

This variety differs from the usual form in having the striae very thick and few in number. The figure represents one of many fruiting specimens found by W. N. Hastings, Rochester, New Hampshire.

C. Dianae. Plate LV, figs. 1, 2.

Two specimens, differing particularly in size from those represented in Des. U. S. Plate VII, figs. 8, 9. Not rare.

C. pronum, Breb. Plate LV, fig. 22. V. Des. U. S. p. 46.

Cells very small, sublanceolate, each end drawn out into a setaceous beak about half as long as the body; cytioderm finely striate.

Diameter 7–12 μ.

Ponds, Florida.

C. Didymotocum, (V. Des. U. S. p. 39). Plate LV, fig. 10.

A large form and distinct variety corresponding to description by Delponte. Cytioderm not longitudinally striate, but smooth and apices obtusely rounded.

Diameter 50–60 μ.

Minnesota and New Jersey.

Genus, DOCIDIUM. V. Des. U. S. p. 47.

D. Archerii, Delp. Plate LIV, fig. 2.

Cells smooth, cylindrical about twenty times longer than broad; scarcely attenuated from the middle to the ends; apices broadly rounded or truncate; base of semi-cells with one or two undulations. Chlorophyl usually arranged in numerous small parallel bands.

Diameter 50–60 μ.

Numerous in pond, Luzerne Co., Pa.

D. NODULOSUM, D. By. Plate LIV, fig. 3.

Cylindrical, eight to ten times longer than broad, scarcely attenuated; undulate with three or more distinct swellings in basal half of semi-cell; apex truncate, angles rounded, furnished with three or four teeth in view, below the margin; chlorophyl parietal.

Diameter 40–50 μ.

Pools near Minneapolis, Minn.

D. BACULUM, var. FLORIDENSE, Wolle. Plate LIV, fig. 5.

Differing from the typical form, Des. U. S. p. 49, in having the margins wavy from base of semi-cell to apex.

Diameter 15–17 μ; length of cell often thirty times greater.

Frequent in pond near Maitland, Florida, March, 1885.

D. RECTUM, Delp. Plate LXI, figs. 20, 21.

Cells cylindrical, straight, twelve or more times longer than broad; slightly narrower at the truncate apex than at the base; moderately swollen at the base of the semi-cells.

Diameter 25–28 μ.

The distinction which Delponte makes between this form and *D. Baculum*, to which it is very closely related, is, that it is perfectly straight, while the former is "straightish," somewhat bent, although not so represented, Plate XI, figs. 3, 4, Des. U. S. The central inflations are usually larger in *D. Baculum* than in *D. rectum.*

D. WOODII, Delp. Plate LIV, fig. 4.

Cell cylindrical, six to ten times longer than broad; apices rounded; basal inflation of semi-cell large, wide and high; cytioderm smooth.

Diameter at ends 50 μ; inflation 65 μ.

Pond, Ocean County, New Jersey.

D. GEORGICUM, Lagh. Plate LXI, fig. 16.

Cells large, twelve times longer than broad; moderately constricted in the middle; suture none; semi-cells much swollen about the middle; basal part with four larger and smaller undulations, alternating large and small; ends somewhat attenuated; apices roundly truncate; membrane hyaline, punctate, thickest at the ends—no aculei nor teeth.

Diameter of cells, basal parts 54 μ; middle 75 μ; apices 39 μ.

Pond waters, Georgia.

D. verticillatum, (*Triploceras verticillatum*, Bail.) V. Des. U. S. p. 53. Plate LXI, fig. 18.

This illustration given as another of many forms in which this species often occurs. The third diverging process of the apical termination not always evident.

W. N. Hastings, Rochester, New Hampshire, reports this form frequent in the Cocheco River.

Genus, CALOCYLINDRUS. V. Des. U. S. p. 54.

C. De Baryi, Arch. Plate LVI, fig. 12.

A specimen from Minnesota, the typical form, unlike the one fig. 5, Plate XV, which is more like a form of C. Cucumis; the constriction is not deep, linear, but merely a shallow notch, hence De Bary classified it with *Pleurotaenium*.

C. Cordanum, Breb. Plate LX, fig. 28.

Diameter about half the length; gently and slightly constricted in the middle; ends round or somewhat truncate; cytioderm lightly granular or punctate. End view circular.

Diameter 26–27 μ; length 47–50 μ; isthmus 17–19 μ.

This form is reported by W. B. Turner, as found in Nova Scotia.

Genus, COSMARIUM. V. Des. U. S. p. 57.

C. inflatum, Wolle. Plate LVII, figs. 18, 19.

Cells one-half longer than broad; semi-cell gradually enlarged from a narrow base to a broadly dilated end; end view broadly elliptic; lateral view circular, with somewhat flattened sides; membrane finely punctate or smooth.

Diameter 25–28 μ; length about 40 μ.

Ponds, Minnesota.

C. pseudoprotuberans, Kirch., has something in common with this form, but the semi-cells are separated by narrow linear sinuses. *C. inflatum* has wide obtuse angled sinuses.

C. LOBATULUM, Wolle. Plate LVII, figs. 33, 34.

Small, one-third longer than broad, end of semi-cell broadly truncate; sides convex with a slight contraction near the apex; side view circular with end truncate. Membrane finely and closely punctate, or granular.

Diameter 25 μ; length 33 μ.

Ponds, Minnesota.

C. CIRCULARE, Reinsch. Plate LVII, fig. 37.

Cells nearly circular; present form slightly shorter than broad; sinuses narrow linear; lateral view ovoid, end view elliptic; isthmus one-third of diameter of cell; membrane finely punctate.

Diameter 75–85 μ; length 70–75 μ.

Frequent in Marsh pools, Tocoi, Florida. This form is considerably larger than the one described by Reinsch, and not quite equal in length and breadth, but otherwise very near it and certainly nearer than the plant described by Lundell under the same name.

C. PERFORATUM, Lund. Plate LVII, fig. 32.

Somewhat circular, slightly longer than broad, moderately constricted in the middle, sinus acute angled, enlarging outwardly, rarely linear; semi-cells sub-semi-circular, back high convex with the middle slightly flattened or rarely slightly retuse; end view broadly elliptical; lateral view circular with base broadly truncate. Membrane distinctly but sparsely punctate often with larger granules arranged in triangular form on basal part. Isthmus fully half of the diameter of the cell.

Diameter 57–63 μ; length 60–68 μ.

Ponds, Minnesota.

C. RHOMBUSOIDES, Wolle. Plate LX, figs. 6, 7.

Cell nearly as long as wide; semi-cells in form of a rhombus, sides all equal, straight or slightly convex; nearly half as long as broad; sinus between, deep and wide; isthmus one-fourth of diameter; end view rhombus-like; membrane finely punctate.

Diameter 55–65 μ; length 50 μ.

From collections made by Mrs. Hanson and Miss Haggin in pools near Lake Tahoe, California, August, 1886.

C. AMERICANUM, Lagh. Plate LX, figs. 15, 16.

Cells small, sinus rather obtuse and widening outwardly; semi-cells sub-circular, the center with seven larger granules (six peripheral and one central) and twelve, more or less distinct, around these; vertical view elliptic; lateral view sub-circular. Membrane smooth excepting the central granules.

Diameter of cell 22 μ; length 40 μ; thickness 18 μ; diameter isthmus 6 μ.

Pond near Tewksbury, Massachusetts.

C. WOLLEANUM, Lagh., var. GRANULIFERUM, Lagh. Plate LX, figs. 1, 2. Syn. *C. pseudogranatum*, Wolle. Des. U. S. p. 158.

Cell rather large, one-fourth longer than wide; sinus somewhat ampliated inwardly and outwardly; semi-cells sub-semi-circular, base subreniform, dorsum narrowly rounded, angles rounded, margins finely crenulate-dentate; in vertical view oval; in lateral view broadly oval. Membrane distinctly punctate.

Diameter 54 μ; length 66 μ.

Tewksbury, Massachusetts.

The author of the present name for a Cosmarium, G. von Lagerheim, of Stockholm, Sweden, finds that we have duplicated the name *pseudogranatum*, previously used by *Nordstedt*, hence re-names the form as above. The new variety *granuliferum* reminds one of *C. cymatopleurum*, Nord., *C. de Notarisii*, (Witt.) Nord., and *C. capense*, Nord., but it is distinct.

C. BRAUNII, forma MAJOR, Reinsch. Plate LVII, figs. 28, 29.

Cell small, one and one-half times longer than broad, sinus narrow linear; sides with two emarginations; ends truncate, membrane smooth; lateral view oval; vertical view elliptic.

Diameter 25–28 μ; length 36–40 μ.

Ponds, Stillwater, Minnesota.

C. (*Euastrum*,) SENDTNERIANUM, Reinsch. Plate LVII, figs. 30, 31.

Cells nearly twice as long as wide; sinus narrow linear; semi-cells nearly as long as wide, ends rounded, lateral margins each with four or five crenulations; lateral view of whole cell elliptic with more or less of a constriction in the middle; end view oval.

Diameter 25 μ; length 44 μ.

Minnesota, not infrequent.

This species reminds one of *C. nasutum*, Des. U. S. p. 89, but that is proportionately shorter and strongly granulate.

C. LOEVE. Comp. Des. U. S. p. 62. Plate XV, fig. 10.

Duplicate specimens are represented, Plate LVII, figs. 35, 36.

From a fountain in Pottsville, Penn., where they occurred by thousands in gelatinous masses, August, 1880.

C. OCULIFERUM, Lagh. Plate LXI, figs. 7, 8.

Cells small, deeply constricted, sinus inwardly and outwardly more or less dilated; semi-cells semi-circular-triangular, ends retuse, sides slightly convex or straight, inferior angles obtuse; above the middle a single large granule and below it a series of six small granules arranged in a semicircle, ends tending towards the retuse apex; viewed from apex oval, from sides sub-circular. Membrane smooth.

Diameter of cell 24 μ; length 32 μ.

Pond, Tewksbury, Massachusetts.

C. NORDSTEDTII, Delp. Plate LVII, figs. 23–25.

Cell somewhat longer than broad, constriction deep; semi-cell rectangular-oblong about twice as wide as long, granulate around the margins, center usually nude.

I adopt this name for a form widely distributed, but variable; sometimes it resembles *C. triplicatum* in size and shape, but differs in the number and arrangement of the granules, which are not in series of threes, but in continuous eccentric rows. Sometimes they cover the upper half of the semi-cell, then again only one or two rows occur within but close to the margin; the center and basal half are usually nude. The sides are not so straight as figured by Delponte, but the front and end views are always more or less rectangular-oblong.

Reinsch has named a very different form *C. Nordstedtii;* it is nearly, if not entirely, identical with *C. cyclicum*, Lund.

C. EXCAVATUM. (V. Des. U. S. p. 77.) var. TRIGONUM, Lagh. Plate LX, figs. 24, 25.

Cells in vertical view triangular, sides straight, or somewhat convex, angles rounded.

Diameter of cells 18 μ; length 20 μ; thickness 18 μ.

Tewksbury, Massachusetts.

C. SPHALEROSTICHUM, Nord. Plate LVII, figs. 26, 27.

Cells small, somewhat longer than broad, sinus narrow linear; semi-cells subreniform-trapezoid, base straight; inferior angles nearly right; ends in middle truncate and nude, granulate, granules often in two or three vertical series, often scattered, inconstant as name implies. In vertical view elliptic, margins granulate; in lateral view circular, granulate. Zygospore globose or subglobose, smooth.

Diameter 13–14 μ; length 16–20 μ.

New Jersey and Pennsylvania. Resembles *C. orthosticum*, Lund., but is somewhat smaller, ends truncate and granules not so regularly arranged.

C. CONSPERSUM, var. RETUSUM, Wolle. Plate LXII, fig. 5. (Comp. Des. U. S. p. 75.)

Unlike the true form in the depressed or retuse ends; sides also incline inwardly from the base of the semi-cell to the end.

Diameter averages the same as the type-forms.

Ponds, Minnesota.

C. PARDALIS, Cohn. Plate LX, figs. 3–5.

Cells suborbicular or subquadrate, equal or slightly longer than broad, constriction narrow linear or often somewhat dilated inwardly, and more or less ampliated outwardly; semi-cells transversely oblong, subreniform; base and vertex truncate or concave, angles inferior and superior rounded; lateral view suborbicular; vertical view oblong, sides straight; membrane verrucose, verrucae (papillae) obtuse, regularly arranged in diagonal rows.

Diameter 54–57 μ; length 75–80 μ; thickness 39 μ; isthmus 18–20 μ.

Lagerheim reports this *African* plant from Tewksbury, Mass. It has not come under my notice. Looks like a close relation to some form of *C. conspersum*. The figures represent a front, a lateral and a transverse view, copied from Cohn's figures.

C. POLYMORPHUM, Nord. Plate LX, figs. 31–33.

Suborbicular, deeply constricted, sinus narrow linear; semi-cells semi-circular, base straight, end truncate; two granules above the base, three about the middle of the area; punctate between the two series; granulate near the margin;

in vertical view broadly elliptic, granulate within the margin, center nude ; in lateral view suborbicular, end truncate.

Diameter of cell 25 μ ; length 33 μ.

Tewksbury, Massachusetts.

C. TAXICHONDRUM, Lund. (V. Des. U. S. p. 71.) Var. BIDENTULUM, Lagh. Plate LX, figs. 17, 18.

Cell sub-circular, semi-cell with one large verruca at isthmus ; five large granules in an arched series between the middle and the margin, and four below this in the form of a cross, or a series of three and one below ; in vertical view elliptic, somewhat contracted at ends, the angles bidentate.

Diameter 45 μ ; length 48 μ.

Tewksbury, Massachusetts.

C. PSEUDOTAXICHONDRUM, Nord. (V. Des. U. S. p. 71.)

G. von Lagerheim appears to give too much prominence to simple differentiations—mere vagaries of the same species. They may be briefly noted.

1. *C. taxichondrum*, var. *bidentulum*, as above.
2. *C. pseudotaxichondrum*, cells more depressed.
3. *C. pseudotaxichondrum*, var. *trichondrum*, semi-cells ornate with a single row of three granules.
4. *C. pseudotaxichondrum*, var. *quadridentulum*; in front view, the inferior angles bidenticulate.
5. *C. pileigerum*. Merely a depauperated form of the above.

Pond, Tewksbury, Massachusetts.

C. QUINARIUM, Lund. Plate LX, figs. 10, 11.

Cells subhexagonal, about one-fourth longer than broad; constriction deep linear; semi-cells subtrapezoid, narrowed toward the subtruncate apex, sides somewhat convex, inferior angles obtuse, margins obsolete granulate-dentate; within the margin a series of prominent granules, in center five obtuse granules arranged in two transverse series ; membrane punctate; in vertical view elliptic granulate around the margin; in lateral view circular.

Diameter 33–35 μ; length 39–42 μ.

Tewksbury, Massachusetts.

C. MICROSPHINCTUM, Nord. var. PARVULA, Wille. Plate LX, figs. 20, 21.

Cells small, elliptic, one-half longer than wide, moderately constricted, sinus narrow linear; semi-cell subelliptic, apex obtusely rounded; sides somewhat convex; in vertical view broadly elliptic, apices somewhat produced; in lateral view ovate. Membrane densely but distinctly punctate. Zygospore globose aculeate, aculei broad at base, apices 2–3 furcate.

Diameter 25–26 μ; length 36 μ.

Tewksbury, Mass. Have given the figure of the type. The form is closely related to *C. pseudopyramidatum* (Des. U. S. p. 69); but the constriction is not so deep, the ends not truncate, and in vertical view not distinctly elliptic.

C. OCTOGONUM, Delp. var. CONSTRICTUM, Lagh. Plate LX, figs. 34, 35.

Cells in front view oblong-tetragonal deeply constricted; semi-cells trapezoidal; in vertical view elliptic with middle somewhat inflated; isthmus one-third of diameter of cell. Membrane smooth. Var. *constrictum* is more deeply constricted, sinus wider, and semi-cell in vertical view not inflated.

Tewksbury, Massachusetts. From these specimens the significance of the name is not evident. Instead of three crenulations or angles on each side of a semi-cell, Delponte describes "sometimes four," or *eight* to the semi-cell. Has some resemblance to *C. Braunii*, Reinsch, but is not so regular.

C. SUBCRUCIFORME, Lagh. Plate LX, figs. 12–14.

Small, somewhat circular, the constriction introrsely and extrorsely ampliated; semi-cells reniform, the end rounded, not crenulate; angles rounded verrucose with margins denticulate; a central inflation granulate; in vertical view subcruciform, angles granulate; in lateral view ovate-circular. Membrane punctate.

Diameter of cell 32 μ; length 36 μ; thickness 25 μ.

Reminds one of *C. ornatum*, Focke, and also of *C. subreniforme*, Nord.

Tewksbury, Massachusetts.

C. ELOISIANUM, Wolle. V. Des. U. S. p. 85.

A species hitherto found only in Minnesota, now turns up also in New Jersey, Splitrock Pond, and more recently, (October, 1886,) Mr. W. N. Hastings has been collecting fine specimens near Rochester, New Hampshire. The specimen represented, Des. U. S., Plate XIX, is an old form and caused too many teeth to be illustrated. A single series on the periphery of a semi-cell does not exceed 23–25.

C. LAGOENSE, Nord. Plate LX, figs. 26, 27.

Semi-cell in vertical view, in the middle much swollen and the ends inflated, granules large; center smooth. It is an exaggerated development of *C. ornatum* and hence a variety of it.

Tewksbury, Massachusetts, and not infrequent in New Jersey ponds.

C. BIRETUM, Breb. V. Des. U. S. p. 86, var. FLORIDENSE, Wolle. Plate LXII, fig. 6

Differs from the typical form in its somewhat larger size, but principally in the retuse ends.

Diameter 70 μ.

Frequent along the shores of lake at Kissimme, Florida.

Genus, TETMEMORUS. V. Des. U. S. p. 90.

T. GIGANTEUS. Plate LIV, fig. 1.

Represents a specimen not infrequent with the ends somewhat contracted, differing in this regard from the form Des. U. S. Plate XX.

Genus, XANTHIDIUM. V. Des. U. S. p. 93.

X. FASCICULATUM, var. SUBALPINUM, Wolle. Plate LVI, fig. 9.

Prof. Delponte, in his DESMIDIACEARUM SUBALPINUM, p. 168, describes this species differently from that described in Des. U. S. p. 93, the variation being mainly in the wider separation of the lateral spines. To distinguish the two I make the above variety.

Not rare in ponds, New Jersey and Minnesota.

X. COLUMBIANUM, Wolle. Plate LVI, figs. 10, 11.

Cells about one-third longer than wide; divided by a deep constriction forming much ampliated, acute-angled sinuses; semi-cells oblong hexagonal, superior and lateral angles each produced into a firm aculeus; within the margins, four, often indistinct, aculei; end view more or less regular hexagonal, each angle somewhat produced and surmounted by a firm aculeus; within the margin are four aculei, the ends of which often extend over the margin; cytioderm smooth.

Diameter 60 μ; length 80 μ, without aculei.

Pond, Ocean County, New Jersey.

X. TORREYI, Wolle. Plate LVI, figs. 13, 14.

Nearly equal in length and breadth; semi-cell somewhat hexagonal, half as long as wide; superior and lateral angles slightly protruding and surmounted each by a firm, straight, or slightly bent aculeus; in vertical view elliptic with one aculeus on, and another within, the margin of each end; on each side a rounded prominence peculiar to the genus. Lateral view elliptic with a constriction in the middle, two aculei at each end and two short tips evident near the middle.

Diameter 33 μ, without aculei; with them 65 μ; length 75 μ.

Ocean County, New Jersey. First found in Horicon Lake, near the home of the venerable brother of the late John Torrey, of botanical fame.

Genus, ARTHRODESMUS. V. Des. U. S. p. 95.

A. INCRASSATUS, Lagh. Plate LXI, fig. 6.

A large form, deeply constricted, sinus largely ampliated outwardly; semi-cells subellipsoid, sides convex, ends highly arched, superior angles surmounted each with a nearly straight aculeus; in middle two series of granules arched, nearly parallel with the ends; in vertical view rhomboid-elliptic; in lateral view somewhat circular; membrane in middle thickened and yellowish.

Diameter of cells 40 μ; length 50 μ, without aculei.

Tewksbury, Massachusetts.

Var. CYCLADATUS, Lagh.

Somewhat smaller, eight granules in the middle of semi-cell, one central and the others in circle around it.

This variety is near my *Xanthidium tetracentrotum*, Des. U. S. p. 95.

Tewksbury, Massachusetts.

A. NOTOCHONDRUS, Lagh. Plate LXI, figs. 4, 5.

In size and constriction like *A. incrassatus;* semi-cells subsemicircular, sides convex, ends straight with margins moderately granulate; angles armed with a long divergent spine; semi-cells in vertical view elliptic, with three longitudinal series of granules; in lateral view subcircular. Membrane smooth, in middle somewhat thickened and yellowish.

Diameter of cells, without spines, 30 μ; length 32 μ.

Tewksbury, Massachusetts.

A. TRIANGULARIS, Lagh. Plate LXI, figs. 14, 15.

Sinus between the semi-cells wide, obtuse; semi-cells triangular connected by a cylindrical isthmus, ends somewhat retuse in middle; angles subacute bearing a long straight spine, either parallel or slightly converging; semi-cells in vertical view lanceolate-oval; in lateral view subcircular. Membrane hyaline, in middle not thickened.

Diameter, without spines, 25 μ; length 30 μ.

Georgia.

A. PACHYCEROS, Lagh. Plate LXI, figs. 13, 14.

Cell small, constriction an acute-angled sinus; semi-cells suboval, sides convex, end arched, angles obtuse, each bearing a firm spine, straight or slightly bent, diverging; semi-cells in vertical view oval; in lateral view subcircular. Membrane smooth.

Diameter, without spines, 18 μ; length 20 μ.

By an oversight this form was put on the plate; do not know it to have been found in the States. It is a Cuba plant.

Genus, EUASTRUM. V. Des. U. S. p. 97.

E. INTEGRUM, Wolle. Plate XXVII, figs. 18–22.

The same is described as *E. simplex* Des. U. S. p. 106. Since the publication of the diagnosis, F. Gay, of Montpellier, France, is found to have anticipated the adoption of the same name for another *Euastrum* form. Hence we substitute *E. integrum* for *E. simplex*.

E. PECTINATUM, Breb. Plate LIV, figs. 10–12.

Semi-cell three-lobed, terminal lobe dilated, usually entire; lateral lobes broad, making the basal portion of the semi-cell somewhat quadrilateral, horizontal, at each side emarginate; lateral view cuneate, with two swellings near the base and one at the apex; transverse view oval with three lobules on each side and one or imperfectly two at each end.

Diameter 40–50 μ; length about 75 μ.

Minnesota. A number of varieties of this species have been described by specialists in different countries. The present is not Ralfs' type-form, but a variety. It is common in England, but hitherto not found here.

E. PURUM, Wolle. Plate LVIII, figs. 9–11.

Small, short; semi-cell three-lobed, broader than long; basal lobe much inflated, terminal lobe short, dilated and notched; in lateral view the base and end are more or less inflated.

Diameter 35–45 μ; length 55–70 μ.

The smaller form from Florida, the larger from New Jersey.

E. CUNEATUM, Jenner. Plate LVIII, figs. 12, 13.

Semi-cells cuneate, not lobed; terminal notch linear.

Diameter of cell 24–28 μ; length about 75 μ.

Not rare; seems of rather doubtful value as a species.

E. MAGNIFICUM, Wolle. Plate LVIII, figs. 6–8.

The largest of our *Euastra;* about twice as long as broad: semi-cell five-lobed, the terminal lobe exserted; dilated, end somewhat convex, connected by a short neck; basal and intermediate lobes entire, with a deep obtuse notch between; upper margin of the basal lobes nearly horizontal and parallel with the base of the semi-cell; no prominent tumors, but one large central undulate inflation shown in lateral view (fig. 7). End view (fig. 8) shows the terminal and intermediate lobes notched at each side.

Diameter 100 μ; length about 190 μ.

Ponds, near Malaga and Manchester, New Jersey.

E. WOLLEI, Lagh. Plate XXIX, figs. 1–5.

G. von Lagerheim, of Stockholm, Sweden, has seen fit to change the name of our *E. intermedium*, Cleve, for the reason that he finds that it does not correspond with the Swedish plant so named by Cleve. It has much of the form, but is much larger, having more than twice the diameter and twice the length. Cleve states the diameter of the plant described by him at 44 μ; and length 77–80 μ. Diameter of our form is 112–120 μ; length 160–170 μ; moreover the end of the semi-cell of the Swedish plant is *two*-lobed, ours is *four*-lobed.

An apology for the error in choosing the name is unnecessary. Will only remark, a full description of Cleve's plant was not convenient at proper time.

Var. QUADRIGIBBERUM, Lagh. Plate LX, fig. 29.

Semi-cells with four horizontal inflations; in vertical view elliptic, apices acuminate, sides quadriundulate.

Tewksbury, Massachusetts.

E. VENTRICOSUM, Lund. Plate LVIII, figs. 1–3.

Large, twice as long as wide, outline subelliptic, deeply constricted, sinus narrow linear; semi-cell trilobed, base much dilated, polar lobe short somewhat dilated, incision narrow linear, sides sinuate, two-lobed, superior lobe obtuse tending upward, entire, not bifid in lateral view; basal tumors three, intermediate two, and two in end lobe; in vertical view elliptic, four undulations on each side; in lateral view narrowed toward the ends, sides undulate, apex subtruncate and dilated; shows the superior lateral lobule entire.

Diameter 60–69 μ; length 105 μ.

Found this plant frequent in pond, Orange County, near Maitland, Florida. Zygospores not infrequent, as fig. 1.

E. CRASSUM, Des. U. S. p. 97, var. SCROBICULATUM, Lund. Plate LVIII, figs. 4, 5.

In outline very nearly the same as the type-form, but differs in having in the middle of the semi-cell four scrobiculae. Lundell represents only two; our form has four; besides these excavations the plant has four papilla-like prominences towards the ends of the semi-cells, which I do not find alluded to; they may give claim for a distinct species.

Pond, Malaga, New Jersey.

Genus, MICRASTERIAS. V. Des. U. S. p. 108.

M. SPECIOSA, Wolle. Plate LVI, figs. 1, 2.

Small, somewhat longer than broad, five-lobed; lateral lobes unequal, the basal pair usually with only half as many divisions as the intermediate ones; each basal lobe consisting of one, and the intermediate of two lobulets, the angles of each section drawn out into two spine-like points; terminal lobe rather narrow, linear, the end exserted and much dilated, usually with three prominent mucros at each angle, center an obtuse angled notch, standing free with a rather wide gap between it and the adjoining lobes; a series of small spines often observed on the margins of the lobes.

Diameter 95 μ; length 110 μ, of specimens from Florida; diameter 125–150 μ; length 155–165 μ, of New Jersey specimens.

This species appears related to *M. radiosa*, var. *ornata*, Nord., but is smaller; the lobes are not so deeply, nor so often intersected, and the polar lobe is more exserted and more dilated at the end.

M. APICULATA, Menegh. Plate LVI, fig. 3.

Large orbicular or oblong, with the surface more or less densely covered with mucros; semi-cell five-lobed; lateral lobes equal in size, not close, bisected; lobulets bifid, each section emarginate, mucronate at each angle; polar lobe prominent, widely dilated, center notched, margins mucronate.

Diameter 175–200 μ.

Ponds, Pennsylvania, New Jersey and Minnesota; rather rare.

M. MAMILLATA, Turner. Plate LXII, fig. 2.

Semi-cells papilionaceous, five-lobed; end lobe broad; its ends and those of the other lobes divided into palmate shapes, with the points broadly rounded; surface adorned with mamilliform processes radiately arranged; provided with a process at isthmus, the purpose of which is apparently (?) to strengthen the segmental union. Only one specimen (semi-cell) seen. Seemingly related to *M. apiculata.*

Diameter 198 μ.

Inasmuch as this semi-cell was found in collections made in a swampy part of Harvey Lake, Pennsylvania, in which *M. apiculata* occurs freely, the author would emphasize the last remark.

M. DENTICULATA. V. Des. U. S. p. 109.

A zygospore. Plate LXII, fig. 3.

From a collection made by W. N. Hastings, Rochester, New Hampshire.

M. AMERICANA. V. Des. U. S. p. 112, var. SPINOSA, Turner. Plate LX, fig. 30.

A form not strictly from the United States, but near it, may be introduced. Mr. Turner describes it thus: A small compressed form. About one-eighth less in length and breadth than the type. Central portion of segments smooth; lobes ornamented with short stout spines; the end lobe bearing near its extremity a species of annular rugoso-spinous coronet.

Diameter 112 μ; length 136 μ.

Pictou, Nova Scotia.

M. ALATA, Wall. Plate LXII, fig. 1.

In anticipation of the possible discovery of this interesting and unique form in Southern Florida, I quote it from G. von Lagerheim's *Bidrag till Amerikas Desmidie-flora.* It is an India plant, but is now also found in Cuba. The figure is drawn direct from an India specimen in my herbarium.

M. FURCATA. V. Des. U. S. p. 111, var. SIMPLEX, Wolle. Plate LIX, figs. 6, 7.

Cell equal in length and breadth, two-lobed, terminal lobe exserted, its divisions spreading and producing a wide, shallow sinus; lateral lobes usually simple, but sometimes divided into two narrow, linear diverging sections, furcate at apices. Length and breadth 140–150 μ.

A singularly variable species. Of thirty-one fresh specimens examined during a stay at Winter Park, Florida, by Rev. H. D. Kitchel and myself, twenty were found of normal form as upper half of fig. 6, 7, no arms divided; five had all the lateral arms divided, like the lower half of figure; one had two arms divided and two single, like figure; two had only one arm divided, and three had each two arms divided. As two-thirds of the forms examined had all the arms single, this is considered the type; the others, one-third, variable, are varieties.

M. CRUX MELITENSIS. V. Des. U. S. p. 111.

Two semi-cells, Plate LVI, figs. 4, 5, differing somewhat from those figures on Plate XXXV.

From Minnesota.

M. RABENHORSTII, Kirch. Plate LVI, fig. 9.

Cells as long as broad, small, three-lobed; terminal cell not much wider than the lateral lobes, widened from the base to the end, apex concave, angles terminating with two short teeth; lateral lobes divided by a wide, almost right-angled sinus, each half somewhat narrowed towards the end; apex indented, a small tooth at each angle. Membrane smooth.

Diameter of cell 85 μ; length 88 μ.

Thus reads a free translation of Kirchner's diagnosis. The figure does not represent the type; merely a small form of it.

Ponds, Minnesota.

M. VERRUCOSA, Roy. Plate LIX, fig. 10.

In outline this species agrees with smaller forms of *M. denticulata*, Ralfs, but differs from these and other described forms by the remarkable row of crenulated, circular or oval basal inflations, crossing from side to side, larger towards the center, gradually growing smaller towards the margins.

The original type was found in Scotland. The first from this country is from a pond near Minneapolis, Minnesota, in collections made by Miss E. Butler.

M. RINGENS, Bail. V. Des. U. S. p. 112, var. SERULATA, Wolle. Plate LIX, fig. 15.

In size and form the same as the original type from Florida. Bailey describes it as "granular near the margins," but not as serrated. This new variety has the margins distinctly serrated, besides having the granules or mucros near the margins.

Diameter 115–130 μ; length 125–145 μ.

Found in large numbers in White Bear Lake, Minnesota, by Miss E. Butler.

Genus, STAURASTRUM. V. Des. U. S. p. 119.

ST. MUTICUM, var. ELLIPTICUM. Plate LX, figs. 41, 42.

A form differing from that of Plate XXXIX, and more strictly elliptical, semi-cells in front view slightly contracted near the ends.

Diameter 33–35 μ.

Pond, St. Anthony Park, Minneapolis, Minnesota.

ST. ORBICULARE. V. Des. U. S. p. 119.

A variety from Watertown, New York. Plate LX, figs. 36–38, not so distinctly orbicular as the form illustrated, Plate XXXIX, figs. 9, 10.

Diameter 34–37 μ; length about 44 μ.

ST. BACILLARE, Breb. Plate LVII, figs. 5, 6.

Cells small, deeply constricted, sinus a wide, acute angle; semi-cell narrow lanceolate, base convex, ends inflated, head-like, in vertical view 3–4–5-angled; angles radiately produced with ends enlarged and rounded.

Diameter 25–30 μ.

Pond, Minnesota.

Brebisson describes a French plant as *St. globosum*, which is somewhat stouter and partially granular, but otherwise nearly similar; the two are considered forms of the same species by recent specialists.

St. brevispina, var. inerme, Wille. V. Des. U. S. p. 122.

A Florida form, Plate LXII, figs. 9, 10, differing slightly in vertical view, but otherwise not distinct from figs. 3, 4. Plate XL.

Diameter 55–60 μ.

St. Cosmarioides, Reinsch. Plate LXII, figs. 7, 8.

Cells large, composed in front view of two orbicular semi-cells attached, forming an isthmus of one-third the diameter of the cell; margins of sides finely dentate; in vertical view triangular, angles rounded, sides slightly convex.

Prof. Reinsch describes this form as found in Pennsylvania, about twenty years ago. To my knowledge it has not occurred since.

St. vesiculatum, Wolle. Plate LIV, figs. 6, 7.

Small, smooth, about one-half longer than broad, constriction deep, sinuses acute-angled, much ampliated; semi-cell subpyramidal, not as long as broad; base wide, inferior angles round, sides convex and inclining to a rounded apex; end view triangular, angles rather broadly rounded, sides slightly convex or straight.

Diameter 31 μ; length 45 μ.

Differs from *St. cordatum*, F. Gay; in front view, sinuses are not narrow linear, but much ampliated, thereby giving the cell a more elevated appearance. Green's Lake, New Jersey.

St. pseudocrenatum, Lund. (St. maamense, Arch.) Plate LVII, figs. 9, 10.

Cells nearly one-fourth part longer than broad, suboval ends somewhat truncate, deeply constricted, sinus narrow linear; semi-cells subsemicircular, base straight, sides subcrenate, crenae roughly truncate-emarginate; end obsoletely erose-dentate, inferior angles subtruncate; in vertical view triangular, sides retuse, angles broadly subtruncate, dentate with three granules.

Diameter 30–35 μ; length 38–42 μ.

Found this species frequent in ponds, Minnesota and California. This form is nearest to *St. crenatum*, Bailey, (in

Ralfs' Br. Des. p. 215,) but differs in having a much narrower sinus between the semi-cells, and semi-cells are not cuneate flabelliform.

St. erasum, Breb., var. espinulosa, Lund. Plate LVII, figs. 16, 17.

Of medium size, as long as broad, coarsely granulate, sinus acute-angled, outwardly ampliated; semi-cells somewhat elliptic, back nearly straight, angles rounded, more or less dentate, with large granules; in vertical view triangular, angles broadly rounded, sides concave.

Diameter 34–38 μ.

Green's Lake, New Jersey.

St. luteolum, Lagh. Plate LX, figs. 22, 23.

Cells rather small, nearly circular, deeply constricted, sinus narrow linear; base of semi-cell straight, back arched, inferior angles obtusely rounded granulate-crenate. Membrane thick, punctate, yellowish.

Diameter 32 μ; length 33 μ; thickness 32 μ.

Tewksbury, Massachusetts.

St. cornutum, Wolle. Plate LVII, figs. 3, 4, duplicated on Plate LXII, figs. 11, 12.

Cells medium size, about one-fourth longer than broad, smooth; semi-cell oval or broadly elliptic, with a prominent, somewhat inwardly curved aculeus at each angle; end view triangular, angles rounded, each with a firm aculeus, sides straight or slightly concave.

Diameter 55–60 μ; length about 70 μ, aculei not included. In front view resembles a large form of *Arthrodesmus convergens*, but the triangular end views prove it distinct.

Ponds, Minnesota, not infrequent.

St. Minnesotense, Wolle. Plate LVII, figs. 7, 8.

Cells large, punctate, spinous, about as long as broad; semi-cells broadly elliptic, twice as wide as long; lateral angles each with two large, straight or incurved spines or aculei, three more pairs of similar spines placed within the margin of the end, one of each pair on opposite sides of the semi-cell; six more, often inconspicuous, arranged around the center; end view triangular, with two spines at each angle and two pairs (near the margin) between the angles, on each side of the triangle; around the center are nine more spines, often indistinct.

Diameter 65–75 μ without, and 90–100 μ with the spines.

Frequent in Minnesota ponds.

St. XIPHIDIOPHORUM, Wolle. Plate LVII, figs. 21, 22, and Plate LX, fig. 19.

Small, one and one-half to two times as long as broad, deeply constricted, sinus narrow, widening irregularly outwardly; semi-cells transversely oblong, with lateral margins notched; the end margins drawn out into a sort of one-sided, hastate, poignard-like spines or slender points, usually nine in number; membrane smooth; with several verrucae; end view triangular, angles broadly truncate and usually each showing three prominences, the bases or supports of three spines, sides concave.

Diameter 25–30 μ; length 40 μ, and upward.

Ponds, near Minneapolis and Stillwater, Minnesota.

Var. SIMPLEX, Wolle, differing from the type-form in having less spines, usually six; (Plate LX, fig. 19,) in end view the truncate angles have only two prominences each.

Found this form frequent in material collected in small pools near Lake Tahoe, California, by Mrs. Hanson and Miss Haggin, of San Francisco.

St. WOLLEANUM, Butler. Plate LVII, figs. 1, 2.

Medium size, membrane punctate, about one-half longer than broad, moderately constricted, sinuses obtuse-angled; semi-cell broadly oval or subhexagonal; superior and lateral angles produced into subcylindrical, somewhat swollen processes or arms, slightly notched at the apices; four more similar processes within the margin; in vertical view regular hexagonal, each angle furnished with an arm in appearance as those in front view; within the margin, arranged in a circle around the center, are six, more or less conspicuous processes.

Diameter of body 40–50 μ; with processes 65–83 μ.

This species was discovered, identified as new and named by Miss E. Butler, Minneapolis, Minnesota, where it was found.

Var. KISSIMMENSE, Wolle. Plate LIX, figs. 1, 2, 3.

Front, lateral and vertical views. A large, smooth and beautiful form fully one-half larger than the original type from

Minnesota. The arms are similarly constructed and arranged, but in proportion with the body, are much longer, nearly equal in length to the diameter of the body; apices not notched but tipped with several small spines.

Diameter, including arms, 100–125 μ.

Grassy shores of Lake at Kissimme, Florida, March, 1885.

St. Tohopekaligense, Wolle. Plate LIX, figs. 4, 5.

Cell smooth, semi-cell in front view oval with radiating arms; in end view triangular, each angle drawn out into a smooth arm nearly as long as the diameter of the body; two similar arms on each side; all at nearly equal distances and bifurcate at the apices.

Diameter, including arms, 75 μ.

This species occurs frequently in small coves of Lake Tohopekaliga, at Kissimme, Florida. It bears features in common with *St. furcatum*, Breb., but is about twice the size, has more arms, and has them differently arranged; the description "one spine at each angle, with two accessory spines at the base," or "three spines at each angle," does not apply.

St. arctiscon, V. Des. U. S. p. 148.

In addition to the forms represented on Plate XLVII, figs. 9, 10, I add another, apparently more highly developed, Plate LXII, fig. 4, distinct in the large, wide-spreading points of the trifid apices of the arms.

Green Lake and other waters of New Jersey.

St. paradoxum, V. Des. U. S. p. 129, var. Osceolense, Wolle. Plate LIX, figs. 8, 9.

This variety differs from the typical form in its larger size, quadrangular body and in the large trifid, hooked, apices of the arms.

Diameter of spread of arms 60–70 μ.

Lake Osceola, Winter Park, Florida.

St. Minneapoliense, Wolle. Plate LVII, figs. 11–13.

Small verrucose; semi-cells in front view subcuneate with the two opposite superior angles drawn out into a short arm with margins serrate, and apices finely toothed; arms diverging from the arms of the connected semi-cell; in vertical view arms straight, body much elevated on each side;

in lateral view arms straight, short; body puffed out high on each side, crenate on the apices.

Diameter in front view, including arms, 50–58 μ; thickness of body 20–25 μ.

The front presentation not unlike other forms, but the vertical and lateral view are quite distinct in the unusual inflation of the body.

The name indicates the habitat.

St. calyxoides, Wolle. Plate LVII, figs. 14, 15.

Nearly equal in length and breadth; smooth or finely punctate; deeply constricted; semi-cells saucer- or calyx-shaped, bearing on the undulate margin five equally distant divergent spines; end view pentagonal, each angle produced and bearing a strong aculeus.

Diameter about 33 μ without, and 75 μ with, the aculei.

Pond, near Manchester, Ocean County, and Green's Lake, Warren County, New Jersey.

St. Brasiliense, V. Des. U. S. p. 146, var. triquetrum, Wolle. Plate LX, figs. 39, 40.

The form hitherto found here is pentangular in vertical view; the form first discovered and described by Nordstedt, is quadrangular, found in Brazil. The present form from California is triangular in vertical view; it appears so nearly related in character of cell, arrangement and character of aculei, think it best described as a variety of the same species.

Diameter of cells, including aculei, 63–67 μ.

Smaller than the pentangular form, but about the same size as the original quadrangular form.

Collected in small pools near Lake Tahoe, by Mrs. Hanson and Miss Haggin, San Francisco, California.

FRESH-WATER ALGÆ.

MARINE Algæ are conventionally classified into four primary divisions, the RED, the OLIVE, the GREEN, and the BLUE. Technically they are known as the RHODOPHYCEÆ, the MELANOPHYCEÆ, the CHLOROPHYCEÆ and the CYANOPHYCEÆ.

The arrangement proposed for the classification of our Fresh-water Algæ is in the same order in as far as it may be adapted. The MELANOPHYCEÆ are not represented. Having disposed of the DESMIDIEÆ, as supplemental to a previous volume, the DESMIDS OF THE UNITED STATES, we commence with the RED fresh-water plants; they are most nearly related to the more highly developed forms, the Marine plants; from these we descend to the lower and lowest forms. The inductive system does not apply, because so many of the hitherto recognized simpler unicellular forms are not established factors—they are not well understood, and indeed have no value except as conditions of plant-life.

The following is an outline of the order of arrangement adhered to in the following pages.

CLASS I.—RHODOPHYCEÆ.

ORDER I.—FLORIDIÆ.

FAMILY I.—Lemaneaceæ.
Genus 1.—Lemanea.
" 2.—Tuomeya.

FAMILY II.—Porphyraceæ.
Genus 3.—Bangia.

FAMILY III.—Batrachospermaceæ.
Genus 4.—Batrachospermum.
" 5.—Thorea.
" 6.—Chantransia.

FAMILY IV.—Hildebrandtiaceæ.
Genus 7.—Hildebrandtia.
" 8.—Compsopogon.

CLASS II.—CHLOROPHYCEÆ.

ORDER II.—CONFERVOIDEÆ.

Section.—OOSPOREÆ.

FAMILY V.—Coleochaetaceæ.

Genus 9.—Coleochaete.

FAMILY VI.—Oedogoniaceæ.

Genus 10.—Oedogonium.
" 11.—Bulbochete.

FAMILY VII.—Sphaeropleaceæ.

Genus 12.—Sphaeroplea.
" 13.—Cylindrocapsa.

Section.—SYNZOOSPOREÆ et ASEXUALIS.

FAMILY VIII.—Confervaceæ.

Genus 14.—Prasiola.
" 15.—Enteromorpha.

Section.—CLADOPHORINÆ.

Genus 16.—Draparnaldia.
" 17.—Stigeoclonium.
" 18.—Chaetophora.
" 19.—Microthamnion.
" 20.—Aphanochaete.
" 21.—Gongrosira.
" 22.—Chroolepus.
" 23.—Cladophora.

FAMILY IX.—Pithophoraceæ.

Genus 24.—Pithophora.

Section.—ULOTRICHINÆ.

Genus 25.—Ulothrix.
" 26.—Schizogonium.
" 27.—Conferva.
" 28.—Chaetomorpha.
" 29.—Rhizoclonium.

ORDER III.—SIPHONEÆ.

FAMILY X.—Vaucheriaceæ.

Genus 30.—Vaucheria.

FAMILY XI.—Botrydiaceæ.

Genus 31.—Botrydium.

ORDER IV.—PROTOCOCCOIDEÆ.

FAMILY XII.—Volvocaceæ.

Genus 32.—Volvox.
" 33.—Eudorina.
" 34.—Pandorina.
" 35.—Euglena.
" 36.—Gonium.

Genus 37.—Stephanosphaera.
" 38.—Chlamydococcus.
" 39.—Chlamydomonas.

FAMILY XIII.—Protococcaceæ.

Genus 40.—Pediastrum.
" 41.—Hydrodictyon.
" 42.—Coelastrum.
" 43.—Sorastrum.
" 44.—Staurogenia.
" 45.—Scenedesmus.
" 46.—Sciadium.
" 47.—Ophiocytium.
" 48.—Characium.
" 49.—Protococcus.
" 50.—Polyedrium.

FAMILY XIV.—Palmellaceæ.

Genus 51.—Dictyosphaerium.
" 52.—Hydrurus.
" 53.—Palmodactylon.
" 54.—Tetraspora.
" 55.—Schizochlamys.
" 56.—Palmella.
" 57.—Porphyridium.
" 58.—Botrydina.
" 59.—Botrycoccus.
" 60.—Gloeocystis.
" 61.—Nephrocytium.
" 62.—Rhaphidium.
" 63.—Dimorphococcus.
" 64.—Mischococcus.
" 65.—Eremosphaera.
" 66.—Urococcus.
" 67.—Apiocystis.

FAMILY XV.—Chytridieæ.

Genus 68.—Chytridium.
" 69.—Olpidium.

ORDER V.—ZYGOSPOREÆ.

FAMILY XVI.—Conjugatæ.

Genus 70.—Spirogyra.
" 71.—Sirogonium.
" 72.—Zygnema.
" 73.—Zygogonium.
" 74.—Mougeotia.
" 75.—Mesocarpus.
" 76.—Pleurocarpus.
" 77.—Plagiospermum.
" 78.—Gonatonema.
" 79.—Staurospermum.
" 80.—Craterospermum.

FAMILY XVII.—Desmidieæ.

V. Desmids of the United States.

Class III.—CYANOPHYCEÆ.

Order VI.—SCHIZOSPOREÆ.

Family XVIII.—Nostocaceæ.

Section a.—RIVULARIEÆ.

Genus 81.—Calothrix.
" 82.—Mastigonema.
" 83.—Isactis.
" 84.—Gloeotrichia.
" 85.—Rivularia.

Section b.—SCYTONEMEÆ.

Genus 86.—Scytonema.
" 87.—Symphyosiphon.
" 88.—Tolypothrix.
" 89.—Plectonema.
" 90.—Petalonema.

Section c.—SIROSIPHONEÆ.

Genus 91.—Sirosiphon.
" 92.—Hapalosiphon.

Section d.—NOSTOCEÆ.

Genus 93.—Nostoc.
" 94.—Anabaena.
" 95.—Sphaerozyga.
" 96.—Aphanizomenon.
" 97.—Nodularia.
" 98.—Cylindrospermum.

Section e.—OSCILLARIEÆ.

Genus 99.—Chamaesiphon.
" 100.—Lyngbya.
" 101.—Symploca.
" 102.—Microcoleus.
" 103.—Oscillaria.
" 104.—Beggiatoa.
" 105.—Leptothrix.
" 106.—Spirulina.
" 107.—Spirillum.

Family XIX.—Chroococcaceæ.

Genus 108.—Gloeothece.
" 109.—Aphanothece.
" 110.—Synechococcus.
" 111.—Merismopedia.
" 112.—Coelosphaerium.
" 113.—Clathrocystis.
" 114.—Gomphosphaeria.
" 115.—Microcystis.
" 116.—Anacystis.
" 117.—Polycystis.
" 118.—Gloeocapsa.
" 119.—Aphanocapsa.
" 120.—Chroococcus.

Class I.—RHODOPHYCEÆ.

Order I.—FLORIDIÆ.

Plants rosy red or purple, dark reddish brown or blackish; multicellular, various in form; crustaceous, filamentous, fasciculate, verticillately branched, etc.

Propagation sexual. The female cell (carpogon) bears a longer or shorter appendage, called the *trichogyne*. This is fertilized by very small granules (spermatozoids or anthorizoids) derived from cells at the ends of short branches or from certain spots or nests (antheridia) in the thallus. These spermatozoids float about in the water, find their way to the *trichogynes*, attach themselves and fructify the *carpogon*.

Asexual propagation takes place by means of *gonidia* which are evolved in cells similar in location and in appearance to the *carpogons*.

Family I.—LEMANEACEÆ.

Filaments simple or sparsely branched, hollow, more or less nodose, rigid, bristle-like, light olive-brown, gray, or with age almost black. Carpospores collect at intervals within the filament.

Genus 1, LEMANEA.

Filaments rather large, 1 to 5 inches long, nodose of dark olive or blackish color, forming tufts most frequently on rocky beds of streams whose current is rapid and cool. Carpospores numerous, collected in branched moniliform series within the nodes. The fertile filaments are hollow except an axillary thread composed of a single series of cells held in position by transverse threads at regular intervals. The walls of the filaments are thick, composed of two distinct layers of cells.

LEMANEA TORULOSA (Roth.) Ag.

Fertile filaments curved like a sickle or a bow, sub-simple, cartilaginous and rigid, 1–2 inches long, light olive-green, changes to darker color, with age nearly black; nodules not always well defined, approximate, papillae flattened and often almost obsolete, mostly 4–6 verticillate; spores oval; sometimes has an axillary thread with others twined around it.

Widely distributed in mountain and other streams of rapid and cold waters. It grows in masses firmly attached by a sort of discoid root to stones or rocks, often forming a turfy covering to them. Much more frequent than the following.

Plate LXIII, fig. 1, natural size; fig. 2, somewhat magnified; fig. 3, a section of a filament magnified showing the nodules and the almost obsolete papillae; fig. 4, a transverse section showing the carpospores in moniliform branched series.

LEMANEA FLUVIATILIS, Ag.

Filaments straight, simple or but slightly branched; 4–5 inches long, often much contracted toward the base, nodules more remote than in the preceding; usually three distinct verticillate papillae to each nodule. An axillary thread composed of a single series of cells is found in the fertile filaments.

The specimens of this species in my possession are from Northern New Jersey, South Carolina, Alabama, Rocky Mountains, and California. All from rapid waters of low temperature.

Plate LXIII, fig. 5, natural size.

LEMANEA CATENATA, Kg.

About five inches long, regularly constricted, simple, compressed, arcuate, in mass obscure violet; papules wanting; spores irregularly oval or subglobose.

Dr. Wood in his Fresh-water Algæ recognizes this species from the Rocky Mountains, "Mountain stream, Diamond Range, altitude 6,500 feet. He adds, "In the dried state they are closely interwoven into a dark purple, rigid, thin mass. When soaked out they preserve the same color as in mass, but each individual stem has a general light yellowish, neutral ground tint, with dark-purplish or greenish black bands at regular intervals. At the position of these bands the filament is nearly round and contracted, whilst between them it is compressed and enlarged. The spores are placed, not at the swellings, but at the constrictions. The filaments between the little knots of spores appear to be hollow. Their walls are everywhere very thin when compared with *L. torulosa*."

Genus 2, TUOMEYA, Harvey.

Filaments cartilaginous, continuous, solid, at first transversely banded, afterwards annularly constricted; composed of a longitudinal axis, and two strata of peripheric cells. Axis columnar, consisting of several longitudinal cohering filaments, beset with closely placed whorls of moniliform ramuli, whose branches anastomose horizontally and vertically into a cellular peripheric membrane, which is coated externally with moniliform filaments, gradually developed.

TUOMEYA FLUVIATILIS, Harvey.

"Grows in tufts an inch or two in length, scarcely as thick as a hog's bristle, much and irregularly branched, bushy; the branches alternate or secund, scattered or crowded, twice or thrice divided and set with scattered patent ramuli which are slightly constricted at the interstices and taper to an obtuse point. When young, the branches and the ramuli are perfectly cylindrical.

"In old, fully developed specimens the branches and ramuli are annularly constricted at short intervals, the nodes becoming swollen, whilst the internodes remain unchanged. When a young branch is bruised between two pieces of glass the axis may be readily extracted. It consists of several parallel longitudinal jointed threads combined together at closely-placed nodes, from which issue horizontal dichotomose filaments, composed of roundish or angular cells. In the young plants a portion of the filament between the axis and periphery is hollow, but in older ones the cavity is quite filled up with cells. The color is a dark olive. The substance is brittle, rigid when dry. The external habit, substance and color are those of *Lemanea*, and without microscopic examination it might pass for one, but, as may be gathered from the above description, it is very different from *Lemanea* in structure."—*Harvey, Nereis Boreali Americana.* Part 3, p. 65.

On stones in rivers and streams, Alabama, Prof. Tuomey. Near Fredericksburg, Virginia, Prof. Bailey, 1844 and 1845. I have no knowledge of this plant, have simply copied Prof. Harvey's description.

Plate LXVI, fig. 1. An ideal form of the plant. No sketches extant, and no preserved specimen to be found.

TUOMEYA GRANDE, Wolle. (*Entothrix grande*, Wolle. Bull. Torrey Bot. Club, November, 1877, p. 17.)

Filament simple, tubular, cartilaginous, light olive, to darker olive brown, nearly black, attached by a discoid prothallus, caespitose, rigid, curved, cylindrical with wavy outline, sublinear, apex obtuse; at base thin and nearly colorless; irregularly somewhat swollen, or irregularly nodose. The outer wall thick, opaque; within hollow with an axillary nodose cord composed of numerous simple filaments, usually 40–50, but sometimes 100–150; at regular intervals are horizontal branchlets supporting the column in position and bearing 10–15 or more spherical spores.

Filaments 600–750 μ diameter; internal threads 7–10 μ; spores 20–25 μ.

Attached to stones in shallow sluggish river water, Bethlehem, Pa. Frequent 1876–1878. In consequence of artificial changes in the river the latter year, the plant disappeared. Have preserved specimens in Rabenhorst's Algæ Exsiccatæ, No. 2538, and in my own herbarium. This plant is evidently closely related to the preceding of which we utterly failed to obtain a specimen, in our oft-repeated efforts; but while it has much in common it can not be the same, being not in the least branched.

Plate LXVI, fig. 2, a plant nearly twice the natural size; fig. 3, a portion of a filament magnified about 40 diameters, walls broken and in part removed to show the axillary cord; figs. 4, 5, 6, are the supporting threads of the nodes and the spores lodged in them; figs. 7 and 8, an axillary cord entirely drawn out of the filament.

Conviction after frequent observation induced the change of the family of the one, and of the genus of the other of these two species. There appears to be no doubt they are both nearly related to the *Lemaneaceæ*.

Family II.—PORPHYRACEÆ.

Thallus mucous, membranaceous or filamentous, formed from a single stratum of cells, most frequently purplish. Vegetation by division of cells in two or more directions. Propagation by tetraspores.

Genus 3, BANGIA, Lyngb.

Thallus filamentous, terete or flattened, nearly plane, simple or branched, usually purple, lubricose, formed from a single series of cells. Cell-membrane thick, colorless, sometimes lamellose. Multiplication by the repeated division of the cell-contents in all directions.

BANGIA ATRO-PURPUREA, (Dillw.) Ag.

Forming lax purple tufts; filaments abbreviated, scarcely more than an inch long, not branched, varying in thickness according to age; articulations nearly equal in length and breadth, sometimes only one-third as long as wide, more or less constricted at the joints.

Diameter of filaments, 28–60 μ.

Syn. *Conferva atro-purpurea*, Dillw. *Girardia fusco-purpurea*, Gray.

Attached to wood and stones in streams more or less subject to tides. In Europe this plant is found also in purely fresh water.

Plate LXVII, figs. 9–11. Four sizes in different stages of growth and cell division.

Family III.—BATRACHOSPERMACEÆ.

Dioecious algæ, violet, violet-purple or bluish green. Thallus filamentous, articulate, branched, composed of a single central series of cells and a secondary system more or less verticillately branched and densely covered with simple or forked branchlets. Spermatozoids and carpogones at the ends of branchlets, usually in dense orbicular clusters. Tetraspores at the ends of branches.

Genus 4, BATRACHOSPERMUM, Roth.

Thallus moniliform, gelatinous, soft, slippery, composed of an axillary or medullary series of cells, and a cortical, accessory parallel series which is clothed with subglobosely clustered fascicles of branches which are sometimes more or less scattered.

Mon. S. Sirodot, of France, has published a monograph on LES BATRACHOSPERMES, on their organization, functions, developments, etc. He points out some extraordinary differences of form, according to the influence of the season, the supply of water, the depth at which they live and the degree of illumination. According to the external conditions under which they are developed, the *Batrachosperms* are found in three different modifications, viz., I. A primordial condition, or prothallium; II. a non-sexual condition or *Chantransia*; III. a sexual condition or *Batrachospermum.*

The prothallium, he says, which has hitherto been overlooked by observers, is a kind of crustaceous pellicle covering the surface of stones on which the plant grows. It is composed of irregular filaments which are sometimes agglomerated into globular masses. This structure is of great importance since, in the perennial species, it is the part which renders the plant able to persist. It is capable of growth and of reproducing itself by sporules.

The non-sexual form he calls *Chantransia*, and describes it as composed of broad tufts of filaments each consisting of a row of cells ramifying and producing sporules, altogether analogous to those of the prothallium. Since this form can reproduce itself through a number of generations it has long been regarded as a distinct genus under the name of *Chantransia.*

That a larger non-sexual condition may exist, and that it may be somewhat similar to *Chantransia*, may not be contradicted, but that all the forms of *Chantransia* are conditions of *Batrachospermum* can not be admitted.

The sexual generation the author (Sirodot), describes as including a vegetative structure composed of whorls and of primary and of secondary prothalli; but the author founds his primary divisions on the character of the trichogyne, according as it is pedicellate or sessile; in the latter case it may be ovoid or in the form of a club, or a truncated cone. In the process of impregnation, the author maintains the actual absorption of the wall of the trichogyne at the point of contact with the cell-wall, the passage of protoplasm from the latter through the orifice thus formed and the appearance of a septum at the base of the trichogyne which separates the cystocarpic vesicle. The rejuvenescence of the protoplasm at the close of impregnation imparts a great activity to this cell which then begins to bud and to produce the carpospores or oospores.

Mon. Sirodot describes thirty-three native and exotic species of *Batrachospermum.*

BATRACHOSPERMUM MONILIFORME, Roth.

Very variable in size, from one inch to a foot in length, clothed with a more or less firm gelatinous mucus; violet, fuscous, reddish brown, purple or bluish green, vaguely and profusely branched; articulations of the branches similar, oblong-subclavate, the outer ones sometimes setigerous; internodes naked or furnished with a few scattered accessory branchlets.

Cellules measure about 10 μ by 20 μ.

Syn. *Conferva gelatinosa*, Dillw. *Batrachosperma ludibunda moniliformia.* Bory.

In fresh, cool rivulets, in springs of rapid limestone waters —rarely in ditches.

Besides this typical form Plate LXIII, figs. 6 and 10, there are many varieties, varying in color, in size and other particulars. The following may be noted as varieties.

Var. PULCHERRIMUM, Bory.

Violet or purple, internodes almost naked, branches elongated, whorls rather distant globose. Plant 3–5 inches long.

Var. SETIGERUM, Rab.

The extremities of the moniliform branchlets drawn out into a long setiform thread.

Var. CONFUSUM, Hass.

Internodes short, robust and corticulate, whorls approximate with numerous interstitial ramuli irregularly disposed.

Var. KUEHNIANUM, Rab.

Rather a small form, blue-green, or purplish-green, stem simple, almost naked, whorls distant and slender.

Plate LXIV, figs. 4, 5.

Mountain springs, Pennsylvania.

Var. ATRUM, Harv.

Internodes long, somewhat corticulate, whorls imperfectly developed, interstitial ramuli very short, often only two-celled, color very dark or black.

Syn. *Conferva atra*, Dillw. *Batrachospermum detersum*, Eng. Bot. *Lemanea setacea*, Bory.

Rivulet, Catalina Mt., Arizona.

Plate LXIV, fig. 6, natural size. Plate LXIII, fig. 9, specimens magnified.

BATRACHOSPERMUM VAGUM, Ag.

Very variable, but a large and well-developed species, two to ten inches long, almost invariably bluish-green; distinguished from the preceding, besides the color by the density of the interstitial ramuli, and the rather imperfectly developed whorls of the main stems; the ramuli are often so impacted that the whorls are not apparent except towards the ends of the stems and on the younger branches.

Syn. *Batrachosperma turfosa*, Bory.

Plate LXV, figs. 1, 2, older fronds; figs. 3–6, younger branches. Only typical specimens from Maine and Canada.

Var. KERATOPHYTUM, Bory.

Separated from the typical plant mainly in having the whorls distinct. Plate LXIV, fig. 1, is the natural size. Fig. 2, a branched end of a filament moderately magnified; fig. 3, two whorls of the last more highly enlarged.

This variety occurs frequently in lakes and streamlets of New Jersey, often six to eight inches long.

Genus 5, THOREA, Bory.

Thallus filamentose, attenuated at the apex, branched, light purple or purple-brown, villose, mucose, with a solid central medullary stratum, surrounded by dichotomously divided branchlets.

THOREA RAMOSISSIMA, Bory.

From a hand's-breadth to a foot long, and rarely two feet long, very much branched; about the thickness of a horse-hair, dark green or when dried of a beautiful purple-violet, ramuli spreading horizontally, long and short alternating, articulate; joints 1–3 times as long as broad, or twice that length.

Syn. *Batrachospermum hispidum*, De Cand.

Found a mere fragment of a frond in lake at Winter Park, Florida; enough to identify the plant, but not sufficient for the above description; have taken it from Cooke's British Fresh-Water Algæ, p. 293.

Plate LXXI, fig. 1, natural size. Figs. 2, 3, fragments of filaments magnified. Figs. 4, 5, base of ramuli greatly enlarged.

Genus 6, CHANTRANSIA, Fr.

Found in small caespitose clusters or tufts, steel blue or purplish violet, of much more simple structure than *Batrachospermum*. Filaments articulate, formed of a single series of cylindrical cells, branched; branches simple or compound, not verticillate, naked. Carpospores in small clusters on the ends of short branchlets.

Sexual propagation takes place, according to Sirodot, by carpogons attached to lateral branches, fertilized by means of trichogynes. Asexual multiplication by means of tetraspores developed on the end of cells, in appearance similar to carpospores.

Sirodot finds that certain *Chantransia*-like forms represent undeveloped conditions of *Batrachospermum*, but he has by no means proved that all forms of *Chantransia* are such undeveloped forms; on the contrary, he admits that some of the species have a sexual existence.

CHANTRANSIA MACROSPORA, Wood.

Caespitose, about an inch long, usually of yellowish green color, or in younger condition, deeper blue green; in dried state olive-gray to deep violet purple; filaments much branched with the branches mostly straight and elongate; fertile branches very short; articulations 3–6 times longer than broad. Spores single or geminate, few, often distinct, globose, or sometimes slightly oval.

Diameter of cells, 20 μ, (15–25 μ).

The plant originally described was from Aiken, South Carolina. Found it in profusion, July, 1879, in pond, Atsion, New Jersey, fringing sticks and rootlets of cypress and other trees extending into the shallow water along the shores; formed also a thick carpet about ten feet square on the planks of the chute of the outlet of the pond. Since then found it frequent in many localities in New Jersey.

The vegetative plants are furnished with setæ (trichogynes) usually attached, singly at the base, or on the apex of a carpogon. Basal stems are sometimes found with smaller filaments entwined around them.

Plate LXIX, fig. 1. Plants magnified 125 diameters; figs. 2, 3, 4, carpospores fertilized; figs. 5, 6, 7, carpogons with trichogynes attached; fig. 8, natural size. Fig. 9, an older stem corticulated; figs. 10, 11, 12, matured carpospores in early stages of development.

CHANTRANSIA VIOLACEA, Kg.

Tufts bright violet, short, scarcely two *mm* long, filaments straight, branches more or less erect, ends obtuse; articulations 3–6 times as long as wide, 8–9 μ thick. Parasitic on *Lemanea* and other plants.

Var. EXPANSA, Wood.

The author describes this plant as "forming a dark purple, slippery, indefinite stratum on stones; filaments purple, moderately branched, almost two lines long, together with branches straight, often elongate; fertile branches short, ascending, joints 3–8 times as long as their diameter, the final articles obtusely rounded; polyspores racemose, crowded on the fertile branches, oval or somewhat ovate.

Var. BEARDSLEI, Wolle.

In the Bull. Tor. Bot. Club, January, 1879, we described a singular form, remarkable for size, having a diameter of 25–50 μ, three to six times more robust than the typical *C. violacea*. It occurred as an undergrowth, intermingled with *Lemanea*, which was fringed with the parasitic *C. violacea*. It was sterile, and may be an abnormal development.

Collected by Dr. Beardslee, Painesville, Ohio. The var. *expansa* occurs frequently on stones in outlets of limestone springs, Pennsylvania.

A favorable opportunity for the study of the growth of the typical *C. violacea* occurred in an aquarium supplied with flowing water. It flourished for several years. The plants developed on the glass-sides. Referring to Plate LXVIII, fig. 1, the plant, natural size on *Lemanea*; fig. 2, natural size on glass; fig. 3, plants magnified 125 diameters; figs. 4, 5, clusters of carpogons (polyspores or sporangia) emitting gonidia which float about in the water until they find a place for rest; fig. 6, a scratch in the glass, with five gonidia lodged and multiplied by the process of cell division until at the end of two weeks, dark, sack-like forms were produced 8–15 *mm* in length. A single gonidia measures 2.5 μ, or one ten-thousandth part of an inch, hence in one of these groupings no more than one-fourth of an inch square there would be in a single layer 625,000 small cells or gonidia.

The purpose of this rapid cell multiplication appears to be a provision to make a bed for a new growth. Placing one of the larger groupings (fig. 6) under higher magnifying power, the development of a young growth becomes evident (fig. 7) and soon the whole space is covered with young plants, fig. 8. The violet color of the species is traceable in all the stages of growth.

Plate LXVIII, figs. 9, 10, represent var. *expansa;* figs. 11, 12, groups of carpogons (polyspores), fig. 13, natural size of plant. Fig. 14, var. *Beardslei* magnified 125 diameters.

CHANTRANSIA HERMANNI, (Roth) Kg.

Caespitose, pale, rosy purple, about 6 *mm* long, branches erect, patent with cuspidate or piliferous ends; articulation 3–6 times as long as wide; 9–12 μ thick.

Syn. *Trentepohlia pulchella*, Ag. *Conferva nana*, Dillw.

Not as frequent as the preceding; in fresh running waters.

Plate LXIX, fig. 13, natural size, fig. 14, two stems magnified 125 diameters. Figs. 15, 16, clusters of carpogons.

CHANTRANSIA PYGMAEA, Kg.

Tufts dark, steel blue or greenish, 2–3 *mm* long, radiating branches erect patent with rounded terminal cells.

Diameter of cells, 11–14 μ, 2–3 times as long.

On wood and grasses in spring water.

Plate LXVII, fig. 1, natural size; figs. 2, 3, stems magnified 125 diameters; figs. 4, 5, cluster of carpogons; (tetra-sporangia.)

CHANTRANSIA VIRGATULA, (Harv.) Thur.

Grows usually as a close fringe 1–4 *mm* long, on *Zostera* and various marine algæ. Filaments about 46 μ diameter, articulations 3–4 times longer than broad; stems rather straight, branches alternate or secund, rarely opposite; tetra-sporangia on short branchlets, single or rarely twin; terminal cells often piliferous.

Syn. *Trentepohlia virgatula*, Farl. *C. luxurians*, J. Ag.; *C. piliferum*, Kg.; *C. Lenormandi*, Suhr.

Mostly in sheltered coves along the New England coast. More of a Marine than a Fresh-water plant.

Plate LXVII, fig. 6, several plants magnified 125 diameters; fig. 7, tetra-sporangia; fig. 8, natural size as a fringe on *Zostera*.

Family IV.—HILDEBRANDTIACEÆ.

Thallus crustaceous, extended and firmly adhering, composed of subcubical cells arranged in close vertical series. Tetraspores in excavations in the surface. Sexual propagation unknown.

Genus 7, HILDEBRANDTIA, Nardo.

Smooth, purplish, crustaceous, forms a firmly attached coating on stones. Propagation asexual by means of tetraspores which are imbedded in pear-shaped cavities under the surface of the thallus.

HILDEBRANDTIA RIVULARES, Ag.

Thallus forms a bright, purplish, smooth crust, on river stones. Tetra-sporangia pear-shaped. Cells of the thallus red, oblong, round or angular. Cells 3.5–4 μ diameter; often twice as long.

The only locality in which we found, or know this plant to have been found in fresh-water is the bed of the Susquehanna River at Harrisburg, Pennsylvania.

Syn. *H. fluviatilis*, Breb.; *Erythroclathous rivularis*, Liebm.; *H. rosea* var. *fluviatilis*, Kg.

Plate LXIX, fig. 17, thallus peeled from a stone, highly magnified. Fig. 18, small transverse section, showing the spore receptacles.

HILDEBRANDTIA ROSEA, Kg.

A marine plant common on stones along the New England coast, differs mainly in smaller size, and spherical form of the cells.

Genus 8, COMPSOPOGON, Mont.

Thallus filiform, terete, branched, articulate, cells more or less inflated, or slightly constricted at the joints; filaments corticate, somewhat parenchymatous. Spores, according to Montagne, contained in small verrucæ in the cortical.

COMPSOPOGON COERULEUS, Mont.

Tufts loose, 2–6 inches long, dark, olive-green; filaments stout and firm, much branched, branches erect patent, mostly alternate, decompound, stems and branches tapering. Diameter of lower part of stems often 250 μ, branches 100 μ more or less, tapering to an obtuse point. Articulations of stems and of branches rarely more than half as long as wide; of the thicker parts only about one-third as long. Older parts of stem corticate, primarily indicated by longitudinal threads over the articulations, then by an irregular and thicker reticulation.

Plate LXX, fig. 1, natural size of plant, figs. 2, 3, younger part, and end of branched filament largely magnified. Figs. 4, 5, two short sections of older parts of filaments, showing the cortical, all magnified 125 diameters.

Collected in fresh-water marsh pool about two miles inland from Green Cove Spring, Florida, March, 1885. About a month later Rev. H. D. Kitchel found the same plant frequent at Blue Springs, on the St. John's River. In a collection made by Captain J. Donnell Smith, 1878, we recognized the same form but did not identify it until the gathering of fresh specimens.

Class II.—CHLOROPHYCEÆ.

Plants normally with cell contents of a chlorophyl-green color, aquatic or ærial, one, two, or many celled, either single or associated in families; branched or simple. Cell contents sometimes change to crimson, flesh-color or yellow-brown, often with a central or lateral nucleus. Vegetation by cell division. Fecundation often sexual. Propagation either by oospores or zygospores or gonidia.

Order II.—CONFERVOIDEÆ.

Filiform algæ, simple or branched; vegetation terminal, unlimited; sometimes united laterally; cell contents chlorophyl-green. Propagation in some genera is sexual, there being female cells (oogonia) which contain one or sometimes more oospores, and male cells (antheridia) in which spermatozoids are developed. In some cases copulation of zoogonidia (swarming spores) has been observed (*Cladophora* and *Ulothrix*); the exact mode of propagation of other genera is not satisfactorily determined.

Family V.—COLEOCHAETACEÆ.

Small, bright green water plants either sexual or asexual. The oogonium is a round cell resting on the end of a slender neck, the continuation of an end cell of the frond. The antheridia, 2 or 3, are formed on a neighboring cell or on a separate frond, and emit the spermatozoids which by means of two ciliæ reach the oogonium and fertilize the oospore, which corticates and becomes a resting or winter spore, developing the following Spring.

Asexual propagation takes place by zoogonidia which may be developed in any of the cells; they are provided with two ciliæ. in appearance like the spermatozoids, but considerably larger.

Genus 9, COLEOCHAETE, Breb.

Filaments articulated, branched, either conjoined into a little cumulated mass or parenchymatously concreted into a plain sub-disciform thallus; articles oblong, anteriorly more or less dilated, often furnished with a long seta on the back or superior angle.

COLEOCHAETE SOLUTA, Pringsh.

Forms small discs composed of radiating dichotomously branched filaments lying closely side by side but not adhering, cells one and one-half to three times as long as wide; carpogons (oogonia) usually develop near the terminal cells, at first small, flask-shaped, but gradually enlarging, becoming orbicular by a cortical forming around them.

Vegetative cells average 25 μ diameter. Carpogons fully developed about 200 μ diameter.

Not rare in ponds; frequent in New Jersey waters.

Plate LXXII, figs. 1, 2, parts of fronds; fig. 3, loose growth in fruit; figs. 4, 5, two carpogons; figs. 6, 7, young forms.

COLEOCHAETE SCUTATA, Breb.

In manner of growth similar to the preceding, but distinct in having the filaments adhering side by side, forming a kind of irregularly orbicular, parenchymatous disc; cells subquadrangular; oogonia subglobose, near the margins, corticated above, naked below. Fronds and cells very variable in size.

Syn. *Phyllactidium setigerum*, Kg.

An aquatic plant, everywhere; much more frequent than *C. soluta*.

Plate LXXII, figs. 8–13, young and older plants of several forms.

COLEOCHAETE ORBICULARIS, Pringsh.

Like *C. scutata* in structure and fruit, but always exact orbicular; the size of the cells is usually smaller.

The distinction does not seem sufficient for a good species; probably a mere variety.

Syn. *Phyllactidium pulchellum*, Kg. Plate LXXII, fig. 14.

Localities similar to the other species.

COLEOCHAETE PULVINATA, A. Br.

Fronds orbicular, upper surface rounded, about 2 *mm* high in the middle, not thin, flat discs as *C. scutata;* the arrangement of the filaments not so distinctly radiating from a central cell or cells; size of cells large, 35–40 μ by 50–60 μ.

Syn. *Phyllactidium Australe*, Ces. *Chaetophora tuberculosa*, K. Mueller.

Occurs in large limestone springs, Northampton County, Pa.; sticks and branches of trees dropped into the water, are often full of this form, as small dark, olive-green prominences or tubercles 4–8–20 *mm* diameter; the larger ones are usually the result of the confluence of two or more smaller ones.

COLEOCHAETE IRREGULARIS, Pringsh.

Thallus bright green, filaments irregularly disposed—not parenchymatous and not with any system of order; articulations longer or more frequently shorter than the diameter. Oogonia transversely broadly oval, usually at the ends of branchlets, nude.

Filaments 15–20 μ wide. Oogonia diameter 40–45 μ.

On water plants, leaves dropped in water, etc. This species assumes many varieties of forms. The one figured was chosen for its good condition of fruit; from a marsh pool, Eastern Pennsylvania.

Plate LXXII, figs. 15, 16, specimens of *Coleöchaete irregularis*, with carpogons.

Family VI.—ŒDOGONIACEÆ.

Filamentous algæ, simple or branched. Monœcious or diœcious. Basal cells mostly lobately divided or ending in a discoid foot by which in early stage the plant is attached. Plants articulate, endowed with a peculiar mode of cell multiplication by transverse division, indicated by transverse striæ usually at the apical end of the mother cell. Plate LXXIII, figs. 2, 2, 3.

The oogonia are developed in the series of vegetative cells, singly or in chains of 2–5 or more, one contiguous to the other, and more or less tumid, with a single *oospore* in each, first green, then gradually changing to orange, to red or brown, and sometimes almost black. The fecundated oospore breaks up before germinating into several, ordinarily four, zoospores.

Male plants are of two kinds, *dwarf* and *elongated*. The dwarf males (*nannandres*) are found attached to the female plant; the elongated males are composed of a series of short interstitial cells in an independent filament; these constitute the *macrandrous* forms, and the former the *nannandrous* forms. Asexual propagation takes place by zoospores which are evolved in vegetative cells; two cells separate (v. Plate LXXIII), the chlorophyl contained in a membrane, escapes, producing a spherical cell, provided with ciliæ around a hyaline point, moves about rapidly, then comes to a rest and develops.

Genus 10, ŒDOGONIUM, Lk.

Filaments simple, articulate. Terminal cell sometimes elongated and setiform. Either monœcious or diœcious; when monœcious the oogonia and the spermogonia cells (antheridia) are on the same filament; *epigynous* or *hypogynous* as the latter are above or below the oogonium. Diœcious, when the spermogonia cells are on different (male) plants. The *nannandres* are dwarf males somewhat of the form of inverted flasks, the lower part, the stipe, and the upper part consisting of one or more short cells, *spermogonia* cells (antheridia); these dwarf males are located parasitically on or near the oogonium, and fertilize it by means of spermatozoids developed in the spermogonia cells. Another diœcious form has no dwarf males, but instead, has interstitial spermogonia cells, in independent filaments, like the female plant except usually slightly smaller; these develop and emit the spermatozoids which find their way to the oogonium and fertilize the oospore. These two kinds are distinguished, the former as *nannandrous*, and the latter as *macrandrous* species.

The dwarf males are supposed to develop from male zoospores (androspores) and these from small cells similar to the interstitial spermogonia cells which are found in the filaments of nannandrous female plants, or in the filaments of independent sterile plants; the former are called *gynandrosporous* and the latter *idioandrosporous* plants. The androsporangia cells and spermogonia cells are barely separable when empty, as most frequently found, except by size, the former being usually considerably larger. The androspores are many times larger than the spermatozoids.

The fertilization of the oospore is effected through a pore or small spherical opening in the oogonium or through a split in the upper part of the oogonium. In some species the oogonium splits round the top and opens as by a lid. The spermatozoids, having matured and escaped from the spermogonia cells, enter and fecundate the oospore which ripens into a perfect, fertile, resting spore.

Plate LXXIII, fig. 1, filament of a female nannandrous plant with oogonium and nannandres or dwarf males. Figs. 2, 2. 3, 3, parts of filaments with transverse striæ indicating the mode of cell multiplication peculiar to this genus. When a cell has reached maturity it splits immediately below the apex by a circular line around the cell and by growth the top is raised and a new cell formed; this new cell may split again as before, below the apex, the top be pushed up by the growth of another cell, leaving two transverse striæ. The same process is often repeated five, six, or more times and thus producing as many striæ. Fig. 4, section of filament of a female alga showing androsporangia (fig. 5), and dwarf males, (figs. 18, 19). Fig. 6, female monœcious plant with spermogonia cells (fig. 7), hypogynous; and oogonium with pore in superior part of it. Fig. 8, filament of monœcious plant with spermogonia cells which are hypogynous, (fig. 9); subhypogynous, (fig. 10); epigynous, (fig. 11); subepigynous, (fig. 12); and apical, (fig. 13); pore of oogonium, (fig. 14), open centrally. Fig. 15, a male plant with androsporangia cells, (fig. 16). Fig. 17, androspores escaping. Fig. 18, dwarf males, stipe, and spermogonia (fig. 19), bicellular. Fig. 20, zoospore making its passage out of mother cell. Figs. 21, 22, 23, fully developed zoospores, furnished with ciliæ and becoming very active. Figs. 24–26, zoospores come to rest and developing young plants. Figs. 27–30, advancing stages of development. Figs. 31–33, imperfect zoospores passed out of cell through a fissure and adhering. Fig. 34, an oospore surrounded by a multitude of active spermatozoids (?). Fig. 35, shows how some oogonia, destitute of pore, open by an operculum or lid. Figs. 36, 37, oospore passing out of oogonium in a vegetative plant. Figs. 38, 39, clusters of young plants, found on an entangled mass of old *Oedogonium* in a water trough, which was dotted with small radiating clusters barely visible to the unassisted eye; many very small, others larger, containing each from ten to fifty shorter or longer radiating filaments in character the same as the mother, or older plants; could not satisfy myself whether these clusters spring from gonidia breaking through the cell walls (compare Plate LXXXIII, fig. 6), or from oospores breaking up into microgonidia. The figures represent two clusters, like which there were hundreds seen under very low magnification. The old forms were identified as *Oe. pachyandrium.* Found October, 1882.

The following are the species of the United States as far as identified, arranged in accord with the plan of Wittrock's monograph.

ŒDOGONIUM.

SECTION I.—MONŒCIOUS SPECIES.

OOGONIA ALWAYS DESTITUTE OF MEDIAN PROCESSES.

A.—Oospores globose or subglobose.

a.—Oogonia globose or subglobose.

Oe. crytoporum, *Wittr.*
Oe. obsoletum, *Wittr.*
Oe. fragile, *Wittr.*
Oe. zig-zag, *Cleve.*
Oe. vernale, *Hass.*
Oe. crispum, *Hass.*
Oe. plusiosporum, *Wittr.*
Oe. polymorphum, *Wittr.*
Oe. autumnale, *Wittr.*

b.—Oogonia elliptic or egg-shaped.

Oe. urbicum, *Wittr.*

B.—Oospores elliptic or egg-shaped.

Oe. paludosum, *Hass.*
Oe. crassum, *Hass.*
Oe. gracillimum, *Wittr.*

SECTION II.—DIŒCIOUS SPECIES.

SUBSECTION I.—WITH DWARF MALES.

A.—Species with dwarf males unicellular.

a.—Oogonia furnished with vertical intersections.

Oe. platygynum.

b.—Oogonia destitute of vertical intersections.

1.—*Oospores globose or subglobose.*

Oe. decipiens, *Wittr.*
Oe. Areschougii, *Wittr.*
Oe. undulatum, *A. Br.*
Oe. cateractum, *Wolle.*

Oospores subellipsoid.

Oe. cyathigerum, *Wittr.*

B.—Dwarf males bi-multicellular.

Spermogonia external.

2.—*Oospores with smooth membrane.*

a.—Oospores globose or subglobose.

Oe. multispora, *Wood.*
Oe. flavescens, *Hass.*
Oe. irregulare, *Wittr.*
Oe. Braunii, *Pringsh.*
Oe. Lundense, *Wittr.*
Oe. macrandrium, *Wittr.*
Oe. crassiusculum, *Wittr.*

b.—Oospores ellipsoid or egg-shaped.

Oe. Borisianum, *LeCl.*
Oe. concatenatum, *Hass.*
Oe. sexangulare, *Cleve.*
Oe. Wolleanum, *Wittr.*
Oe. acrosporum, *D.By.*
Oe. obtruncatum, *Wittr.*
Oe. ciliatum, *Hass.*
Oe. Huntii, *Wood.*

3.—*Membrane of oospores echinulate.*

a.—Oospores globose.

Oe. stellatum, *Wittr.*
Oe. Donnellii, *Wolle.*
Oe. echinospermum, *A. Br.*
Oe. echinatum, *Wood.*

b.—Oospores ellipsoid.

Oe. Hystrix, *Wittr.*

SUBSECTION II.—DIŒCIOUS WITH ELONGATED MALE PLANTS; MACRANDROUS.

c.—Oogonia not, or scarcely swollen.

Oe. capillare, *Kg.*
Oe. stagnale, *Kg.*

d.—Oogonia manifestly swollen.

1.—*Oospores globose or subglobose.*

Oe. capilliforme, *Kg.*
Oe. pachyandrium, *Wittr.*
Oe. rufescens, *Wittr.*
Oe. Franklinianum, *Wittr.*

Oe. cardiacum, *Hass.*
Oe. carbonicum, *Wittr.*
Oe. Pringsheimii, *Cram.*
Oe. punctato-striatum, *D. By.*

2.—*Oospores ellipsoid or oval.*

Oe. Boscii, *LeCl.*
Oe. Landsboroughi, *Hass.*
Oe. rivulare, *LeCl.*

SECTION III.—ORGANS OF FRUCTIFICATION IMPERFECTLY KNOWN.

a.—Oospores globose or subglobose.

Oe. delicatulum, *Kg.*
Oe. moniliforme, *Wittr.*
Oe. Fonticola, *A. Br.*
Oe. princeps, *Hass.*
Oe. Londiense, *Wittr.*
Oe. vesicatum, *Lyngb.*
Oe. hexagonum, *Hass.*

b.—Oospores ellipsoid or oval.

Oe. giganteum, *Kg.*
Oe. grande, *Kg.*
Oe. pyriforme, *Wittr.*
Oe. longatum, *Kg.*

SECTION I.—MONŒCIOUS SPECIES.

A.—Oogonia always destitute of median processes.

a.—Oospores globose or subglobose.

Oedogonium cryptoporum. Wittr.

Oogonia single, elliptic, or somewhat depressed globose, opening by a median pore, almost filling the oogonium. spermogonia 2–7 celled, scattered.

Diameter veg. cells, 7–9 μ; 4–6 times as long.
Diameter oogonia, 24–25 μ by 26–27 μ.
Diameter oospore, 22–23 μ by 19–21 μ.
Diameter sperm. cells, 6–8 μ by 7–9 μ.

Var. vulgare, Wittr.

Oogonia 2–5 continuous, or single; spermogonia subepigynous or subhypogynous or scattered. Measures all somewhat less than the typical form, and much more frequent.

Ponds, Pennsylvania and New Jersey.

Plate LXXIV, figs. 1, 2.

Oedogonium obsoletum, Wittr. (*Oe. vernale*, Wittr.)

Oogonia single, globose to depressed globose, opening by a pore above the middle; oospore same form as the oogonium nearly filling it. Spermogonia 1–3 celled, subepigynous; spermatozoids single.

Diameter veg. cell, 9–14 μ; 3–5 times longer.
Diameter oogon., 34–38 μ by 34–40 μ.
Diameter oospor., 31–34 μ by 28–31 μ.
Diameter sperm. cell, 8–9 μ by 12–16 μ.

Ponds, Pennsylvania—specimens imperfect, but probably of this species—needs farther research.

Plate LXXIV, fig. 3. Plate LXXXI, figs. 6, 7.

Oedogonium fragile, Wittr.

Oogonia single or twin, globose or subegg-shaped-globose, opening by pore above the middle; oospore fills the oogonium; spermogonia 1–3 celled, hypogynous or subepigynous; spermatozoids twin.

Diameter veg. cell, 12–17 μ; 4–5 times longer.
Diameter oogon., 42–47 μ by 44–50 μ.
Diameter oospor., 40–44 μ by 39–44 μ.
Diameter sperm. cell, 12–15 μ by 10–12 μ.

Ponds and ditches, Pennsylvania.

Plate LXXIV, figs. 4, 5, 6.

Oedogonium zig-zag, (Cleve.) Wolle.

Oogonia 2–5 or single, opening by a pore above the middle, globular, oospore filling the oogonium; spermogonia 2–5 celled; a series of spermogonia cells alternating with one, or a series of two or more oogonia.

Diameter veg. cells, 17–18 μ; 2–4 times longer.
Diameter oogon., 50–51 μ by 53–54 μ.
Diameter oospor., 47–48 μ by 49–50 μ.
Diameter sperm. cells, 17 μ by 10–11 μ.

Have changed the diagnosis slightly to suit the plant, frequent in Northampton County, Pennsylvania.

Plate LXXIV, figs. 7, 8.

OEDOGONIUM VERNALE, (Hass.) Wittr.

Oogonia single, obversely egg-shaped, opening with an operculum, fissures narrow; oospore globose not filling the oogonium; spermogonia bicellular, subepigynous.

Diameter veg. cells, 10–16 μ; 4–6 times as long.
Diameter oogon., 39–45 μ by 45–51 μ.
Diameter oospor., 34–38 μ by 34–39 μ.
Diameter sperm. cells, 10–12 μ by 8–9 μ.

Syn. *Vesiculifera vernalis*, Hass.; *Vesiculifera Candollei*, Hass.

Ponds, Pennsylvania.

Plate LXXIV, figs. 9, 10.

OEDOGONIUM CRISPUM, (Hass.) Wittr.

Oogonia single, obversely egg-shaped, opening with an operculum, fissure narrow, oospores nearly globose, not filling the oogonium; spermogonia 2–5 celled, hypogynous or subepigynous; spermatozoids binate, terminal cell obtuse.

Diameter veg. cells, 12–18 μ; 2–4 times as long.
Diameter oogon., 37–49 μ by 42–54 μ.
Diameter oospor., 33–46 μ by 34–46 μ.
Diameter sperm. cells, 9–14 μ by 7–12 μ.

Syn. *Vesiculifera crispa*, Hass. *Oedog. rostellatum*, Pringsh. *Oedog. pulchellum*, A. Br.

Ponds and pools, Pennsylvania.

Plate LXXIV, fig. 15.

Var. ROSTELLATUM, Pringsh.

Agrees in all essential points with the type-form except the terminal cell, not obtuse but rostellate.

Meadow pools, ponds, etc.

Plate LXXIV, fig. 11, young plant with oogonium, etc.; fig. 12, first development from zoospore; figs. 13, 14, more advanced stages.

OEDOGONIUM PLUSIOSPORUM, Wittr.

Oogonia single, subelliptic-globose; opens by pore slightly above the middle; oospore globose, not quite filling the oogonium; spermogonia 2–6 celled, subepigynous, rare; terminal cell obtuse.

Diameter veg. cells, 14–19 μ; $2\frac{1}{2}$–$3\frac{1}{2}$ times longer.
Diameter oogon., 38–45 μ by 42–50 μ.
Diameter oospor., 33–39 μ by 31–37 μ.
Diameter sperm. cells, 12–14 μ by 8–12 μ.

Sluggish waters, Pennsylvania, New Jersey, California.

Plate LXXIV, figs. 20, 21.

OEDOGONIUM POLYMORPHUM, Wittr. and Lund.

Oogonia single, rarely twin, globose-egg-shaped, opens by pore above the middle; oospore globose not filling the oögonium closely; spermogonia 1–10 celled, often terminal, subepigynous or vague and rare; spermatozoids binate; terminal cell, obtuse, or apiculate or setiform.

Diameter veg. cells, 8–14 μ; 4–10 times as long.
Diameter oogon., 30–33 μ by 30–35 μ.
Diameter oospor., 25–30 μ by 25–30 μ.
Diameter sperm. cells, 8 μ by 6–7 μ.

Brown's Mills and other ponds, New Jersey.

Plate LXXIV, figs. 16–19.

OEDOGONIUM AUTUMNALE, Wittr.

Oogonia single, obversely egg-shaped-globose, or globose, opening by an operculum, fissure narrow; oospore subglobose filling the oogonium; spermogonia 1–2 celled, subepigynous or hypogynous, or sparse; spermatozoids binate; terminal cell apiculate or rostellate.

Diameter veg. cells, 16–19 μ; $1\frac{1}{4}$–$2\frac{1}{2}$ times longer.
Diameter oogon., 39–43 μ by 45–51 μ.
Diameter oospor., 37–40 μ by 39–43 μ.
Diameter sperm. cells, 15–18 μ by 9–10 μ.

Ponds and streamlets, Pennsylvania.

Plate LXXXI, figs. 1, 2, 3, parts of filaments in fruit. Figs. 4, 5, first stages of development from zoospores.

Species with elliptic or oval oogonia.

OEDOGONIUM URBICUM, Wittr.

Oogonia single, elliptic, opens by a pore in superior part; oospore globose, not filling the oogonium; spermogonia most frequently only two celled; spermatozoids binate; the supporting cells of oogonia usually destitute of chlorophyl.

Diameter veg. cells, 15–16 μ; $2\frac{1}{2}$–6 times longer.
Diameter oospor., 33–45 μ by 33–45 μ.

Syn. *Oe. tumidum*, Pringsh.

Plate LXXXII, fig. 10.

Marsh pools, eastern counties of Pennsylvania.

Species with elliptic or oval oospores.

OEDOGONIUM PALUDOSUM, (Hass.) Wittr.

Oogonia single, elliptic, sometimes suboblique, opens by a pore above the middle; oospore elliptic, moderately filling the oogonium; spermogonia 1–8 celled, sparse, usually in upper end of filament; spermatozoids binate.

Diameter veg. cells, 15–20 μ; 3–7 times longer.
Diameter oogon., 39–48 μ by 66–84 μ.
Diameter oospor., 36–45 μ by 54–63 μ.
Diameter sperm. cells, 14–16 μ by 6–13 μ.

Syn. *Vesiculifera paludosa*, Hass.

Marsh pools, Northampton County, Pennsylvania.

Plate LXXV, fig. 1.

OEDOGONIUM CRASSUM, (Hass.) Wittr.

Oogonia single, rarely twin, obovate-ellipsoid, somewhat tumid, opening by a pore above the middle; oospore ellipsoidal nearly filling the oogonium, spermogonia 2–4 celled, hypogynous or subhypogynous or epigynous; spermatozoids binate.

Diameter veg. cells, 33–35 μ; 2–5 times longer.
Diameter oogonium, 65–70 μ by 100–125 μ.
Diameter oospore, 60–66 μ by 80–110 μ.
Diameter sperm. cells, 30–33 μ by 12–15 μ.

Having found this species with spermogonia cells, not heretofore observed, the diagnosis is adapted to our form. Iowa and Kansas.

Plate LXXVI, figs. 2 and 3. Two filaments with spermogonia cells.

OEDOGONIUM GRACILLIMUM, Wittr. and Lund.

Oogonia single or twin, oblong; opening by an operculum, fissure narrow; oospores oblong-elliptic, not filling the oogonium; spermogonia uni-bicellular, subepigynous; spermatozoids binate.

Diameter veg. cells, 3–5 μ; 5–6 times longer.
Diameter oogon., 14–16 μ by 34–42 μ.
Diameter oospor., 13–15 μ by 24–31 μ.
Diameter sperm. cells, 3–3½ μ by 4 μ.

Ponds, Pennsylvania.

Plate LXXV, fig. 2.

SECTION II.—DIŒCIOUS SPECIES.

SUBSECTION I.—SPECIES WITH DWARF MALES.

A.—Species with dwarf males unicellular.

a.—Oogonia vertically constricted.

OEDOGONIUM PLATYGYNUM, Wittr.

Gynandrosporous, oogonia single, rarely binate, depressedly obverse egg-shaped; constrictions 7–12, angles rounded; oogonia cut round (circumscissile) below the middle, opening by a pore seated in the fissure, vertical view orbicular, margin sinuate with depressions corresponding with the constrictions; oospore somewhat depressed-globose nearly filling the oogonium androsporangia 1–3 celled; terminal cell obtuse; dwarf males small, obverse egg-shaped, seated on the oogonia.

Diameter veg. cells, 6–8 μ; 2–5 times longer.
Diameter oogon., 21–30 μ by 16–24 μ.
Diameter oospor., 17–24 μ by 15–20 μ.
Diameter androsp. cells, 6–8 μ by 7–8 μ.
Diameter of dwarf males, 4–5 μ by 8–9 μ.

Frequent in ponds, New Jersey, Florida, Minnesota.

Plate LXXVII, figs. 1, 2, filaments; figs. 3, 4, transverse sections of oogonia.

b.—Oogonia destitute of vertical constrictions.

1.—*Oospore globose or subglobose.*

OEDOGONIUM DECIPIENS, Wittr.

Gynandrosporous, oogonia single or two or three in series; depressed-globose, narrowly circumcised in middle, opening by a pore in the fissure; oospore depressed-globose, not filling the oogonium; androsporangia 2–6 celled, dwarf males obverse egg-shaped, situated on the oogonium.

Diameter veg. cells, 10–12 μ; 3–5 times longer.
Diameter oogon., 32–38 μ by 30–40 μ.
Diameter oospor., 29–34 μ by 25–28 μ.
Diameter androsp. cell, 9–10 μ by 11–15 μ.
Diameter dwarf male, 6–7 μ by 14–15 μ.

Syn. *Oedog. vesicatum*, D. By.

Ponds, New Jersey, rare.

Plate LXXVII, figs. 5, 6.

OEDOGONIUM ARESCHOUGII, Wittr.

Gynandrosporous, oogonia 2–6 continuous, or single, rather depressedly globose, broadly cut round (circumscissile) in the middle, opening by a pore in the fissure; oospore exact globose, not filling the oogonium. Androsporangia 1–6 celled, hypogynous or subepigynous, or rarely scattered, terminal cell (which sometimes is the androsporangium) obtuse, dwarf males obversely egg-shaped, seated on the oogonia.

Diameter veg. cells, 9–12 μ; 4–6 times longer.
Diameter oogon., 38–39 μ by 36–40 μ.
Diameter oospor., 22–24 μ by 22–24 μ.
Diameter androsp. cells, 10–11 μ by 10–12 μ.
Diameter dwarf males, 6–7 μ by 14–15 μ.

Ponds, New Jersey. *Oe. Areschougii* is recorded with some hesitation; it is very near *Oe. decipiens*, the one may be a mere variety of the other.

Plate LXXVII, fig. 7, a filament with oogonia, dwarf males, etc.

OEDOGONIUM UNDULATUM, (Breb.) A. Br.

Oogonia single or twin, elliptic-globose or subglobose, opens by a pore below the middle; oospore in form like the oogonium, nearly filling it; vegetative cells four times undulatingly constricted; terminal cell (which is sometimes the oogonium) obtuse; dwarf males elongate-obconical, seated on the supporting cell.

Diameter veg. cells, 15–17 μ; 3–5 times longer.
Diameter oogon., 51–56 μ by 57–75 μ.
Diameter oospor., 46–50 μ by 48–60 μ.
Diameter dwarf males, 9–10 μ by 65–70 μ.

Syn. *Conferva undulata*, Breb.; *Cynatonema confervaceum*, Kg.

Filaments single, not massed, widely distributed.

Plate LXXVII, fig. 8, filament with oogonium, dwarf male, and pedicel.

OEDOGONIUM CATERACTUM, Wolle.

Idio-androsporous; oogonia often terminal, single or twin, obovate globose, subglobose or broadly oval, opens by a pore above the middle; oospore globose or obovate globose nearly filling the oogonium; androsporangia 2–6 celled, dwarf males unicellular, considerably curved, seated on, or sometimes below the supporting cell; spermatozoids internal.

Diameter veg. cells, 28–38 μ; 1½–3 times as long.
Diameter oogon., 55–60 μ by 60–75 μ.
Diameter oospor., 50–55 μ by 50–60 μ.
Diameter androsp. cell, 26–30 μ by 10–15 μ.
Diameter dwarf males, 10 μ by 65 μ.

Attached to rocks in rapids below water-fall, Pike County, Pennsylvania.

Plate LXXXV, figs. 10, 11, 12.

b.—Oospores subellipsoid.

OEDOGONIUM CYATHIGERUM, Wittr.; forma AMERICANA, Wolle.

Idio-androsporous; oogonia single, or two to three seriate, oboviform or ellipsoid, opens by a pore above the middle; oospores of same form, nearly filling the oogonium; supporting cell slightly tumid; terminal cells obtuse; androsporangia pluricellular; dwarf males cyathiform, somewhat curved, seated on the supporting cell or on the oogonia.

Diameter veg. cells, 17–21 μ; 1¼–3 times longer.
Diameter oogonium, 45–50 μ by 55–63 μ.
Diameter oospore, 39–40 μ by 44–46 μ.
Diameter dwarf males, 12–15 μ by 50–54 μ.

Ponds, Pennsylvania. This form is somewhat more slender than the type-form; dwarf males are seated on the oogonia, not on the supporting cells, and the vegetative cells are shorter; but we prefer to retain this name as appropriate and until more numerous specimens are found.

Plate LXXXI, figs. 20–22.

OEDOGONIUM MULTISPORA, Wood.

Oogonia single, bi- or tri-seriate, globose with a distal lateral pore; oospore globose about the same size as the cavity of the oogonium. Dwarf males (antheridia) bi- or tri-cellular, curved with the lower part much the largest, generally adhering in considerable numbers to all parts of the female plant.

Dr. Wood remarks: "This species differs from its nearest European congeners, *Oe. Rothii* and *Oe. depressum*, very markedly in the bi-cellular antheridia." He gives no measures; the plant illustrated, Plate LXXX, figs. 6, 7, is from the vicinity of Philadelphia, and supposed to be the plant referred to. The oogonia are not only tri- but often MULTISPORA.

Diameter veg. cells, 12–15 μ; 2–3 times longer.
Diameter oogon., 45–50 μ by 45–50 μ.
Diameter oospor., 42–47 μ by 42–47 μ.
Diameter sperm. cells, 11–13 μ by 40–50 μ.

Plate LXXX, figs. 6, 7.

B.—Species with dwarf males bi-multicellular, spermogonia external.

A.—Oospores with smooth membrane.

a.—Oospores globose or subglobose.

OEDOGONIUM FLAVESCENS, (Hass.) Wittr.

Idio-androsporous, oogonia single, egg-shaped-globose or hexagonally globose, opening by a pore in the middle or a little above the middle, oospore globose, not filling the oogonium; androsporangia 1–9 celled; dwarf males slightly curved, seated on the supporting cell; spermogonia usually one-celled.

Diameter veg. cell, 18–21 μ; $4\frac{1}{2}$–6 times longer.
Diameter oogon., 49–52 μ by 51–60 μ.
Diameter oospor., 45–49 μ by 45–49 μ.
Diameter androsp. cell, 17–20 μ by 8–18 μ.
Diameter stipe dwarf male, 11–12 μ by 39–45 μ.
Diameter sperm. cell, 9–10 μ by 15–20 μ.

Syn. *Vesiculifera flavescens*, Hass.

Minnesota, near Minneapolis.

Plate LXXVIII, figs. 1, 2, filaments with oogonia, dwarf males, etc.

OEDOGONIUM IRREGULARE, Wittr.

Oogonia single, globose, opening by a pore above the middle, oospore filling the oogonium, dwarf males seated near or on the oogonia, spermogonia 2–4 celled, terminal cells attenuated.

Diameter veg. cells, 16–20 μ; 2½–4 times longer.
Diameter oogon., 37–45 μ by 36-43 μ.
Diameter oospor., 30–40 μ by 34-38 μ.
Diameter stipe dwarf males, 12–15 μ by 20–24 μ.
Diameter sperm. cells, 10-12 μ by 6–8 μ.

Marshes, Florida.

Plate LXXVIII, figs. 4, 5.

OEDOGONIUM BRAUNII, (Kg.) Pringsh.

Gynandrosporous; oogonia single, elliptic-globose, opens by pore in the middle; oospore globose, nearly filling the oogonium; androsporangia 1–2 celled; dwarf males somewhat curved, seated near the oogonium, usually on the supporting cell; spermogonia unicellular.

Diameter veg. cells, 13–15 μ; 2–4 times longer.
Diameter oogon., 30–33 μ by 33-36 μ.
Diameter oospor., 27–29 μ by 27–29 μ.
Diameter androspr. cells, 14–15 μ by 11–12 μ.
Diameter dwarf male, 7 μ by 15 μ.
Diameter sperm. cells, 5 μ by 9 μ.

Pennsylvania, New Jersey.

Plate LXXIX, figs. 6, 7.

OEDOGONIUM LUNDENSE, Wittr.

Oogonia 2–4 seriate or single, subglobose, opening by an operculum, fissure very narrow and indistinct; oospore globose, very nearly filling the oogonium; terminal cell obtuse; dwarf males seated on the oogonia, stipe curved; spermogonia one-celled.

Diameter veg. cells, 15–17 μ; 1¼–2½ times longer.
Diameter oogon., 32–34 μ by 34–35 μ.
Diameter oospor., 30–31 μ by 30–31 μ.
Diameter stipe dwarf males, 12 μ by 27–30 μ.
Diameter sperm. cells, 10 μ by 6–8 μ.

Marsh pools, Eastern Pennsylvania.

Plate LXXVII, figs. 9, 10.

Oedogonium macrandrium, Wittr.

Oogonia single or 2–3 seriate, egg-shaped or globose egg-shaped, opening by an operculum, fissure very narrow; oospore globose or egg-shaped globose, not filling the oogonium; terminal cells apiculate; dwarf males much curved, seated on the oogonium, stipes often 2–3 celled; spermogonia two or more, often seven-celled.

Diameter veg. cells, 15-16 μ; 3–5 times longer.
Diameter oogon., 36–40 μ by 43–54 μ.
Diameter oospor., 31–34 μ by 33–39 μ.
Diameter stipe dwarf males, 12 μ by 24–33 μ.
Diameter sperm. cells, 9 μ by 5–9 μ.

Marsh grounds, Eastern Pennsylvania.

Plate LXXXII, figs. 1, 2, 3.

Oedogonium crassiusculum, Wittr.

Idio-androsporous or gynandrosporous; oogonia single or binate; globose egg-shaped or nearly globose, opening by a pore above the middle; oospore ellipsoid-globose or obverse egg-shaped globose, membrane thick, nearly filling the oogonium; androsporangia 2–6 celled; dwarf males straightish, seated on or about the supporting cells; spermogonia 1–2 or more celled.

Diameter veg. cells, 27–30 μ; 3½–5 times longer.
Diameter oogon., 54–60 μ by 60–75 μ.
Diameter oospor., 51–57 μ by 52–63 μ.
Diameter androsp. cells, 26–28 μ by 10–18 μ.
Diameter stipe dwarf males, 13 μ by 60 μ.
Diameter sperm. cells, 7–9 μ.

Not infrequent; had good fruiting specimens from Pennsylvania, New Jersey and Minnesota, all idio-androsporous. No doubt widely distributed.

A specimen from Northern New Jersey presented an unusual appearance, an oogonium swarming in the space between the wall of the oogonium and the oospore with small spermatozoid-like cells, most numerous in the upper part of the oogonium, passing in and out through the pore. Their function was not evident; if spermatozoids, their number was extraordinary. In the course of 8–10 minutes they gradually disappeared.

Plate LXXVII, figs. 14, 15, 16, sections of filaments. Fig. 17, the oogonium referred to in the last lines.

b.—Oospores ellipsoid or egg-shaped.

OEDOGONIUM BORISIANUM, (LeCl.) Wittr.

Gynandrosporous; oogonia single, or in series of 2–4, obversely egg-shaped, opening by a pore above the middle; oospore obversely egg-shaped or subglobose, almost filling the oogonium; supporting cells swollen and usually curved; androsporangia 2–5 celled; terminal cells obtuse; dwarf males slightly curved, seated on the supporting cells; spermogonia cells single or twin. Very variable in size.

Diameter veg. cells, 15–33 μ; 3–5 times longer.
Diameter supporting cells, 31–40 μ; 2 times longer.
Diameter oogon., 45–50 μ by 60–75 μ.
Diameter oospor., 40-60 μ by 40–80 μ.
Diameter androsp. cells, 17–20 μ by 10–12 μ.
Diameter stipe dwarf male, 15–18 μ by 45-80 μ.
Diameter sperm. cells, 8–10 μ by 12–20 μ.

Syn. *Prolifera Borisiana*, LeCl.; *Oe. apophysatum*, A. Br.; *Oe. setigerum*, Vaup.; *Oe. mirabile*, Wood.

Dr. Wood says of this species (*mirabile*) that its oogonia have two pores of fecundation. But this statement, suggests Dr. Wittrock, is based on a misconception of facts as may be seen by Wood's own figures. No form of *Oedogonium* has more than one pore of fecundation on a single oogonium.

Frequent, and widely spread; very variable in size, but readily distinguished by the large and more or less bent, supporting cells. Have made several slight changes in the diagnosis of the European plant to adapt it to our forms.

Plate LXXVIII, fig. 6, an undeveloped oogonium; fig. 7, a smaller form; fig. 8, a large form; fig. 9, the more frequent form.

OEDOGONIUM CONCATENATUM, (Hass.) Wittr.

Gynandrosporous, oogonia 2–6 seriate, or single, egg-shaped or quadrangularly ellipsoid, opening by a pore above the middle; oospore nearly filling the oogonium; sporoderm delicately porose; supporting cell somewhat swollen; androsporangia 2–6 celled; terminal cell obtuse; dwarf males moderately curved, seated on the supporting cells; spermogonia two-celled.

Diameter veg. cells, 25–40 μ; 3–6 times longer.
Diameter oogon., 70–83 μ by 90–105 μ.
Diameter oospor., 65–76 μ by 85–95 μ.

Diameter androsp. cells, 26–28 μ by 30–36 μ.
Diameter stipe dwarf male, 20–25 μ by 55–75 μ.
Diameter sperm. cells, 10–12 μ by 22–25 μ.

Syn. *Vesiculifera concatenata*, Hass.; *Oe. apophysatum*, Pringsh.

Frequent in Pennsylvania, New Jersey and probably in every State.

Plate LXXIX, figs. 1, 2, filaments with oogonia, dwarf males, androsporangia, etc.; fig. 3, an outline of a series of quadrangularly ellipsoid oogonia.

Var. SETIGERUM, (Vaup.) Wolle.

A plant which bears a very close relation to *Oe. concatenatum* except that the terminal cell is not obtuse but bears a long seta.

Ponds, Northampton County, Pennsylvania.

Plate LXXIX, figs. 4 and 5, parts of two filaments showing the setae.

OEDOGONIUM SEXANGULARE, Cleve.

Gynandrosporuos; oogonia single, rarely twin, sexangular-ellipsoidal, open by a pore slightly above the middle; oospore nearly filling the oogonium; androsporangia 2–4 celled; dwarf males somewhat curved, seated on the supporting cells; spermogonium one-celled.

Diameter veg. cells, 9–16 μ; $3\frac{1}{2}$–7 times longer.
Diameter oogon., 29–32 μ by 33–38 μ.
Diameter oospor., 27–30 μ by 31–36 μ.
Diameter androsp. cells, 13–14 μ by 10–14 μ.
Diameter stipe dwarf male, 7–9 μ by 21–27 μ.
Diameter sperm. cells, 6–7 μ by 9–12 μ.

A widely distributed species.

Plate LXXIX, figs. 8, 9, a filament with oogonia, dwarf males and androsporangia.

OEDOGONIUM WOLLEANUM, Wittr.

Idio-androsporous; oogonia single, or 2–5, rarely ten, seriate, elliptic or oval; oospore oval, nearly filling the oogonium; more or less densely, longitudinally, costate; androsporangia 6–10 celled; dwarf males somewhat curved, seated on the supporting cells—spermogonia 1–4 celled; supporting cells somewhat tumid; oogonium often terminal.

Diameter veg. cells, 18–36 μ; 3–7 times longer.
Diameter supporting cells, 60–65 μ by 116–140 μ.
Diameter oogon., 68–80 μ by 78–92 μ.
Diameter oospor., 64–73 μ by 74–84 μ.
Diameter androsp. cells, 24–30 μ by 18–25 μ.
Diameter stipe dwarf males, 18–22 μ by 60–70 μ.
Diameter sperm. cells, 12–14 μ by 10–12 μ.

Very variable in size; widely distributed—Pennsylvania, New Jersey, Minnesota, Florida, etc. Specimens are preserved in Wittr. and Nord.'s series, Algæ Exsiccatæ, No. 107, Pennsylvania specimens; and No. 207, New Jersey specimens.

Plate LXXXII, figs. 1, 2, filaments of larger form; fig. 3, male plant; figs. 4, 5, filaments of smaller form.

Usually fringing rootlets along the shores of ponds, sticks and the like, but found also in quantity on the rocky shores of lakes in New Jersey.

Oedogonium acrosporum, D. By.

Idio-androsporous; oogonium single, rarely twin, always terminal, ellipsoid; opening by a small, apical deciduous operculum; oospore manifestly filling the oogonium, membrane longitudinally costate; supporting cell often swollen; terminal cell of sterile plants, obtuse; dwarf males curved, seated on the supporting cells, stem or stipe often bi-cellular, long; spermogonia 1–2-celled.

Diameter veg. cells, 10–14 μ; 2–7 times longer.
Diameter supporting cells, 15–18 μ by 2–3 times longer.
Diameter oogon., 30–35 μ by 45–51 μ.
Diameter dwarf males, inferior cell, 9–12 μ by 24–32 μ.
Diameter dwarf males, superior cell, 6–8 μ by 55–65 μ.
Diameter sperm. cells, 6–8 μ by 14–15 μ.

The above is Wittrock's description of the European plant. Our United States plants are not altogether identical. One form we may distinguish as

Var. Floridense, Wolle.

It is nearest the European form, but differs in having the filaments more slender, and cells proportionately much longer, nearly twice the length. The long dwarf males are characteristic; they are seated about the middle of the supporting cell and extend beyond the top of the oogonium.

Found it in tangled masses floating in a pool in Florida, near Winter Park; filaments a foot or more in length, almost devoid of chlorophyl; oospores and supporting cells vegetative green.

Diameter veg. cells, 7–8 μ; 5–11 times longer.

Diameter oogon., 33–35 μ by 45–50 μ.

Plate LXXXV, figs. 1, 2.

Var. BOREALE, Wolle.

Is the form common in Pennsylvania and New Jersey; it is short, more robust, articulations only 3–5 diameters, dwarf males short, with spermogonia one-celled.

Diameter veg. cells, 14–16 μ; 3–5 times longer.

Plate LXXIX, figs. 10, 11.

OEDOGONIUM OBTRUNCATUM, Wittr.

Oogonium single or more rarely twin, broadly elliptic or globose-ellipsoid, usually terminal, opens by an apical operculum; supporting cells the same as the vegetative cells. Oospore filling the oogonium.

Diameter veg. cells, 8–12 μ; 2–4 times longer.

Diameter oogon., 15–17 μ by 17–20.

Frequent in pools, parasitic on culms of water plants. Not quite identical with the India form described by Wittrock, but nearly related; may be considered a small form.

Plate LXXIX, figs. 12, 13.

OEDOGONIUM CILIATUM, (Hass.) Pringsh.

Gynandrosporous; oogonia 2–7 seriate or single, oval, opening by an operculum; oospore oval, nearly filling the oogonium; androsporangia 2–8 celled; terminal cell setiform; dwarf males curved, seated on the oogonium; spermogonia unicellular.

Diameter veg. cells, 12–20 μ; $2\frac{1}{2}$–5 times longer.

Diameter oogon., 40–45 μ by 52–70 μ.

Diameter oospor., 38–44 μ by 45–55 μ.

Diameter dwarf males, 10–15 μ by 28–30 μ.

Marsh pool, Atsion, New Jersey. Not quite the same as the European form but near it.

Syn. *Vesiculifera ciliata*, Hass; *Oe. piliferum*, Auers.

Plate LXXXIV, fig. 10, a filament (fem.) in fruit.

OEDOGONIUM HUNTII, Wood.

Filaments mostly produced into a long apical seta; oogonia mostly single, globose, now and then hexagonal; somewhat tumid in the middle; the lateral pore placed below the middle; oospore globose, not filling the cavity of the spore-case, its surface with four spiral elevated lines or ridges; antheridia bi-cellular (sometimes tri-cellular.) Diameter oospore, 50 μ.

F. W. Algæ of U. S., Wood, p. 198. Hitherto have not identified any plant answering this description.

Plate LXXXIV, fig. 9.

3.—*Membranes of oospores echinulate.*

a.—Oospores globose.

OEDOGONIUM STELLATUM, Wittr.

Gynandrosporous; oogonia single or 2–3 seriate, oboviform globose, opening by a pore above the middle; oospore globose, nearly filling the oogonium, spinulose, spines conical, spirally disposed; androsporangia 1–2 celled; terminal cell somewhat slender and subhyaline, apex obtuse; dwarf males rather straight, usually seated on the supporting cell, sometimes scattered; spermogonia bi-cellular.

Diameter veg. cells, 15–35 μ; $2\frac{1}{2}$–5 times longer.
Diameter oogon., 51–61 μ by 58–70 μ.
Diameter oospor., with spines, 50–58 μ by 50–58 μ.
Diameter androsp. cells, 14–19 μ by 20–27 μ.
Diameter stipe dwarf male, 11–13 μ by 45–52 μ.
Diameter sperm. cells, 6–9 μ by 8–10 μ.

Frequent in Florida waters.

Plate LXXXIV, figs. 1, 2, two filaments.

OEDOGONIUM DONNELLII, Wolle.

Idio-androsporous; oogonia single, rarely twin, quadrangularly globose; oospore globose, echinulate, spines conical, nearly filling the oogonium; androsporangia 4–10 celled; dwarf males somewhat curved, stipe two-celled, spermogonia two or more celled. Male plants moderately smaller than female.

Diameter veg. cells, 55–62 μ; 1–2 times as long.
Diameter oogon., 70–75 μ by 85–95 μ.

Diameter oospor. with echinæ, 70–75 μ by 70–75 μ.
Diameter androsp., 40–45 μ by 10–12 μ.
Diameter dwarf males, 15–18 μ by 80–90 μ.
Diameter sperm. cells, 10–12 μ 5–6 μ.

Coll. Capt. J. Donnell Smith; v. Bull. Torrey Bot. Club, 1879, p. 48. A very distinct species.

Plate LXXXIV, figs. 3, 4, female filaments with oospores and dwarf males; fig. 5, male plant with androsporangia.

OEDOGONIUM ECHINOSPERMUM, A. Br.

Gynandrosporous or idio-androsporous; oogonium single, ellipsoid globose or subglobose, opening by a pore in the middle; oospore globose, coated with subulate spines, filling the oogonium; androsporangia 2–5 celled; dwarf males rather short, curved, seated on the supporting cell; spermogonia unicellular.

Diameter veg. cells, 18–30 μ; $2\frac{1}{4}$–$4\frac{1}{2}$ times longer.
Diameter oogon., 40–50 μ by 42–57 μ.
Diameter oospor., 38–47 μ by 38–49 μ.
Diameter androsp. cells, 21–25 μ by 9–15 μ.
Diameter dwarf males, 10–12 μ by 30–35 μ.
Diameter sperm. cells, 8–10 μ by 8–10 μ.

Frequent in Pennsylvania, New York, New Jersey and probably everywhere east of the Rocky Mountains. A distinct form from Florida may be noted as

Var. SPERMOGONIA MULTICELLULARIA, Wolle.

Excels the ordinary form in fine development, larger size, densely spinulose oospores and most prominent, the many celled spermogonia.

Plate LXXXIV, fig. 7, the ordinary form.
Plate LXXXV, figs. 6–9, the new variety from Florida.

OEDOGONIUM ECHINATUM, Wood.

Gynandrous, very elongate; joints 6–14 times longer than broad; sporangia globose, mostly depressed, about 35 μ diameter; oospores of the same form as the sporangia whose cavity they fill, covered with sharp spines; the lateral pore placed above the middle; antheridia bi-cellular.

Dr. Wood remarks, "I found this distinct species in a little stagnant pool, in Centre County, Pa. The filaments are very long and were matted together into a sort of fibrous mass. The male plants (dwarf males) were few in number and were attached to the female plant in the neighborhood of the sporangia. The spines are thorn-like, sharp at the points, but robust at the base." Wood, Fresh-Water Algæ of the United States, p. 198. With the exception of the lateral pore *above* the middle, this plant might be identified as *Oe. Aster*, Wittr.

Plate LXXXV, figs. 13, 14.

b.—Oospores ellipsoid.

OEDOGONIUM HYSTRIX, Wittr.

Gynandrosporous or idio-androsporous; oogonia single, ellipsoid to globose ellipsoid, opening by a pore in the middle; oospore same form as oogonium, nearly filling it, coated with subulate spines; androsporangia 2–3 celled; terminal cell obtuse, dwarf male stipe 2-celled, moderately curved, seated on the supporting cell; spermogonium one-celled.

Diameter veg. cells, 17–28 μ; $2\frac{1}{2}$–$4\frac{1}{2}$ times longer.
Diameter oogon., 38–44 μ by 45–65 μ.
Diameter oospor. with spines, 37–42 μ by 43–55 μ.
Diameter androsp. cells, 17–18 μ by 13–18 μ.
Diameter dwarf males, 10–11 μ by 50–65 μ.
Diameter sperm. cells, 7–8 μ by 10–14 μ.

Eastern Pennsylvania.

Plate LXXXIV, fig. 8.

SUBSECTION II.—DIŒCIOUS, WITH ELONGATED MALE PLANTS; MACRANDROUS.

c.—Oogonia not, or scarcely swollen.

OEDOGONIUM CAPILLARE, (Linn.) Kg.

Oogonia simple, not swollen, cylindrical, opening by a pore above the middle; oospore globose or cylindrical-globose (somewhat quadrangular in longitudinal section) not filling the oogonium; male plants the same or almost the thickness of the female plants; spermogonia 1–4 celled, alternate with vegetative cells; spermatozoids binate.

Diameter veg. cells, 25–55 μ; 1–2 times longer.
Diameter oogon. 25–55 μ by $1\frac{1}{2}$ times longer.
Diameter oospor. 22–52 μ by 38–62 μ.
Diameter sperm. cells, 24–48 μ by 5–6 μ.

Syn. *Conferva capillaris*, Linn; *Oe. regulare*, Vaup.

One of our most common forms, at the same time one rarest in fruit. Variable in size from 25–50 μ in diameter; filaments often a yard or more in length.

Plate LXXXIII, figs. 7, 8, female and male plant.

OEDOGONIUM STAGNALE, Kg.

Oogonium single, slightly tumid, subcylindrical, opens by a pore above the middle; oospore subcylindrical or globose-ellipsoidal, sometimes slightly constricted in the middle, nearly filling the oogonium; masculine plant slightly less in diameter than the female; spermogonia 1–3 celled, alternating with vegetative cells.

Diameter veg. cells, 42–46 μ; $1\frac{1}{2}$–2 times longer.
Diameter oogon., 49–50 μ by 65–75 μ.
Diameter oospor., 47–49 μ by 50–66 μ.
Diameter sperm. cells, 36–38 μ by 7–9 μ.

Very near *Oe. capillare*, barely separable except by the somewhat swollen oogonia.

Plate LXXXIII, figs. 3, 4, two filaments of female plant; fig. 5, male plant; fig. 6, a cell in a neutral plant, the chlorophylous contents broken up into small spherical motile cells (gonidia) which are passing out by an aperture in the side.

d.—Oogonia manifestly swollen.

1.—*Oospores globose or subglobose.*

OEDOGONIUM CAPILLIFORME, Kg.

Oogonia single, obversely egg-shaped, opens by a pore above the middle; oospore subellipsoid, globose or cylindrical-globose, not filling the oogonium; male plant slightly smaller than female; spermogonia 2–10 celled; terminal cell obtuse.

Diameter veg. cells, 32–38 μ; $1\frac{1}{4}$–3 times longer.
Diameter oogon., 42–48 μ by 51–62 μ.
Diameter oospor. 37–45 μ by 40–50 μ.
Diameter sperm. cells, 20–25 μ by 8–10 μ.

Stagnant waters.

Plate LXXV, figs. 11, 13, filaments of female plants; fig. 12, male plant with spermogonia cells.

OEDOGONIUM PACHYANDRIUM, Wittr.

Oogonia single or twin, moderately swollen, obovate-ellipsoid, opening by a pore above the middle; oospore ellipsoid nearly filling the oogonium; male plant slightly thicker than the female; spermogonia 1–4 celled; spermatozoids binate.

Diameter veg. cells, 31–36 μ; $2\frac{1}{2}$–$6\frac{1}{2}$ times longer.
Diameter oogon., 54–57 μ by 90–108 μ.
Diameter oospor., 51–54 μ by 73–85 μ.
Diameter sperm. cells, 35–43 μ by 11–20 μ.

Stagnant waters, railroad ditches, Pennsylvania, New Jersey, frequent.

Plate LXXV, fig. 9, female, and fig. 10, male plant.

OEDOGONIUM RUFESCENS, Wittr.

Oogonia single or 2–3 seriate, globose or obovate globose, opening by a pore in the middle; oospore globose filling the oogonium; male and female plants of same size; spermogonia 6–12 celled.

Diameter veg. cells, 8–10 μ; 5–6 times longer.
Diameter oogon., 22–24 μ by 24–30 μ.
Diameter oospor., 21–23 μ by 20–22 μ.
Diameter sperm. cells, 6–8 μ by 8–12 μ.

Plate LXXXI, figs. 16, 17, male and female plants.

OEDOGONIUM FRANKLINIANUM, Wittr.

Diœcious, macrandrous; oogonia single or rarely twin, subglobose, opening by a pore above the middle; oospore globose filling the oogonium, membrane firm; filaments of male plant slightly smaller than the female.

Diameter veg. cells, fem., 9–12 μ; 3–6 times longer.
Diameter veg. cells, mas., 8–9 μ; 3–5 times longer.
Diameter oogon., 26–31 μ by 29–41 μ.
Diameter oospor., 25–29 μ by 24–30 μ.
Diameter sperm. cells, 8–9 μ by 5–7 μ.

This species from pond, Franklin, New Jersey, stands between *Oe. rufescens*, Wittr., and *Oe. Lundellii*, Wittr.

Plate LXXXII, figs. 7, 8, two female plants; fig. 9, male plant. V. specimens, Wittrock and Nordstedt's Algæ Exsiccatæ, No. 309.

OEDOGONIUM CARDIACUM, (Hass.) Wittr.

Oogonia single, between heart-shaped and globose, opening by a pore a little above the middle; oospores globose, not filling the oogonia; male plants a little slenderer than the female; spermogonia 2–10 celled; spermatozoids binate, terminal cells obtuse.

Diameter veg. cells, fem., 18–30 μ; 2–7 times longer.
Diameter veg. cells, mas., 15–25 μ; 2–6 times longer.
Diameter oogon., 50–70 μ by 58–85 μ.
Diameter oospor., 42–60 μ by 42–60 μ.
Diameter sperm. cells, 15–21 μ by 10–13 μ.

Syn. *Oe. inequalis*, Wood; *Oe. pulchellum*, Rab.

In pools near Philadelphia, Pa. The description by Wood is imperfect, nevertheless the plant appears to belong to this species.

OEDOGONIUM CARBONICUM, Wittr.

Oogonia single or twin, obovate, or ovate globose, opening by a pore above the middle; oospores ellipsoid-globose or nearly globose, barely filling the oogonium; male plants a little more slender than the female; spermogonia 2–5 celled; spermatozoids binate; terminal cells obtuse.

Diameter veg. cells, fem., 16–30 μ; 3–6 times longer.
Diameter veg. cells, mas., 14–16 μ; 3–6 times longer.
Diameter oogon., 43–52 μ by 50–72 μ.
Diameter oospor., 42–50 μ by 46–56 μ.
Diameter sperm. cells, 13–14 μ by 12–14 μ.

The only specimens of this species identified were collected in Iowa.

Plate LXXXII, figs. 14, 15, male and female plants.

OEDOGONIUM PRINGSHEIMII, Cram.

Oogonia single or 2–6 seriate, sub-obovate-globose, opening by an operculum, with a very narrow fissure; oospore globose, not distinctly filling the oogonium; male plants somewhat smaller than the female; spermogonia 2–10 celled, often alternate with vegetative cells towards the ends of filaments; terminal cells obtuse or shortly apiculate.

Diameter veg. cells, 12–20 μ; 2–4 times longer.
Diameter oogon., 30–43 μ by 36–45 μ.
Diameter oospor., 28–35 μ by 28–34 μ.
Diameter sperm. cells, 10–15 μ by 6–9 μ.

Syn. *Oe. Nordstedtii*, Wittr.

Plate LXXXII, figs. 4, 5, two male filaments; fig. 6, female plant.

Pennsylvania, New York, Florida, and probably every State.

OEDOGONIUM PUNCTATO-STRIATUM, D. By.

Oogonia single, depressed-globose, manifestly splitting round in the middle, opening by a pore in the fissure; oospore depressed-globose, nearly filling the oogonium; male plant slightly more slender than the female; spermogonia 3–7 celled, spermatozoids single; membrane of the vegetative cells and of the oogonia spirally punctate.

Diameter veg. cells, fem., 18–22 μ; 2–6 times longer.
Diameter veg. cells, mas., 16–19 μ.
Diameter oogon., 48–55 μ by 38–48 μ.
Diameter oospor., 44–51 μ by 35–43 μ.
Diameter sperm. cells, 16–18 μ by 6–10 μ.

Only specimens hitherto identified in the United States, from Winter Park, Florida, 1885. Frequent there.

Plate LXXXV, figs. 3, 4, 5, two female and a male plant.

2.—*Oospores ellipsoid or oval.*

OEDOGONIUM BOSCII, (Le Cl.) Wittr.

Oogonia single or rarely twin, oblong-ellipsoidal, opening by a pore above the middle; oospore ellipsoidal, by no means filling the oogonium; longitudinally costate; male and female plants nearly the same thickness; spermogonia 3–6 celled; spermatozoids binate; terminal cell slender and somewhat hyaline.

Diameter veg. cells, 12–20 μ; 4–6 times longer.
Diameter oogon., 40–45 μ by 80–100 μ.
Diameter oospor., 36–40 μ by 60–65 μ.
Diameter sperm. cells, 13–14 μ by 6–9 μ.

Pennsylvania, New York, New Jersey, etc.

Plate LXXXII, figs. 11, male; 12, 13, female plants.

OEDOGONIUM LANDSBOROUGHII, (Hass.) Wittr.

Oogonia single or twin, obovate, opening by a pore above the middle; oospore obovate, usually filling the oogonium;

male plant slightly thinner than female; spermogonia 5–25 celled; spermatozoids binate, terminal cell obtuse.

Diameter veg. cells, fem., 33–36 μ; 4–6 times longer.
Diameter veg. cells, mas., 21–33 μ.
Diameter oogon., 63–75 μ by 105–120 μ.
Diameter oospor., 59–70 μ by 75–102 μ.
Diameter sperm. cells, 27–30 μ by 9–12 μ.

Syn. *Vesiculifera Landsboroughi*, Hass.; *Oe. gemelliparum*, Hantzsch.

Pond, near Elmira, New York.

Plate LXXXI, figs. 8–11, two female and two male plants.

OEDOGONIUM RIVULARE, (LeCl.) A. Br.

Oogonia single or 2–7 seriate, obovate, opening by a pore above the middle; oospore obovate, rarely ellipsoidal or subglobose; very much smaller than the cavity of the oogonium; the male somewhat smaller than the female plant; spermogonia 3–9 celled; spermatozoids binate.

Diameter veg. cells, fem., 35–45 μ; 3–7 times longer.
Diameter veg. cells, mas., 30–36 μ; 4 times longer.
Diameter oogon., 70–85 μ by 130–160 μ.
Diameter oospor., 55–65 μ by 65–100 μ.
Diameter sperm. cells, 21–28 μ by 14–16 μ.

Syn. *Prolifera rivulare*, LeCl.

Florida, Iowa.

Plate LXXXIII, figs. 1, 2, female and male plants.

Var. MAJOR, Wolle.

Oogonia single, or in series of 2–3, broadly elliptic or oval, opening by a pore above the middle; oospore oval, nearly filling the oogonium.

Diameter veg. cells, 55–70 μ; 2–5 times longer.
Diameter oogon., 90–100 μ by 130–150 μ.
Diameter oospor., 70–75 μ by 120–125 μ.

The largest of our *Oedogoniums*, unlike the typical form; not in matured fruiting condition; occurring frequently in waters of Florida. Seems nearest to *Oe. rivulare.*

Plate LXXVI, figs. 7, 8; Plate LXXXIII, fig. 9, probably belongs to the same variety.

SECTION III.—SPECIES OF WHICH THE ORGANS OF FRUCTIFICATION ARE IMPERFECTLY KNOWN.

a.—Oospores globose or subglobose.

OEDOGONIUM DELICATULUM, Kg.

Oogonia single, subglobose, inflated, ends somewhat drawn out, or extended, oospore perfectly globose; usually affixed by a discoid base.

Diameter veg. cells, 5–6 μ; 3–4 times longer.
Diameter oogon., 17–18 μ by 20 μ.
Diameter oospor., 12–14 μ by 12–14 μ.

Often parasitic on larger forms of *Oedogonia*.

Plate LXXXI, figs. 12, 13.

OEDOGONIUM MONILIFORME, Wittr.

Oogonium single or 2–5 seriate, subglobose, or obovate-globose, opening by pore above the middle; oospore globose or obovate-globose, nearly filling the oogonium, membrane of oospore thick and often indistinctly verrucose.

Diameter veg. cells, 9–11 μ; 3–5 times longer.
Diameter oogon., 24–28 μ by 28–35 μ.

Stagnant waters, not frequent.

Plate LXXXI, figs. 14, 15.

OEDOGONIUM FONTICOLA, A. Br.

Oogonium single, rarely twin, globose-obovate, opens by pore above the middle; vegetative cells often very variable in length and in breadth in different parts of the same filament; usually a deep-green.

Diameter veg. cells, 16–38 μ; 12–15 μ long.
Diameter oogon., 36–40 μ by 44–45 μ.

Frequent in stagnant or sluggish waters, also in spring water. The largest form figured was found fringing a basin hewn in slate rock for cold spring water.

Plate LXXV, figs. 4, 5, 6.

OEDOGONIUM PRINCEPS, (Hass.) Wittr.

Oogonia single, subobovate-globose, opening by a pore above the middle; oospore globose, not quite filling the oogonium.

Diameter veg. cells, 37–45 μ; 1¼–2¼ times longer.
Diameter oogon., 61–75 μ by 68–80 μ.
Diameter oospor., 58–66 μ by 60–65 μ.

Minnesota, near Minneapolis.

Plate LXXVIII, fig. 3.

OEDOGONIUM LONDIENSE, Wittr.

Monœcious? oogonia single or twin, globose, cut round in the middle, opening by a pore seated in the fissure; oospore globose, almost filling the oogonium; spermogonia, or androsporangia, 1–2 celled, hypogynous.

Diameter veg. cells, 10–15 μ; 1½–5 times longer.
Diameter oogon., 33–35 μ by 33–43 μ.
Diameter oospor., 27–32 μ by 26–32 μ.
Diameter sperm. cells, 26–27 μ by 27–29 μ.

Plate LXXV, figs. 7, 8, fruiting filaments found in New Jersey.

OEDOGONIUM HEXAGONUM, Kg.

Oogonia almost globose, inclining to hexagonal; oospore globose, rufous-brown not filling the oogonium; terminal cell obtuse or sometimes setigerous.

Diameter veg. cells, 11–13 μ; 2–4 times longer.
Diameter oogon. 24–25 μ by 26–28 μ.
Diameter oospor. 16–18 by 16–18 μ.

Syn. *Vesiculifera hexagona*, Hass.

Occasionally intermingled with other species.

Plate LXXXI, figs. 18, 19.

b.—Oospores ellipsoid or oval.

OEDOGONIUM GIGANTEUM, Kg.

Oogonia single, somewhat tumid, cylindrical-obovate, opening by a pore above the middle; oospore cylindric-ellipsoid or broadly obovate, nearly filling the oogonium (sometimes flask-shaped, short-necked,) epispore delicately scrobiculate; supporting cell somewhat swollen.

Diameter veg. cells, 30–42 μ; 2–4 times longer.
Diameter oogon., 57–69 μ by 78–106 μ.
Diameter oospor., 54–65 μ by 75–103 μ.

A form very nearly related to *Oe. capilliforme*, Kg., and may be a mere variety of that species.

Plate LXXVI, figs. 4, 5, 6.

OEDOGONIUM GRANDE, Kg.

Oogonia oval, elliptic, considerably longer than wide; oospores oval, elliptic, filling the oogonia; terminal cell obtuse.

Diameter veg. cells, 25–30 μ; 3–5 times longer.
Diameter oogon., 50–55 μ by 75–80 μ.
Diameter oospor., 45–50 μ by 68–72 μ.

Meadow pools, Pennsylvania.

Plate LXXVI, fig. 1, filament with oogonium, and two zoospores having passed out through a fissure in the side of cell, remaining attached.

OEDOGONIUM PYRIFORME, Wittr.

Monœcious, oogonium single, pear-shaped; spermogonia 2–3 celled, subepigynous or hypogynous.

Diameter veg. cells, 13–14 μ; $3\frac{1}{2}$–6 times longer.
Diameter oogon., 40–42 μ by 54–60 μ.
Diameter oospor., 35–36 μ by 45–48 μ.
Diameter sperm. cells, 10–12 μ by 5–6 μ.

Branchville, New Jersey.

Plate LXXVII, figs. 11, 12, 13, filaments with oogonia and spermogonia.

OEDOGONIUM LONGATUM, Kg.

Oogonia single (often solitary, terminal) rarely 2–3 continuous, ellipsoid, opening by an operculum, with a narrow fissure; oospores globosely-ellipsoid, scarcely filling the oogonia; terminal cell obtuse.

Diameter veg. cells, 5–6 μ; 2–3 times longer.
Diameter oogon., 16–17 μ by 21–24 μ.
Diameter oospor., 15–16 μ by 17–19 μ.

Stagnant waters, far and near.

Plate LXXV, fig. 3, four short filaments.

Genus 11, BULBOCHAETE, Ag.

Filamentous plants, much branched; terminal articulations, and almost all others thickened upward and bearing at or near the apex a long, thin, hyaline seta, bulbous at the base; cell membrane often punctate; reproduction sexual as in *Oedogonium;* oogonia opening by a lateral pore above the middle. Nearly all of our species are diœcious.

The following arrangement of our United States species is near in accord with Prof. Wittrock's suggestion.

BULBOCHAETE.

SECTION I.—OOGONIA GLOBOSE OR SUBGLOBOSE, PATENT.

OOSPORES THE SAME FORM AND FILLING THE OOGONIA. DIŒCIOUS.

A.—Dwarf males unicellular.

B. elachistandra, *Wittr.*

B.—Dwarf males bicellular.

a.—Basal cell of the dwarf males shorter than the spermogonia.

B. intermedia, *D.By.*
B. crenulata, *Pringsh.*
B. polyandra, *Cleve.*
B. setigera, (*Roth.*) *Ag.*
B. Brebissonii, *Kg.*

b.—Basal cell of the dwarf males longer than the spermogonia.

B. gigantea, *Pringsh.*

SECTION II.—OOGONIA ELLIPSOID OR SUBELLIPSOID.

OOSPORES OF THE SAME FORM, FILLING THE OOGONIA; EPISPORE LONGITUDINALLY COSTATE; COSTÆ MORE OR LESS CRENULATE.

SUBSECTION I.—SPECIES MONŒCIOUS.

B. mirabilis, *Wittr.*
B. nana, *Wittr.*

SUBSECTION II.—SPECIES DIŒCIOUS.

A.—Dissepiment of supporting cells obsolete.

B. pigmaea, (*Pringsh.*) *Wittr.*

B.—Dissepiment of supporting cells present.

B. insignis, *Pringsh.*
B. minor, *A. Br.*
B. subsimplex, *Wittr.*
B. repanda, *Wittr.*
B. rectangularis, *Wittr.*
B. rhadinospora, *Wittr.*

SECTION I.—OOGONIA GLOBOSE OR SUBGLOBOSE.

A.—Dwarf males unicellular.

BULBOCHAETE ELACHISTANDRA, Wittr.

Oogonia globose, beneath the androsporangia; dissepiment of the supporting cell about the middle; epispore smooth; androsporangia above the oogonia, or scattered; dwarf males very small, obovate, extending downward to a thin point, nearly straight, seated on, or near the oogonia.

Diameter veg. cells, 15–20 μ; $1\frac{1}{2}$–$2\frac{1}{2}$ times longer.
Diameter androsp., 12–14 μ by 10–12 μ.
Diameter oogon., 40–45 μ by 40–45 μ.
Plate LXXXVI, fig. 5.

B.—Dwarf males bicellular.

a.—Basal part (stem or stipe) shorter than the spermogonia cells.

BULBOCHAETE INTERMEDIA, D.By.

Oogonia subdepressedly globose, seated under the androsporangia; dissepiment of the supporting cell in the middle; epispore delicately crenulate (rarely smooth); androsporangia 1–2 celled, epigynous, rarely scattered; dwarf males seated on the oogonia, stems slightly curved.

Diameter veg. cells, 16–19 μ; $1\frac{1}{2}$–3 times longer.
Diameter androsp., 13 μ by 10 μ.
Diameter oogon., 40–48 μ by 31–40 μ.
Diameter dwarf males, 9–10 μ by 24–30 μ.

Common in ponds and sluggish waters; varies considerably in diameter of filaments, length of cells, etc.

Plate LXXXVI, figs. 1, 2, 3, three forms.

BULBOCHAETE CRENULATA, Pringsh.

Oogonia depressedly globose, seated beneath terminal setae, rarely beneath androsporangia or vegetative cells. Dissepiment of supporting cell in the middle or slightly below it; epispore distinctly crenulate; androsporangia scattered, rarely epigynous; dwarf males seated on or near the oogonia, stems nearly straight.

Diameter veg. cells, 16–19 μ; 2–$3\frac{1}{2}$ times longer.
Diameter androsp., 12 μ by 10 μ.
Diameter oogon., 45–48 μ by 35–38 μ.
Diameter dwarf males, 9 μ by 26 μ.

Pennsylvania, New Jersey and probably in every State.

Plate LXXXVI, fig. 4.

BULBOCHAETE POLYANDRA, Cleve.

Idio-androsporous; oogonia somewhat depressedly globose, seated beneath a terminal seta or a vegetative cell; dissepiment of supporting cell usually much above the middle; epispore delicately crenulate or nearly smooth; androsporangia 4–10 celled; dwarf males seated on the oogonia, stem curved.

Diameter veg. cells, 15–20 μ; 3–6 times longer.
Diameter oogon., 36–46 μ by 32–38 μ.
Diameter androsp. cells, 13–14 μ by 12–15 μ.
Diameter dwarf males, 8–9 μ by 20–23 μ.

Culms, margins of lakes, Florida, often full of this species; did not identify it farther north.

Plate LXXXIX, figs. 6, 7, female and male plants; 8, 9, the androsporangia.

BULBOCHAETE SETIGERA, (Roth.) Ag.

Oogonium depressedly subquadrangularly globose, seated beneath a terminal seta, or beneath an androsporangium; membrane of the oogonium thickened after fertilization, dissepiment of the supporting cell a little above the middle or at the middle; epispore granulated; androsporangia scattered or epigynous, bicellular; dwarf males seated upon or about the oogonia, stems straight.

Diameter veg. cells, 25–28 μ; $2\frac{1}{2}$–5 times longer.
Diameter androsp., 18–20 μ by 14–18 μ.
Diameter oogon., 75–80 μ by 60–65 μ.
Diameter dwarf males, 12–14 μ by 34–36 μ.

Syn. *B. Canbyii*, Wood.

Cannot find sufficient distinction in this form described in Wood's Contribution, p. 202, to separate it from the European *B. setigera*. It bears also a resemblance to *B. sessilis*, Wittr.

Not infrequent in New Jersey, Florida, South Carolina. A peculiar form probably of this species found in quantity fringing willow rootlets, sticks and the like in pond, at Hammonton, New Jersey, August, 1879. It was destitute of fruit; no oogonia, instead the plants were numerously furnished with distinct, sessile, oval, pod-like cells dehiscing at the top, making a lid (operculum) which opens, and soon a zoospore escapes.

Plate LXXXVI, figs. 6 and 7 represent this form; figs. 8–11, zoosporangia, and zoospores in different stages of exit.

Plate LXXXIX, fig. 1, a specimen from New Jersey pine barrens; figs. 2, 3, var. *Canbyii*, Wood.

BULBOCHAETE BREBISSONII, Kg.

Oogonia obcordiform-globose; truncate below, erect, seated beneath terminal setae or androsporangia; dissepiment of supporting cell low; epispore delicately crenulate; androsporangia 2–3 celled, scattered or epigynous; dwarf males seated on the oogonium or more rarely near it; stems straight, or nearly so.

Diameter veg. cells, 17–20 μ; 3–4½ times longer.
Diameter oogon., 42–50 μ by 37–45 μ.
Diameter dwarf males, 10–12 μ by 28–33 μ.

A plant found in pond, Hammonton, New Jersey, is referred, with some hesitation, to this European species; it is not strictly identical, but nearer it than any other species. Fresh specimens are desirable for more definite determination.

Plate LXXXVIII, fig. 1, a filament with oogonia, and dwarf males.

b.—Basal cell of stem of dwarf males longer than the spermogonia.

BULBOCHAETE GIGANTEA, Pringsh.

Idio-androsporous? oogonia rather depressed obcordate-globose, seated beneath terminal setae, rarely beneath vegetative cells; dissepiment of supporting cell at or a little above the middle; epispore verrucose; dwarf males a little longer than the oogonium and seated upon it; stem twice as long as the spermogonium, arcuate.

Diameter veg. cells, 24–27 μ; 2–3 times longer.
Diameter oogon., 62–66 μ by 51–58 μ.
Diameter dwarf male stem, 11–12 μ by 40–45 μ.
Diameter sperm. cells, 13–14 μ by 20–22 μ.

Sluggish river water, Pennsylvania.

Plate LXXXVII, fig. 1, branched filament with four oogonia and one dwarf male.

SECTION II.—OOGONIA ELLIPSOID OR SUBELLIPSOID.

OOSPORES OF SAME FORM AND FILLING THE OOGONIA; EPISPORE LONGITUDINALLY COSTATE; COSTÆ MORE OR LESS CRENULATE.

SUBSECTION I.—MONŒCIOUS.

BULBOCHAETE MIRABILIS, Wittr.

Oogonia ellipsoid or oblong-ellipsoid, patent or more rarely erect, seated beneath a terminal seta or vegetative cell (or androsporangium); spermogonia 2–4 celled, erect, rarely patent, subepigynous or scattered. Horizontal division of vegetative cells not infrequent.

Diameter veg. cells, 16–20 μ; $1\frac{1}{4}$–$1\frac{2}{3}$ times longer.
Diameter oogon., 27–35 μ by 46–56 μ.
Diameter sperm. cells, 10–12 μ by 7–9 μ.

Have illustrated two forms (Plate LXXXVII, figs. 2, 3), which I hesitatingly refer to this species, the former from Minnetonka Lake, Minn., and from ponds, New Jersey; the other (fig. 3) occurs now and then in ponds, New Jersey, always sterile, hence perhaps valueless, but too distinct to be entirely rejected.

BULBOCHAETE NANA, Wittr.

Oogonia ellipsoid, erect or patent, seated beneath terminal setae or beneath vegetative cells; spermogonia 1–2 celled, subepigynous or scattered.

Diameter veg. cells, 12–15 μ; 1–$1\frac{1}{4}$ times longer.
Diameter oogon., 20–25 μ by 33–36 μ.
Diameter sperm. cells, 8–9 μ by 6–9 μ.

Frequent in pond waters, New Jersey and elsewhere. Our plant is equally near to *B. Monile*, Wittr., and *B. nana*, Wittr. Have united the two and adapted the diagnosis.

Plate LXXXVII, fig. 6.

SUBSECTION II.—DIŒCIOUS.

A.—Dissepiment of supporting cells obsolete.

BULBOCHAETE PYGMAEA, (Pringsh.) Wittr.

Oogonia ellipsoid, patent, seated beneath a terminal seta or beneath a vegetative cell; in longitudinal section rather quadrangular; androsporangia scattered; dwarf males seated near the oogonia. Filaments often short and curved.

Diameter veg. cells, 12–15 μ; less than diameter in length.
Diameter oogon., 23–25 μ by 34–40 μ.
Diameter dwarf males, 11–12 μ by 15–18 μ.
Diameter sperm. cells, 7–8 by 7–8 μ.

Not rare.

Plate LXXXVII, fig. 4, a condition not infrequent. Have not seen a typical plant.

B.—Dissepiment of supporting cells present.

BULBOCHAETE INSIGNIS, Pringsh.

Oogonia ellipsoid, patent or erect, seated beneath the androsporangia or terminal setae; epispore delicately transversely striate; androsporangia epigynous or scattered; dwarf males seated on or near the oogonia.

Diameter veg. cells, 20–25 μ; $2\frac{1}{2}$–$4\frac{1}{2}$ times longer.
Diameter oogon., 46–60 μ by 70–100 μ.
Diameter androsp. cells, 16–20 μ by 20–25 μ.
Diameter dwarf male (stem), 17–19 μ by 29–31 μ.
Diameter sperm. cells, 10–11 μ by 7–8 μ.

Hopatcong and other lakes, New Jersey.

Syn. *B. speciosa*, Wittr.; *B. Pringsheimiana*, Arch.

Plate LXXXVIII, figs. 2, 3, branched filaments with oogonia, dwarf males, etc.

BULBOCHAETE MINOR, A. Br.

Oogonia somewhat oblong ellipsoid, erect or rarely patent, seated beneath terminal setae, androsporangia or vegetative cells; androsporangia epigynous or scattered; dwarf males located near an oogonium.

Diameter veg. cells, 20–25 μ; $1\frac{1}{2}$–3 times longer.
Diameter oogon., 33–42 μ by 60–69 μ.
Diameter androsp. cells, 14–16 μ by 17–21 μ.
Diameter dwarf males (stem), 13 μ by 22 μ.
Diameter sperm. cells, 6 μ by 7 μ.

Ponds, New Jersey.

Plate LXXXVII, fig. 7, a branched filament in fruit.

BULBOCHAETE SUBSIMPLEX, Wittr.

Oogonia ellipsoid, patent, beneath the androsporangia or terminal setae; androsporangia epigynous; dwarf males seated near the oogonia or on them; plants erect, branches often imperfectly developed.

Diameter veg. cells, 15–16 μ; 1–1½ times longer.
Diameter oogon., 26–28 μ by 39–42 μ.
Diameter androsp. cells, 11–12 μ by 12–16 μ.
Diameter dwarf males, 10–11 μ by 15 μ.
Diameter sperm. cells, 7 μ by 7 μ.

Syn. *B. pygmaea* var. *major*, Pringsh.; *B. dumosa*, Wood, is probably a form of this species or of *B. varians*, Wittr.
Pennsylvania.

Plate XC, fig. 5, a fertile plant.

BULBOCHAETE REPANDA, Wittr.

Oogonia somewhat oblong ellipsoid, patent or rarely erect, beneath vegetative cells or terminal setae or androsporangia; androsporangia epigynous; dwarf males on or near the oogonia.

Diameter veg. cells, 12–15 μ; 2–3½ times longer.
Diameter oogon., 26–30 μ by 45–58 μ.
Diameter androsp. cells, 11–14 μ by 16–21 μ.
Diameter dwarf males, 10–14 μ by 21–22 μ.
Diameter sperm. cells, 8–9 μ by 5–6 μ.
Lake Hopatcong, New Jersey.

Plate XC, fig. 4, a fully developed plant in fruit.

BULBOCHAETE RECTANGULARIS, Wittr.

Oogonia ellipsoidal, patent or rarely erect, beneath a terminal seta, or beneath an androsporangium cell, or a vegetative cell; androsporangia scattered or epigynous; vegetative cells somewhat quandrangular in longitudinal sections; horizontal division of vegetative cells often occurs. Branches few but often long; dwarf males seated about or upon the oogonia.

Diameter veg. cells, 16–23 μ; 1¼–2 times longer.
Diameter oogon., 33–39 μ by 48–55 μ.
Diameter androsp. cells, 15–16 μ by 16–27 μ.
Diameter dwarf males, 15–18 μ by 22–27 μ.
Diameter sperm. cells, 8–9 μ by 5–6½ μ.

A species which varies considerably in size and in the branching; filaments often long, almost devoid of branches; the dwarf males often scattered and spermogonia cells sometimes separated by septae which project, rib-like, beyond the walls of the spermogonia. *B. ignota*, Wood, is probably a form of this species.

Plate XC, figs. 1–3, two forms of this species.

BULBOCHAETE RHADINOSPORA, Wittr.

Oogonia oblong-ellipsoid, patent, beneath the androsporangia or the terminal setae; androsporangia epigynous; dwarf males near to or seated on the oogonia.

Diameter veg. cells, 10–13 μ (Wittr. 15–21); 1½–2 times longer.
Diameter oogon., 29–35 μ by 50–56 μ (Wittr. 64–80 μ).
Diameter androsp. cells, 13–15 μ by 16–23 μ.
Diameter dwarf males, 14–16 μ by 23–25 μ.
Diameter sperm. cells, 8 μ by 6–7 μ.

Specimens from Florida.

Plate LXXXIX, figs. 4, 5.

Family VII.—SPHAEROPLEACEÆ.

Filamentous, green, branchless and rootless; denizens of water and of the air; propagation in a manner sexual. The oogonia are formed by a spherical massing of the chlorophyl of a cell of a filament into one or many oospheres. In other filaments the chlorophyl separates into small bodies which change color from green to red, or yellowish red, producing spermatozoids; these escape through fissures in the walls, find their way to the oospheres and fructify them; when impregnated they also change color to red or reddish yellow; a thick membrane is formed around them; now resting spores, they lie dormant a long time before they germinate.

Genus 12, SPHAEROPLEA, Ag.

Filamentous, green, composed of long cells in which the chlorophylous contents are so distributed as to produce large vacuoles at regular intervals, each surrounded by annular bands enclosing 3 to 7 starch grains. All the vegetative cells develop sexual organs. The oospheres are green and numerous in a mother cell; after fertilization these become oospores clothed with 2 or 3 membranous envelopes; color changes from green to red. The exterior hyaline membrane is loose and beautifully plaited. The spermatozoids are developed in large numbers in separate cells; they are club-shaped with two ciliæ at the thinner end, color red. They pass out through fissures, enter the cells of the oospheres through pores in the wall of the cells, and fructify them.

SPHAEROPLEA ANNULINA, Ag.

Green, yellowish, brick-red or scarlet; cells 8–10–20 times as long as broad, with 20–30 chlorophylose rings in each cell; spores at length densely seriate, rarely disposed irregularly; at first green, afterwards olive-brown and then red.

Diameter veg. cells, 36–72 μ.
Diameter oospor., 17–36 μ.
Diameter spermat., 8–9 μ; long.
Diameter zoosp., 11.5–16 μ; long.

As far as my personal observations aid me, this genus has no representative in the United States. In Europe it appears frequent in quarries, pits and inundated fields. It is reported from California but without certain knowledge as to locality. The characters and figures are taken from European works.

Plate CXXIII, fig. 1, a filament with chlorophyl in rings; fig. 2, shows arrangement of mature (red) spores; fig. 3, a frequent appearance of filament previous to development of spermatozoids; fig. 4, escaped spermatozoids, highly magnified; fig. 5, zoogonidia.

Genus 13, CYLINDROCAPSA, Reinsch.

Filaments primarily attached; later floating; composed of a single series of cells; cells short, cylindrical, spherical or oblong, chlorophyl green, containing numerous starch grains; cell walls colorless. Oogonia are developed in the vegetative cells, each cell forming one spherical or ovate oogonium. Antheridia are formed in small cells which appear in pairs in the same filament with the oogonia and produce each two, somewhat elongated spermatozoids, each furnished with two ciliæ, by means of which they make their way to the oogonium and fertilize it, producing an oospore clothed with a twofold membranous envelope; these oospores sometimes multiply by direct division, dividing into four parts, each producing a young plant; or they may divide into two and these again into two, thus making four; each of these in turn producing four, thus developing sixteen young plants. These processes were observed repeatedly in the months of July and August. The same oospore may lie dormant through the Winter and develop the following Spring.

CYLINDROCAPSA GEMINELLA, Wolle.

Vegetative cells ellipsoidal, more or less elongated as they approach division; normally they are about one half longer than broad; largely in pairs, enclosed in a hyaline sheath. Oospores globose, with a wide hyaline envelope when matured.

Vegetative cells with sheath, 14–16 μ wide.

Oospores, 23–25 μ.

Envelopes about 50 μ.

Widely distributed, New York to Florida and Westward.

Plate XCI, figs. 1–17, from Pennsylvania specimens: fig. 1, vegetative filament; 2, 3, 4, filaments with cells in part developed into oospores; 5, 6, matured oospores; 7, oospore passing out of the envelope; 8, 9, antheridia; 10, 11, 12, oospore dividing and developing young plants; 13, 14, spore divided into two, and another into four; 15–17, a spore developing.

Cylindrocapsa amœna, Wolle.

Filaments long and tenacious, clear and pearly in appearance, particularly at the ends of the cells; chlorophyl rather light green; contracts, forming a macrospore in each cell, which rarely divides into two; articulations not formed by mere septae; each cell has its own walls; filaments not contracted at joints.

Diameter of filaments 7–12 μ, often 2–3 feet long. Articulations before division 2–3 times longer than broad. Macrospores 7–10 μ by 13 μ. Gelatinous tegument at maturity about twice the diameter of the vegetative cells.

A peculiar plant; has in appearance much in common with *Conferva amœna*, Kg., and also with *Ulothrix*, but the spore formation is more nearly related to *Cylindrocapsa*.

Plate XCI, fig. 18, a vegetative filament indicating the process of the cell division; fig. 19, chlorophyl gathering in center of cells; fig. 20, the same more decidedly concentrated; fig. 21, the condensed masses now develop into macrozoospores; fig. 22, more enlarged and showing signs of active life by a vibrating motion, and then breaking through the walls and escaping; they are provided with two ciliæ, and live a short but active life; coming to rest (fig. 23), the older break up into many small ciliated cells, microzoogonidia. This may seem a somewhat abnormal proceeding, nevertheless an actual observation; possibly a result of the drying up of the small pit.

Have not rediscovered the plant since May, 1880. The pools were examined year after year but without satisfactory result. The plant may need farther study.

SYNZOOSPOREÆ et ASEXUALES.

Sexual fertilization through the agency of spermatozoids and oospheres does not take place in plants under this head; cases of copulation between two zoospores occurs now and then; the product is a zygospore (*isospore* according to Rostafinski), which often lies dormant a long time before developing a young plant. The more frequent propagation is asexual by zoospores which are developed within the thallus, sometimes as *microzoospores* with two ciliæ, and sometimes as *macrozoospores* with four ciliæ.

Family VIII.—CONFERVACEÆ.

Chlorophylous green plants, usually filamentous, simple or branched; more rarely forming a membranaceous thallus of a single stratum.

Subsection A.—ULVACEÆ.

Membranaceous or foliaceous plants, rarely crustaceous, formed of a single layer or stratum of cells, expanded, plane or crisped, tubulose or vesiculose.

Genus 14, PRASIOLA, Ag.

Thallus at first filamentous, not unlike *Ulothrix*, then expanded, leaf-like, plane, smooth or crispate, composed of angular cells; base sometimes loosely fibrillose. Vegetation by division of the cells in two directions.

Prasiola crispa, Kg.

Tufts dark green, usually dense, soft and elastic; leaf-like thallus plicately crisped, of variable size and form, often bullate, 2–6 *mm* high and about the same breadth; cells oblong or quadrate arranged in distinct areolas, sometimes confluent, cells 4–6 μ diameter, often twice as long.

Have seen very few specimens. Had them from damp ground, rather foul places. In Europe the plant appears to occur frequently and often in patches widely expanded.

Syn. *Ulva crispa*, Hass.; *Ulva lactuca*, var. Huds.; *Ulva terrestris*, Gray.; *Prasiola Rothii.*; *P. orbicularis; P. Flotowii*, Kg.

Plate XCI, fig. 25, a frond, natural size; figs. 26, 27, two small portions of fronds with fibrillose margins, enlarged about 400 diameters.

PRASIOLA MEXICANA, Liebm.

Thallus 1–3 inches long and broad, margins lobately undulate; areolas distinctly seriate; cells somewhat quadrangular, angles rounded, 6–8 μ diameter, arranged in fours; bright vegetative green, attached to rocks in rapid stream.

The specimens examined were collected by T. S. Brandegee, in 1877, in a high mountain stream, 9,000 feet elevation, Colorado.

Plate XCI, fig. 24.

No doubt more forms of *Prasiola* will be identified as the country is more thoroughly explored. Compare notes under *Ulothrix Lenormandi.*

Thallus membranaceous, vesiculose or tubulose.

Genus 15, ENTEROMORPHA, Link.

Thallus membranaceous, tubular or utricle-shaped, fixed at the base when young, afterwards floating; composed of one stratum of cells, sometimes branched.

Propagation by zoogonidia produced by repeated division of the cytioplasm, rostrate at one extremity and furnished with two ciliæ.

ENTEROMORPHA INTESTINALIS, (Linn.) Link.

Pale or darker green, fronds simple, elongated; variable in size and form, usually becoming more or less inflated, obtusely rounded above, attenuated at the base. Cells of fronds 3–5–6 angled. Diameter of cells 12–20 μ.

Syn. *Tremula marina tubulosa*, Dill.; *Enter. spermatoidea*, Kg.; *Solenia intestinalis*, Jurg.; *Ulva intestinalis*, Linn.

In ditches, brackish water, near the sea coast. Western salt-water lakes. Salt Lake, Utah. It appears to grow indifferently in salt, and in fresh water.

Plate CXXV, fig. 9, a younger frond; fig. 10, specimen of arrangement of cells.

ENTEROMORPHA COMPRESSA, (Linn.) Grev.

Thallus compressed tubular; pale, herbaceous or darker green, usually simple filaments, sometimes branched; ends obtusely rounded and often inflated, tapering at the base. Fructification in the cells of the membrane of which the frond is composed.

Grows everywhere on the sea coast and in estuaries of tidal rivers. Filaments are not so irregularly inflated and constricted (intestine-like) as the preceding. Many varieties of these two species have been described, but being more of marine than fresh-water plants, they are omitted.

Subsection B.—CLADOPHORINÆ,

As a second subsection, are filamentous plants, articulate and branched; lower branches often assuming the character of rhizomes and the distal cells often terminating in a long hair-like point. The escape of microzoospores is frequently observed, but copulation has not been seen; thick-walled resting spores occur occasionally, but nothing is known of their origin or of their development.

Genus 16, DRAPARNALDIA, Ag.

Filamentous, articulate, much branched; the main stem comparatively thick, composed of large cells, mostly hyaline, with a broad chlorophylose transverse band, always sterile; more or less densely furnished with bright green penicellate, fasciculate branchlets, alternate or opposite, composed of smaller fertile cells. Terminal cells of the branchlets empty, hyaline, and often elongated into a bristle. The whole plant enveloped in a soft gelatinous covering; soft and slippery to the touch.

DRAPARNALDIA GLOMERATA, Ag.

Filaments and primary branches nearly colorless, lower articles about as long, or a little shorter than broad, more or less swollen; upper articles longer, for the most part hyaline with a light green, central, narrow, transverse, chlorophylose band; always sterile; primary branches spreading at nearly right angles; fascicles of branches obtuse, oval, crowded, alternate or opposite.

Syn. *Conferva mutabilis*, Dillw.; *Batrachospermum conglomeratum*, Vauch.

In clear streamlets, slow or rapid, attached to stones or water plants. Frequent and readily distinguished.

The following, among many varieties very closely related and running into one another, may be separated.

a.—*genuina*, Kirch. Diameter of stem about 35 μ; length, the same; primary branches close, clothed with crowded secondary branchlets.

b.—*remota*, Rab. Primary branches remote.

c.—*acuta*, Ag. Stems thicker, often 70 μ in diameter, articles 2–10 times longer.

d.—*gracillima*, Ag. Secondary branchlets rare.

e.—*maxima*, Wood. Stems attain diameter of 100 μ, articles much swollen, twice as long as wide.

Plate XCII, fig. 1, a main stem with branches; figs. 2, 3, part of a rhizome, and smaller stem with branches; 4, 5, 6, young, not fully developed stems; 7, 8, stems of branches producing zoospores; 9, ciliated zoospores; 10, 11, 12, progressive stages of development and growth of zoospores.

DRAPARNALDIA PLUMOSA, Ag.

Cells of the main stems very slightly or not at all swollen; the fasciculate branches somewhat lanceolate in outline, not so obtuse or oval as *D. glomerata;* beside these two rather unsatisfactory differences the two species can not be separated.

Found in similar localities.

Diameter of cells of main stems about 45 μ; $\frac{1}{2}$–$1\frac{1}{4}$ times as long.

Diameter of cells of lower branches, 10–11 μ; 1–2 times as long.

Syn. *D. hypnosa*, Bory.; *Batrachospermum plumosum*, Vauch.; *D. pulchella*, Kg.

Plate XCIV, figs. 1, 2, specimens of a rather robust form.

DRAPARNALDIA SPINOSA, Kg.

Articulations of stems average $1\frac{1}{2}$ diameters, ranging from $\frac{3}{4}$ to 1, rarely 2 diameters; sparsely branched; branches opposite, at right angles; fascicles somewhat triangular in outline; stems of branches short, thick at the base, rapidly tapering to an acute point or seta.

A distinct form, hitherto found only in one locality in the United States, in a streamlet issuing from a large, high mountain spring, Carbon County, Pennsylvania.

Diameter of cells of main stems, 45–75 μ; $\frac{3}{4}$–2 times as long.

Diameter of cells of branches, 20–25 μ.

Rabenhorst suggests the species of Kuetzing under this name approximating the European *D. gracillima*, Ag. Our form appears more distinct.

Plate XCIII, figs. 1–4, larger and smaller stems; figs. 5–8, branchlets of various sizes.

DRAPARNALDIA RAVENELII, Wolle.

Cells of filaments and primary branches hyaline, as long as wide, or shorter; constricted at the joints; matured plants furnished at every joint with 2, 3, sometimes 4, fasciculate branches spherical in outline; branchlets radiating, yellowish green color. Younger stems almost nude, only here and there a very small fascicle, barely as wide or less than the diameter of cells; apices of branchlets acute.

Diameter of cells of larger stems, 150–170 μ; $\frac{3}{4}$–1 diameter long.

Diameter of cells of smaller stems, 60–100 μ; 1–1$\frac{1}{4}$ diameter long.

Diameter of cells of branchlets of fascicles, 6–8 μ; $\frac{1}{2}$–2 diameters long.

A very large and distinct new species; the fascicles of branchlets short, radiately spreading, seldom exceeding the diameter of the filament to which they are attached; the central cells of the fascicles longer than broad, those of ends only half as long as broad and seem to be of a microsporangial character.

Collected by H. W. Ravenel, in sluggish water, July, 1881, at St. John's Berkley, South Carolina.

Plate XCV, parts of two stems and an arm, with the fascicles.

Genus 17, STIGEOCLONIUM, Kg.

Filaments articulate, simply branched; in size and general appearance the stems and branches are barely separable; green; branches not in fascicles; attenuated and often ending in a colorless bristle; cell membrane very thin and hyaline; cell contents with the chlorophyl scattered or arranged in transverse bands as in *Draparnaldia.* Resting spores developed in the cells of the branches, one in a cell.

Zoogonidia (microzoospores) formed by the division of the cell-contents, 4–16 in a cell, each furnished with four vibratile ciliæ.

STIGEOCLONIUM TENUE, Kg.

Bright vegetative green, variable in size, 4–50 *mm* long; lubricous; filaments somewhat branched; branches simple; cells 1–3 times longer than broad, often slightly constricted at the joints; branchlets scattered, shortened, nearly erect, subulate, apices acute, but not ending in setae.

Dr. Kirchner suggests the following division of the many varieties of this species.

a.—*genuinum*, Kirch. Secondary branchlets sparse, short, subulate, upright, about two inches long.

b.—*lubricum*, Rab. Stems decidedly thicker than the primary branches; secondary branchlets numerous, close, short, subulate.

c.—*uniforme*, Rab. Chlorophyl scattered, stems and branches similar; secondary branchlets slender and long, attached about the middle of the cell. Filaments $\frac{1}{3}$–$\frac{3}{8}$ inch long.

d.—*irregulare*, Rab. Filaments often more or less flattened in process of development; they divide longitudinally.

e.—*bulbiferum*, Wolle. We add this as a peculiar form with large oval oogonium-like cells at the base of the forked stems. Are they sporangia?

Syn. *Draparnaldia tenuis*, Hass.; *Conferva lubrica*, Dillw.

Found everywhere in one or another form, most frequently in rapidly flowing waters, in midwinter as well as during the summer months.

Plate XCVI, fig. 6, a large sporangium as occurring frequently in cultivation of this plant; figs. 7, 8, 9, clusters of microzoospores come to rest and developing young plants; fig. 12, var. *bulbiferum*; figs. 13–16 representing the sporangium-like cells.

Plate CI, figs. 5, 6, 7, three plants, var. *irregulare*; show the proliferation of the cells of filaments.

Plate CI, figs. 8, 9, var. *uniforme*, forma *gracile*, Kg., "basal articulations about three times as long as wide; branches sometimes cuspidate, torulose;" figs. 10, 11, 12, cells of filaments developing sporangia.

STIGEOCLONIUM THERMALE, A. Br.

Bright green, affects waters of high temperature; one to two inches long, very much branched in a fasciculate manner; filaments and branches attenuated upward to a cuspidate apex; branches mostly alternate, rather remote, erect patent; articulations equal, or twice as long as wide at the base, longer above.

Diameter of cells of filaments, 7–10 μ; 2–5 times longer.

Thermal springs; in flumes of hot waste water from steam engines, etc.

Syn. *Draparnaldia elongata*, Hass.

Plate XCVI, fig. 1, a single well-formed plant; figs. 2, 3, parts of filament producing series of microzoospore-bearing cells; figs. 4–6, microzoospores passing from the sporangia and developing.

STIGEOCLONIUM NANUM, (Dillw.) Kg.

Filaments alternately branched, branches abbreviated, somewhat attenuated upward, ends obtuse, not piliferous; cells equal or a little longer or shorter than their diameter. Ordinarily very short, only 2–3 *mm* long.

Diameter of cells, 6–8 μ.

Forming a thin, slippery coating on stones in streams.

Syn. *Draparnaldia nana*, Hass.; *Conferva nana*, Dillw.

Plate XCVI, fig. 10.

STIGEOCLONIUM SUBSECUNDUM, Kg.

Bright, yellowish green, filaments sparingly branched; primary and secondary branches attenuated, ending in a short, colorless bristle; primary branches in most part short, but sometimes elongated; basal articulations 6–8 times longer than wide, in upper part 2–4 times longer.

Diameter of filaments, 11–20 μ.

Collected by H. W. Ravenel, in rice-field ditches, South Carolina.

Plate XCIX, fig. 2, a single filament.

STIGEOCLONIUM PROTENSUM, (Dillw.) Kg.

Pale green, caespitose, slender; filaments and branches long drawn out; cells nearly cylindrical, equal or twice as long as broad, terminal cells extended into a colorless somewhat tapering bristle; branches usually scattered, rarely in pairs.

Diameter of cells of filaments, 12–16 μ.

Syn. *Draparnaldia condensata*, Hass.; *Conferva protensa*, Dillw.

Border of lakes, Florida.

Plate CI, figs. 1, 2, two ordinary filaments; figs. 3, 4, two long cuspidate ends.

STIGEOCLONIUM FLAGELLIFERUM, Kg.

Floccose caespitose, bright yellowish green, half an inch or more in length; somewhat fasciculately branched, articulations cylindrical or swollen, often hyaline, 2–6 times longer than broad; chlorophylous contents scattered, or collected into narrow bands; branches flagelliform, opposite, on distinct cells, shorter and more oval than the others of the filaments, erect patent; sometimes the cell with a pair of branches is single, sometimes 2 or 3 are in close connection; articulations intervening are nude; secondary branches short, flagelliform, ends piliferous.

Var. CRASSIUSCULUM, Kg.

A larger and more robust form.

Diameter of basal cells, typical form, 12–16 μ.

Diameter of basal cells, variety, 18–25 μ, the latter considerably swollen.

The former collected by Dr. Hobby, in sluggish streams, Iowa; the latter from a rapid mountain stream, Carbon County, Pennsylvania.

The diagnosis is somewhat modified to adapt it to our American forms.

Plate XCVII, fig. 1, the Iowa plant; fig. 2, the Pennsylvania plant.

STIGEOCLONIUM AMŒNUM, Kg.

Bright green, about half an inch long, caespitose; branches mostly opposite, fasciculately branched, short, subulate, not piliferous; diameter of articulations 12–17 μ; 3–8 times longer; in upper part of filaments, cylindrical; in basal part, often considerably swollen; chlorophylous contents of cells thin, usually centrally concentrated.

Mountain springs and pools, Pennsylvania.

Plate XCVIII, fig. 4.

STIGEOCLONIUM NUDIUSCULUM, Kg.

Caespitose, floccose, bright green, about half an inch long, lubricous; basal part of filament, 25–40 μ in diameter; articulations 1–2–3 times longer than broad, always somewhat swollen; constricted at joints; epidermis sometimes plicate at joints; lower branches often single, upper ones opposite and simple, rarely with secondary branchlets, patent, short, tapering, apex acute piliferous.

Attached to stones in a rapid mountain streamlet, Monroe County, Pennsylvania.

Plate XCVIII, figs. 1, 2, nearly a full length of plant; fig. 3, the upper end of another, and a part of a third in which the contents of the cells have developed zoospores.

STIGEOCLONIUM FASCICULARE, Kg.

Caespitose, two or more inches in length, bright green, mucous, branching mostly opposite, dichotomous; upper part fasciculately branched; diameter of basal cells, 12–15 μ; length 4–8 times more (1–2, Kg.); primary branches erect patent, short, close, ending with a bristle point; chloro phylous contents of cells usually scattered. A marked distinction between the plant found here and that described by Kuetzing is in the length of the articulations. Not to multiply species the name is retained with the correction 4–8, instead of 1–2.

In trench of rapidly running water, attached to rootlets; Northampton County, Pennsylvania.

Plate XCIX, fig. 1, a single plant picked from a caespitose cluster.

STIGEOCLONIUM FASTIGIATUM, Kg.

Pale green, small, much branched, fastigiate, radiately disposed, mucous; upper branches fastigiate, moniliform, somewhat pinnate, close together, erect patent, apices piliferous; articulations vary from 1–3 diameters in length; sometimes constricted at the joints.

Diameter of filaments 10–15 μ.

Syn. *Chaetophora fastigiata*, Ralfs.

Plate C, fig. 1, a single plant, very near the forms described of this species, if not absolutely the same; it has a history worthy of note. Some of the species of *Stigeoclonium* are very closely related to species of *Chaetophora*, as is evident from personal observation. Referring to Plate CIII, figs. 1, 2, two thalli of *Chaetophora pisiformis* magnified about 250 diameters. These show a few of the radiating filaments, normally imbedded in a firm gelatinous mucus, extending beyond the mucous tegument; this figure, (1, 2,) is such a filament more fully developed, drawn with all of its branches; it is one of many which occurred in the same pool; *Chaetophora* also was prevalent in quantity. This observation may open the inquiry, "is this a normal process of development? Is the plant a *Stigeoclonium* or a *Chaetophora?* Or is the latter a mere condition of development of the former?

Plate CII, figs. 1–3 and 5–8. Other forms developing from *Chaetophora*, comp. *Stigeo. Longipilus*, and *Stigeo. radians.*

STIGEOCLONIUM LONGIPILUS, Kg.

Bright vegetative green, mucous, pulvinate, 2–10 *mm* long, stems simple until near the end, then fasciculately branched; all or nearly all the apices prolonged into hyaline setae. Diameter of the stems 11–14 μ; length of articulations 1–2 diameters. My specimens have the basal cells about six times as long as wide.

Syn. *Myxonema drapernaldioides*, Rab.; *Chaetophora draparnaldioides*, Kg.

There are two distinct forms of this species, the one 8–10 *mm* long, represented Plate CII, figs. 1, 2, 3, with long bare stems and bushy tops. Kirchner remarks that this species may represent a transition state, going over to *Chaetophora.* Personal observations prove the reverse, *Chaetophora* developing *Stigeoclonium.*

The other form, as described by Rabenhorst, only 2 *mm* long, represented Plate C, figs. 2, 3, forms a bright green coating on stones in mill-races, often not 1 *mm* high.

Plate CII, figs. 5–9, are very much elongated filaments of *Chaetophora*, evidently going over to or developing *Stigeoclonium.*

STIGEOCLONIUM RADIANS, Kg.

Dwarf parasitic plant; about 2 *mm* in length, filaments radiate in small clusters, sparsely branched; branches short, tapering, pilose, involved in a somewhat firm mucus; intermixed with *Chaetophora*; basal part of stems, 11–14 μ, articulations between 1 and 2 diameters long. Sometimes constricted at joints. This form is also evidently related to *Chaetophora.* Compare *St. fastigiatum* and *St. Longipilus.*

Parasitic on water plants.

Plate CII, fig. 4, a small cluster.

Genus 18, CHAETOPHORA, Schrank.

Plants involved in a firm, gelatinous, coriaceous or hard mass, of a globose or semiglobose, or plane, expanded, variously lobed, form.

Plants filamentous, articulate, branched; stems radiately disposed, composed of elongated vegetative cells with light chlorophylous contents in bands or centrally concentrated, divided upwards into numerous branchlets which are shortly articulated; the ultimate joints attenuated, sometimes ending in a *chaeta*, (bristle).

Propagation by zoospores, which develop in the cells of the upper branches.

CHAETOPHORA PISIFORMIS, (Roth.) Ag.

Thallus globose, smooth, about the size of a pea, often smaller, and sometimes as large as a cherry; bright green, shining; frequently aggregated, not rarely confluent; filaments much branched, radiating; articulations cylindrical; terminal cells awl-shaped, not rarely ending in a *chaeta.*

Diameter of filaments, 6–9 μ; 1–2½ times longer.

Diameter of branchlets, 6 μ; 1½–3 times longer.

Syn. *Ulva pisiformis*, Huds., *Chaetophora elegans*, Lyngb.

On submerged plants and stones.

Plate CIII, figs. 1, 2, 3, as frequently seen attached to grasses; figs. 12–15, surfaces of river stones frequently covered; thalli primarily very small, then enlarging, and often confluent.

CHAETOPHORA ELEGANS, Ag.

Thallus smooth, elastic, soft, rarely becoming hard; size of a pea or cherry; fascicles of branches lax, rather flaccid, extremities shortly cuspidate, usually terminating in a bristle.

Filaments 9–12 μ in diameter; 1½–3 times as long.

Branches, 7–10 μ in diameter; 1–1½ times as long.

Syn. *Rivularia elegans*, Eng. Bot.

Attached to submerged grasses, leaves, etc.

Plate CIII, fig. 7, thalli on a submerged fallen leaf; figs. 4, 5, a part of a larger and a smaller thallus magnified about 250 diameters; fig. 6, a branch producing zoospores; figs. 8–10, three branches developing long filaments. For full development see Plate C, fig. 1.

Compare note under *Stigeoclonium fastigiatum*, Kg.

CHAETOPHORA TUBERCULOSA, (Roth.) Ag.

Thallus subglobose, the size of a cherry or larger, usually rather dull green, surface tuberculose, elastic; fascicles of branches very dense, lower articulations cylindrical, the upper swollen, extremities cuspidate, sharp pointed, rarely hair-like.

Diameter 9–12 μ; branchlets slightly thinner.

Syn. *Rivularia tuberculosa*, Eng. Bot.

In clear, usually, spring water.

Plate CIII, fig. 11, a thallus of larger size.

The last three are very closely related; scarcely separable; appear to be conditions of growth rather than species.

CHAETOPHORA ENDIVIAEFOLIA, Ag.

Thallus gelatinous, bright or dark green, often elongated to 80 *mm* (3 inches), with margins tattered, forming ragged, laciniate, dichotomose branches; composed of a union of many slender articulate branched filaments; articulations long, cylindrical, or somewhat swollen, mostly colorless; fascicles of branchlets lateral, more or less dense, spreading; articulations nearly equal in length and diameter; cell contents granulose, effused.

Diameter of articulations, 10–25 μ.

A variable species, appearing in different stages of growth, and under different conditions, as distinct forms which have been arranged by Rabenhorst as

VARIETIES.

a.—*linearis*, Rab. Thallus linear, simple, elongate, bright green.

b.—*ramosissima*, Rab. Thallus plane, 3 inches long, repeatedly pinnatifid.

c.—*incrustans*, Rab. Lobately sinuate, densely caespitosely aggregated and incrusted.

d.—*crassa*, Ag. Sub-plane, short, thick, lacinula spinose.

e.—*cornuta*, Rab. *Ch. cornu-damae*, (Roth.) Ag. Thallus somewhat terete, papillose, lobed.

f.—*clavata*, Ag. Thallus terete, vaguely sinuate, club-shaped.

g.—*crystallophora*, Kg. Thallus variously sinuate, sub-terete, obscure green, hard, incrusted.

Syn. *Batrachospermum fasciculatum*, Vauch; *Ulva incrassata*, Eng. Bot.; *Conferva gelatinosa-Damae-cornu*, Ray Syn.; *Tremella gelatinosa-Dama-cornuum*, Dillw.; *Myriodactylon endiviaefolium*, Gray.

Plate CIV, fig. 1, var. *cornuta* or *cornu-damae*, twice the natural size; fig. 2, a simple lobe of the same largely magnified; fig. 3, var. *linearis;* fig. 4, small section of var. *linearis* largely magnified; fig. 5, small form of var. *ramosissima*, natural size; figs. 6, 7, larger form of var. *ramosissima*, natural size; figs. 8, 9, small section of the last, the tip of a lobulet, much enlarged.

Not rare in sluggish streams and small pools. Had specimens from many States and Canada.

CHAETOPHORA MONILIFERA, Kg.

Thallus subglobose, scarcely 2 *mm* in diameter, dull olive or reddish; filaments dichotomous, largely colorless, branches radiately disposed, more or less moniliform; articulations elliptical globose; (probably developing zoospores), extremities acute or rounded, not hair-like.

Pools, swampy places, Pennsylvania.

Plate CIII, fig. 19, natural size of thallus; fig. 18, small part of thallus magnified 250 diameters.

CHAETOPHORA LONGIPILA, Kg.

Thalli very small, about the size of Poppy seed, orbicular, green, smooth; filaments fasciculately branched, apices produced into a long, articulate, colorless hair-point.

Often abundant on old culms of *Sagittaria* and other plants in mill ponds.

This plant appears to be perfectly developed, and there is much uniformity in size, yet I have questioned whether it may not be a young, or dwarfed form.

Plate CIII, figs. 16, 17, the thalli; natural size, and one magnified. Filaments without gelatinous sheaths. Rhizomes none.

Genus 19, MICROTHAMNION, Naeg.

Articulate filaments dichotomously or trichotomously branched; now and then very much branched, straight, with the terminal cell primarily linear, obtuse; later swollen, forming a sporangium. Cell contents effused, containing scattered amylaceous granules. A peculiar mode of branching has been observed, at least in one species; in the development of a new branch the lower of two cells grows out or turns to one side; the branch does not start at the point of bending but a little above, where the joint is formed; ultimate joints obtuse.

Propagation by zoospores.

MICROTHAMNION KUETZINGIANUM, Naeg.

Vegetative green; branches somewhat dichotomously spreading; basal cells colorless, attached, ends obtuse; articulations cylindrical, usually somewhat geniculate near the upper ends; 3–6 times as long as wide.

Diameter, 4–6 μ.

Ponds, water troughs, floating or attached.

Plate CV, figs. 1–4, four parts of plants with sporangia.

Genus 20, APHANOCHAETE, A. Br.

Articulate, branched filaments, prostrate; sometimes creeping, and sometimes more or less united into an irregular stratum. Branches decumbent or ascending, cells usually bearing on their apex or back, a longer or shorter bristle or spine. Oogonia not observed.

APHANOCHAETE REPENS, A. Br.

Filaments and branches procumbent, adpressed; cells slightly swollen, as long as broad, bearing on the back a short bristle.

Diameter of cells, 5–10 μ.

Parasitic on *Cladophora* and other algæ.

Plate CV, fig. 8, a simple filament on *Cladophora*.

APHANOCHAETE GLOBOSA, (Nord.) Wolle.

Thallus somewhat globose, filaments procumbent; cells globose, or now and then ovate, supporting on the back of each a seta, often very long. The thallus is involved in a colorless mucus.

Diameter of cells, 14–16 μ.

Syn. *Herposteiron globosa*, Nord.

Plate CV, fig. 5, a group of cells as they frequently occur in pond waters.

Fig. 6, a series of cells, may be an undeveloped condition or may be another species; farther observation desirable for positive identification.

A true *Aphanochaete* is filamentous, but this form has very often the cells scattered, as fig. 5; more rarely are they arranged as fig. 6. It may be well to note also, the globose body has a conical neck, flask-like, to which the long seta is attached.

G. von Lagerheim describes a plant in a report made to the Academy of Natural Sciences, Stockholm, 1883, which is evidently nearly related to this species; it is globose, is involved in a hyaline gelatinous sheath and carries a long seta —however, there are only 2 or 4 cells in a tegument and the color is *aerugineo-coerulea*.

APHANOCHAETE VERMICULOIDES, Wolle.

Cells polymorphose, not usually connected; somewhat globose, depressed globose, elongate, curved, worm-like;

parasitic on filamentous algæ; cells in part furnished with a short seta or spine on the apex or back; cell contents granular.

Diameter of cells, 5–7 μ.

Marshy inlet to Lake Harvey, Luzerne County, Pa.

Plate CV, figs. 9, 10, a filament of *Zygnema*, with the forms described.

Genus 21, GONGROSIRA, Kg.

Filaments simple or dichotomously branched; branches as thick as the stem. Cells thick walled, with chlorophyl-green contents. The lower cells usually form a rhizome.

Live in the water and in the air.

GONGROSIRA SCLEROCOCCUS, Kg.

Thallus small, composed of semi-orbicular discs about 1 *mm* in diameter, bright green, often numerously attached to stones in shallow flowing waters, often confluent; filaments radiating, branched, cells somewhat globose, the upper cells larger than the lower ones. Cells about 10 μ diameter.

Beside this form there are others that have found a place under this head; we have a number beside those recorded from Europe. Prof. Wille, of Sweden, wisely rejects this genus as a *pseudo*-genus. The plants arranged under it belong to a class of undeveloped growths known as *prothalli*, or *protonemae*. Thus:

G. Sclerococcus, Kg., is an undeveloped form of *Chroolepus*.

G. dichotoma, Kg., is a peculiar condition of *Vaucheria*.

G. ericetorum, Kg., is a *protonema*, a prothallus of a moss.

G. DeBaryana, Rab., is a condition of *Chroolepus*.

Plate CVI, figs. 1, 5, 6, are forms of *protonema;* figs. 2, 3, magnified filaments of *G. Sclerococcus;* fig. 4, natural size of thallus of the same, found on moist rocks, submerged stones in shallow water, and on old wood; figs. 7, 8, a growth sometimes found in large patches on moist earth, or moist rocks, has much of the appearance of *Cladophora*; the diagonal divisions, or septae, of the larger stems separate it. It is a prothallus of *Bryum*, a moss; figs. 9, 10, from the trunk of a tree in Florida, is probably a prothallus of a fern.

These forms have not a proper place here; they are introduced merely as illustrations of the *pseudo*-genus *Gongrosira*, and as aids to the novice.

Genus 22, CHROOLEPUS, Ag.

Filaments irregularly branched, often so closely interwoven that the branches are scarcely discernible. Stems and primary branches of the same thickness; cell contents of a reddish brown, golden yellow, or olive color, sometimes with a tendency to green; zoospores about thirty-two in a cell, also of reddish brown or golden yellow color, provided with two ciliae. These little motile bodies are produced in certain cells set apart for the purpose, usually on the end of a filament, sometimes on the side, seldom in the middle of a filament; when these cells are sufficiently matured the endochrome breaks up into minute parts, the future zoospores. Wille, of Sweden, made these bodies a special study and found that they copulate freely. After a motile life of a few hours they grow sluggish, sink in water, divide, and soon commence to form new filaments.

Plate CXV, figs. 18, 19, represent the individual zoospores (under higher power than figs. 16, 17), then the first stage of copulation; next, the cells uniting more closely and finally the two running together form a perfect sphere with one head and four ciliae; figs. 20, 21, similar progressive stages.

Chroolepus aureus, (Linn.) Kg.

Golden red or orange; threads either collected in small tufts, or spreading in a soft silky stratum; sometimes intricately and densely matted and expanded; very much branched. Cells as long, or two or three times longer, than the diameter.

Diameter of cells, 10–12 μ.

Diameter zoosporangia, about 20 μ.

Syn. *Conferva aurea*, Dillw.; *Byssus aurea*, Eng. Bot.; *Ceramium aureum*, Hook; *Trentepohlia aurea*, Ag.

Affects moist places, walls, rocks, old wood, etc.

Plate CXV, figs. 1–4, filaments of fruiting plants; figs. 5, 6, 7, another form; figs. 8–15, zoosporangia; figs. 16, 21, zoospores escaping from the sporangia; figs. 18–21, zoospores, some swarming singly, others in first stages of copulation; others, spherical, united, completely fertilized.

Var. CORTICULUM, Wolle.

In size and form very near the typical plant, not golden yellow, but yellowish green with a seeming tendency to yellow; on the bark of trees, sometimes in firm mats of 3-4 inches in extent.

Trees, Southern Florida.

Plate CXV, figs. 18-21; figs. 22-25, sporangial cells, var. *corticulum.*

CHROOLEPUS IOLITHUS, (Linn.) Ag.

Stratum thin, scarcely 2 *mm* thick, glaucous or dirty greenish when dry, sometimes reddish orange; threads and branches elongated, rather dichotomous, variously curved, ascending; cells 1½-3 times as long as their diameter; in the upper portion of the branches reaching double that length.

Diameter filaments, 25-40 μ.

Diameter zoosporangia, 50 μ.

Syn. *Byssus Iolithus*, Linn.; *Olivia violacea*, Gray; *Trentepohlia Iolithus*, Wallr.; also familiarly known on the Alps as *Veilchenmoos* and *Veilchenstein*, the stones overgrown with it, emitting, particularly when moistened, a strong fragrance of violets.

Moist rocks, White Mountains, N. H.

CHROOLEPUS ODORATUS, (Lyngb.) Ag.

Stratum thin, rather tomentose, rufous-tawny; when dry cinereous, becoming greenish. Filaments and branches short, erect, parallel, flexuously curved, torulose; cells equal or twice as long as broad.

Diameter of filaments, 9-14 μ.

Have copied this diagnosis from Rabenhorst's *Flora Algarum.* It does not describe the plants figured in all details; they appear to be young plants, not fully developed. They occur on the bark of shade trees along the highways.

Syn. *Conferva odorata*, Lyngb.

Plate CXVI, fig. 6.

CHROOLEPUS LICHENICOLUS, Ag.

Stratum reddish orange; filaments short and thin, gregarious, often confluent; when dry, of light yellow color; branches variously and flexuously curved. Diameter of filaments 7-9 μ; articulations 1-3 times longer; cylindrical or sometimes tumid; sporangia most frequently terminal, more rarely lateral, somewhat globose.

Syn. *Conferva lichenicola*, Eng. Bot.; *Chroolepus abietinum*, Rab.

On the bark of pine and other trees.

Plate CXVI, figs. 7, 8, filaments with sporangia.

CHROOLEPUS UMBRINUM, Kg.

Stratum thin, somewhat crustaceous and pulvereus, dull or brighter red, fades with age. Filaments with short branches, torulose. Diameter of cells, 14–22 μ, nearly globose, or broadly elliptic.

Bark of various trees, old wood, etc. The form figured is from Florida.

Var. QUERCINUM, Rab.

Stratum thin, red or yellowish, pulvereus; diameter about 16 μ.

Bark of oak trees.

Syn. *Protococcus umbrinus*, Kg.; *Chroolepus irregulare*, Kg., *Pleurococcus seriatus*, Wood.

Plate CXVI, figs. 1, 2, Southern form; figs. 4, 5, Pennsylvanian form.

CHROOLEPUS MONILIFORME, Kg.

Crustaceous, pulvereus; when dry, ash color; filaments decumbent, short. Diameter of cells, 20–25 μ, oval, or ovate, about twice as long as wide.

From rocks, Shawangunk Mountains, N. Y. Saw this form only twice; it appeared distinct in size, in color, and form of cells.

Plate CXV, figs. 30–33.

Genus 23, CLADOPHORA.

Filamentous, much branched; the ultimate branches much thinner than the primary. Cell membrane usually thick, cells longer than broad; cell contents green, containing numerous starch grains.

Propagation by zoogonidia which develop in large numbers in the cells and afterwards escape by a lateral or terminal opening; they are furnished with two or four vibratile ciliae; after a short motile life they come to rest and germinate without fecundation.

The following arrangement from Rabenhorst's *Flora Algarum*, will be useful in their identification.

FILAMENTS COLLECTED IN FLOATING MATS, MORE OR LESS LAXLY INTRICATE.

A.—At first attached as tufts, afterwards floating as mats.

a.—Cell contents not spirally disposed.

Fruiting cells not terminal.

1. C. FRACTA, Kg.—Cell-membrane smooth, articulation more or less swollen.

b.—Var. *gossypina*, Kg.
c.—Var. *horrida*, Kg.
d.—Var. *rigidula*, Kg.
e.—Var. *viadrina*, Kg.

2. C. OLIGOCLONA, Kg. / C. FLOTOWIANA, Kg. } Articulations not swollen, cylindrical, filaments long, sparsely branched.

3. C. CRISPATA, Kg.—Cell-membrane delicately plicate-striate.

b.—Var. *vitrea*, Kg.
c.—Var. *brachyclados*, Kg.

B.—Tufts attached for the whole life.

b.—Cell-contents vaguely disposed in lax spirals.

Fruiting cells terminal or subterminal.

4. C. CANALICULARIS, Kg.—Cell-membrane even; branches connate at the base.

5. C. GLOMERATA, Kg.—Branches not connate at the base.

b.—Var. *mucosa*, Kg.
c.—Var. *rivularis*, Rab.
d.—Var. *simplicior*, Rab.
e.—Var. *subsimplex*, Rab.
f.—Var. *clavata*, Wolle.
g.—Var. *pumila*, Bail.

6. C. FLUITANS, Kg.—Filaments long, sparsely branched.

7. C. FLAVESCENS, Ag.—Cell-membrane plicate.

8. C. ÆGAGROPILA, Kg.—Filaments radiating from a common center, aggregated in a more or less spongy globe.

9. C. BRACHYSTELECHA, Rab.—Doubtful species.

CLADOPHORA FRACTA, Kg.

Filaments irregularly branched, in clusters or turfy masses of dark green color. Zoogonidia are developed in cells of the filaments, not terminal, usually more or less turgid. Cells cylindrical or more frequently somewhat swollen. Cell-membrane strong and smooth; cell contents green, covering the inside of the walls.

Diameter of stems, 50–120 μ; 1–3 times as long.

Diameter of branches, 15–40 μ; 3–6 times as long.

The following are some of the varieties enumerated by Rabenhorst, which agree with forms found here.

a.—Var. NORMALIS, Rab.

Corresponding with the diagnosis.

b.—Var. GOSSYPINA, Kg.

Filaments long and thin, sparingly branched; articulations 6–10 times longer than broad, often of silky appearance, loosely interwoven into large masses. Another form has the articulations much shorter.

c.—Var. HORRIDA, Kg.

Much branched, branches in most part, secund, robust, articulations short, 1½–2–3 diameters long.

Often in masses in limestone springs.

d.—Var. RIGIDULA, Kg.

Green, but more frequently a dull brown or nearly black; in comparison with the last (*horrida*) not quite so robust; articulations longer and more swollen.

Floating masses in ponds of spring-water.

e.—Var. VIADRINA, Kg.

Filaments elongated, numerously branched; cells cylindrical or somewhat swollen, densely interwoven; forms largely expanded masses, which when dried have the appearance of a skin or very coarse paper, 2–4 *mm* in thickness.

Frequent in pools of stagnant or sluggish, brackish water.

Plate CVII, figs. 1, 2, filament var. *normale*; figs. 3, 4, escape of zoogonidia.

Plate CVII, figs. 5, 6, filament var. *gossypina.*

Plate CVIII, fig. 3, filament var. *horrida.*

Plate CVIII, figs. 4, 5, filament var. *rigidula.*

Plate CIX, figs. 1, 2, filament var. *viadrina*; fig. 3 illustrates how a filament out of the water, on moist ground, seeks to retain life by throwing out a sort of rootlets.

CLADOPHORA OLIGOCLONA, Kg.

Filaments sparingly branched forming pale or dull green mats; primary branches somewhat dichotomous; secondary branches often long with short one-celled branchlets; articulations cylindrical, of primary branches 2–6 times as long as broad; of secondary branches 4–10 times as long.

Diameter of cells of stems, 40–55 μ.

Diameter of branches, 28–40 μ.

Stagnant waters.

Plate CVIII, figs. 1, 2, three short sections of filaments.

CLADOPHORA FLOTOWIANA, Kg.

Forms loosely entangled mats; branches remote dichotomose, thin, very long, nearly simple, about 15 μ diameter; frequently at joints, short papilliform, one-celled branchlets.

Stagnant pond waters.

Plate CVII, figs. 7, 8, parts of filaments.

Very near the preceding (*oligoclona*), perhaps the same; Kirchner has united the two as *C. oligoclona.*

CLADOPHORA CRISPATA, Kg.

Filaments sparingly branched below, more fully toward the upper ends, insertion, at least of the lower branches, apical; cells cylindrical, membrane rather thin, often delicately plicate-striate; cell contents in part disposed in a lax spiral manner; not observed in older filaments.

Diameter of lower cells, 40–75 μ.

Diameter of branches, 25–30 μ.

Frequent in large floating masses in ponds.

Var. VITREA, Kg.

Light green or colorless; irregularly branched; cells 6–20 times as long as wide.

Var. BRACHYCLADOS, Kg.

Pale green, laxly interwoven; dichotomously branched, ultimate branches subulate, patent, mostly unicellular; cells 3–6 times longer than broad.

Plate CIX, figs. 4–6, *C. crispata*, var. *vitrea;* figs. 7–10, var. *brachyclados.*

CLADOPHORA CANALICULARIS, Kg.

Dichotomously or trichotomously branched; branches connate at the base, often fasciculately branched above as

C. glomerata. Fructiferous cells terminal. Cell-membrane often thick; cells cylindrical, 5–8 times longer than broad; those of the branches rather shorter. Contents of cells arranged somewhat lax-spirally.

Diameter of stems, 80–110 μ.

Diameter of branches, 35–50 μ.

Rapid waters, Niagara, Portage, N. Y.

Plate CXI, figs. 1, 2, specimen from Portage.

CLADOPHORA GLOMERATA, Kg.

Branches and branchlets of the second and third order fasciculate or penicellate. The cell contents of the larger cells applied in a net-like, or somewhat spiral manner, to the interior of the walls. Walls of cells externally smooth. The zoospores, (zoogonidia) always escape from terminal cells; lower cells are sterile.

Diameter of cells of stems, 60–100 μ.

Diameter of cells of branches, 30–50 μ.

A variable species; the lines between different varieties are difficult to determine; the following may be enumerated.

a.—Var. GENUINA, Kirch.

Bright vegetative green, 6–12 inches long, much branched; the ultimate branchlets more or less penicellate; cell-membrane firm; articulations of the stems generally about 6–7, and of the branches, 3–6 times longer than broad.

From rapid streams.

b.—Var. MUCOSA, Kg.

Bright darker green, somewhat mucous, not as long as (*a*), lighter structure and thinner membrane.

Mountain streams.

c.—Var. RIVULARIS, Rab.

2–4 inches long, branches somewhat scattered, ultimate cells penicellate fascicles.

Frequent on river stones, in character near (*a*) but much shorter.

d.—Var. SIMPLICIOR, Rab.

Dull green, sparingly branched; the penicellate fascicles very thin.

e.—Var. SUBSIMPLEX, Rab.

Very sparingly branched, devoid of penicellate fascicles.

9

f.—Var. CLAVATA, Wolle.

Bright vegetative green, sparingly branched, articulations with ends usually rounded and swollen; below about 100 μ, smaller branches 50 μ diameter; 5–8 times as long as broad.

Mountain stream, Colorado.

g.—Var. PUMILA, Bail.

Barely one inch long, corymbose-fasciculate, erect; dark green (pale subglaucous green, Rab.) membrane firm.

In clusters on stones or wood at water-falls, frequent.

Plate CX, figs. 1, 2, *C. glomerata*, an ultimate branch of a robust form from Florida, (magnified 125 diameters,) zoogonidia escaping; fig. 3, fasciculate branch of (*g*) var. *pumila;* figs. 4–8, apparently young growths from nostoc-like cysts found with (*g*) var. *pumila.*

Plate CXI, figs. 1, 2, parts of filaments of *C. canalicularis,* Genesee River; figs. 3, 4, (*f*) var. *clavata;* fig. 5, (*c*) var. *rivularis.*

Plate CXII, figs. 1, 2, 3, 4, (*d*) var. *simplicior.*

Diameter of cells from base to apices, 125–25–15 μ.

Ponds, near New York City.

CLADOPHORA FLUITANS, Kg.

Filaments elongated, forms clusters one to two feet and upward in length, rather sparingly branched, dark green color. Articulations of the branches proportionately longer than those of the stems. Primary branches furnished with short, 2–6 celled, erect branchlets; cells cylindrical, with thick membrane; those of stems $1\frac{1}{2}$–2 times, and of the branches 3–12 times longer than broad; otherwise like *C. glomerata.*

Diameter of stems, 120–135 μ.
Diameter of branches, 43–86 μ.

Found in Watkin's Glen, three feet long.

CLADOPHORA FLAVESCENS, Ag.

Pale yellowish, about six inches long, very much branched, fasciculate in a plumose manner, branches patent or incurved; cell membrane often distinctly plicate; cell contents distributed in a reticulate manner.

Diameter of branches, 70–80 μ; articulations 6–12 times as long as wide.

Syn. *Clad. glomerata*, var. *flavescens*, Rab.; *Clad. flavida*, Kg.; *Conferva flavescens*, Dillw., and others.

New Jersey shores, pools of brackish water.

CLADOPHORA AEGAGROPILA, (Linn.) Kg.

Dark green, threads rigid, very much branched, radiating from a common center, at length agglomerated into a more or less densé spongy globe. Ramula erect, often quite obtuse, articulations sometimes incrassated upwards; cell-membrane now and then thickened.

Diameter of filaments, 25–50 μ; cells 1–1½ times longer than broad.

Syn. *Conferva aegagropila*, Linn.; *Conferva globosa*, Phil. Trans. Roy. Soc.; *Cladophora glomerata*, Hass.

Occurs here in limestone springs, attached to walls, and to stones in streams of cold water, in small subspherical clusters, composed of radiating filaments irregularly and variously branched, every branched filament differing from the other; diameter of clusters 6–8 *mm.* Not unlike some of the smaller forms which occur frequently in northern Europe; but our plants appear like small depauperated forms, when compared with some of the large specimens in my herbarium, from Sweden, compact, globular bodies measuring 3–4 inches in diameter.

Plate CXII, fig. 5.

CLADOPHORA BRACHYSTELECHA, Rab.

This form recognized by Dr. Wood, as one of our *Cladophora* species, does evidently not belong here. It is one of the forms referred to under *Gongrosira*, a *pseudo*-genus.

It is nothing more nor less than a prothallus, a *protonema* of some moss.

Subsection C.—PITHOPHORINÆ.

(*Family Pithophoraceæ*, Wittr.[1])

This new division is described by the author (Wittrock), as "Chlorophyliferous Cladophora-like Fresh-water Algæ, consisting of cells formed by bipartition of the terminal cell. The thallus has two distinct parts, *viz:* 1st, the cauloid part, developed from the germinated spore upward, propagative, and almost

[1] Erroneously entered in the system of arrangement adopted for this work, page 48.

always branched; the branches placed a little below the top of their supporting cells; 2d, the rhizoid part developed, from the germinating spore downward, almost always sterile and branchless, commonly unicellular. Spores neutral, quiescent (agamohypnospores), generally cask-shaped, single, formed by division into two of the cauloid cells, of the chlorophyl-filled and commonly widened upper parts of these cells; in germinating, as a rule, dividing into two cells, the one giving rise to the cauloid and the other to the rhizoid part of the thallus.

Prof. V. B. Wittrock has prepared an elaborate Monograph, "*On the Development and Systematic Arrangement of the Pithophoraceæ; a New Order of Algæ.*" It is fully illustrated; contains 80 pp. For full and interesting details consult the Monograph.

Genus 24, PITHOPHORA, Wittr.

Character and features the same as of the subsection given above.

PITHOPHORA OEDOGONIA, (Mont.) Wittr.

Var. VAUCHERIOIDES, (Wolle) Wittr.

The stem, or cauloid part of the thallus in fertile specimens on an average 65 μ thick, with partly solitary, partly opposite branches of two and more, rarely three degrees; sporal branches rather common; spores usually single, but sometimes twin, partly inclosed, partly terminal; the inclosed spores cask-shaped, on an average 95 μ thick and 220 μ long; the terminal spores cask-shaped, on an average 80 μ thick and 220 μ long, with the upper end conical, apex rounded.

The type of this species was collected in *Guiana*, and all of the species of this genus were supposed to be tropical plants. The *variety* originally found in a sterile state, had the branching characteristics of a *Cladophora*, and the long unicellular divisions of a *Vaucheria*, hence the name. Later gatherings were full of cask-shaped spores, and changed the generic position of the plant. It was found in successive years in a small pond, here, Bethlehem, Pennsylvania, and in three localities within a circuit of ten miles around Plainfield, New Jersey. It is a somewhat near approach to *P. Oedogonia*, but differs in size, being slightly more slender, and in minor details.

Syn. *Cladophora Vaucherioides*, Wolle, 1878.

Plate CXIII, figs. 1, 2, 3, parts of three fertile stems with inclosed and terminal spores; figs. 4, 5, sporal branches; figs. 6, 7, two parts of filaments as first found, in an immature condition.

PITHOPHORA ÆQUALIS, Wittr.

Var. FLORIDENSE, Wolle.

Principal filament of the cauloid part of the thallus in fertile specimens on an average 175 μ thick (Wittr. 102), more or less swollen, either with branches of two degrees, (those of the first, few and long, those of the second, short) or with branches of only one degree, numerous and short; spores single or more rarely double, inclosed in the principal filaments or in the branches of the first degree; more seldom terminal; the inclosed spores cask-shaped with somewhat rounded ends, on an average 120 μ (Wittr. 111) thick and 215 μ (Wittr. 250) long; the terminal spores cask-shaped, with upper end conical and the apex somewhat rounded; on an average 90 μ thick, and 270 μ long.

Collected by J. D. Smith, Florida, 1878.

A character peculiar to this variety is noticed in the swollen cells and in their larger diameter.

Plate CXIV, figs. 1, 2, two fragments of fertile filaments; figs. 3, 4, 5, three spores, simple and branched.

PITHOPHORA KEWENSIS, Wittr.

Principal filament of the cauloid part of the thallus in fertile specimens on an average 59 μ thick, with solitary branches of only one degree, or rarely of two degrees; spores single, partly inclosed, partly terminal; the inclosed spores cask-shaped, but more elongated; on an average 81 μ thick and 205 μ long; the terminal spores cask-shaped, with upper end conical; apex somewhat rounded, on an average 88 μ thick and 219 μ long; the rhizoid part of the thallus as a rule unicellular.

Found in Florida (March '85) on the planked sides of the outlet of the large sulphur springs at Green Cove Spring, growing just above the water line, a plant, in caespitose clusters one-half to one inch long; it has the size and the features of this *Pithophora*, but being sterile at the time of collection could not be identified with certainty. The diagnosis above is from Wittrock's Monograph.

Plate CXIV, figs. 6, 7, parts of two sterile filaments from living plants; figs. 8, 9, part of a fertile filament from Wittrock's Monograph.

Subsection D.—ULOTRICHINÆ.

Simple, unbranched filaments. Rarely with short, lateral, rhizome-like branchlets; zoospores of two kinds; macrozoospores with four ciliae which do not copulate; microzoospores with two ciliae of which eight or more are developed in a cell; these may copulate, but without it they propagate the species vegetatively. Two microzoospores copulating produce a fertilized macrozoospore, which gradually develops a plant. Resting spores have not been observed.

Kirchner remarks, "filaments of plants of this *section* often divide, or break up irregularly; the chlorophylous granules of the contents enlarge, the cell walls break and decay and then the cell contents are dispersed and often produce large colonies of spherical unicellular forms similar to *Palmella* or *Protococcus.*

Inasmuch as the *Ulotrichinæ* forms develop from macrozoospores and from microzoospores they are not always quite uniform in size or appearance.

Some of the species enumerated below are of questionable value.

Genus HORMISCIA, (Fr.) Aresch.

(*Hormotrichum*, Kg. *Hormospora*, Breb.)

Three names which have been applied, and which continue in use by some algologists, to represent a class of plants embracing a number of forms more or less nearly allied, possessing an outer investment of colorless mucus. Cienkowski and other modern observers consider them mere stages of growth, or perhaps rather, stages of decay. In illustration of some of the differentiations common to some of the *Ulotrichinae* compare some of the following references.

Plate CXX, figs. 21–30; *Conferva floccosa*, first the vegetative condition (figs. 21–25); next, may be termed a sporangial condition (figs. 26–27) and lastly (figs. 29–30) a true *Hormiscia*, or *Hormospora* form. These and intermediate conditions are often traceable in the same plant. Turning to Plate CXXI, figs. 6, 7, and 10, 11, we have *Conferva vul-*

garis; with this species there often occur such filaments as figs. 14–17. First specimens seen were a puzzle to me and suggested names for new species of *Hormospora*, but repeated observations removed all doubt concerning the unity of the species; these are not stages of development, but different forms approaching decay.

Plate CXXIV, figs. 10–16, are parts of filaments of similar character, green cells dividing not only in one, but sometimes in two directions. Figs. 17–20, a very distinct form, purplish red, or reddish brown, very gelatinous; found in quantity sufficient for mounting nearly two hundred cards; in pool, Bethlehem, Pennsylvania. Many of the cells elongate laterally as in an early stage of growth, others divide transversely making short, lateral series. Unlike any known form; and as all the filaments are apparently of nearly the same age, it was impossible to trace a positive relationship to either *Ulothrix* or *Conferva*, but there is little doubt they are merely a condition of one or the other. The plant in its present condition has the appearance of a small form of *Bangia*, but can not reconcile it to that genus. Diameter of gelatinous sheath, 15–17 μ; of cells, 7–8 μ. Figs. 21–23, same plate, yet another *Hormiscia*-like form, also red, or reddish brown, found on damp forest ground in Vermont. The cells primarily green, then yellow, then reddish brown; evidently not a vegetative condition, or a normal form, but what it really may be, remains for future observers to determine; perhaps merely a *Zygnema*.

Diameter of sheaths, 25–30 μ.
Diameter of cells, 15–17 μ.

Genus 25, ULOTHRIX, Kg.

Filaments simple, articulate; articulations short, more frequently shorter than longer than the diameter; cell membrane thin, often very thin, very rarely lamellose. Cell contents green, effused, or parietal, inclosing an amylaceous granule.

Propagation by macro- and microzoospores. Copulation of the latter has been observed in *U. zonata*; both are set free by the breaking of the walls of the mother cell.

Ulothrix zonata, (W. and M.) Aresch.

Rather bright green, mucous, from 2–3 inches to two feet in length; in vegetative state always attached; sterile cells equal, or half as long as wide; fructiferous cells usually a little longer than broad, slightly constricted at the joints.

Diameter of filaments, 14–40 μ.
Diameter of macrozoospores, 12–18 μ.
Diameter of microzoospores, 4–7 μ.

In vegetative state of bright green color, affecting cold and rapid waters, firmly attached to stones, two to six inches long. Foreign authors describe it as found in floating, interwoven masses. As such have not seen it. The largest growth and greatest quantity occurred later in the season, in sluggish and warmer water; had a dull yellowish green, faded color; it was attached to stones in the bottom, ascending to the surface, one to two feet long.

Syn. *Hormiscia zonata*, Aresch.; *Lyngbya zonata*, Hass.; *Conferva zonata*, Ag. Syst.; *Conferva lubrica*, Dillw.

Plate CXVII, figs. 1, 2, 3, filaments in ordinary vegetative condition; fig. 4, part of a filament with one macrozoospore in each cell; fig. 5, one escaping, and two free macrozoospores with four ciliae; fig. 6, macrozoospores, one at rest germinating, and three having already developed a number of cells; fig. 10, cells with ripe microzoospores, some in cells, others escaped; fig. 11, microzoospores passing out of cells, in a cyst; fig. 12, the same separated and at rest; figs. 13, 14, part of a filament with microzoospores germinating in the cells, without having copulated; figs. 15, 16, resting zygospores, the result of two macrozoospores conjugating; the three in different stages; figs. 17–19, microzoospores conjugating; two fertilized.

Ulothrix æqualis, Kg.

Filaments yellowish green, articulations as long or somewhat longer than the diameter, (12–14 μ), not constricted at the septae; cell-membrane rather thick.

Attached to plants in shallow river waters. Very near if not identical with *U. Juergensii*, Kg.

Plate CXVIII, figs. 3, 4, 5.

Ulothrix tenuis, Kg.

Dark green, attached; from half to two or three inches long, mucous, cells equal, to two, to four times shorter than the diameter; cell-membrane thin, homogeneous.

Diameter of filaments, 17–25 μ.

Plate CXVIII, figs. 1, 2.

Attached to stones in streamlets. A form not infrequent, but am not convinced that it may not be a young condition of *U. zonata*.

ULOTHRIX SPECIOSA, Carm.

Filaments robust, soft, straight when young, becoming curled at maturity, 2–4 inches long, growing in flowing or spreading tufts, attached to rocks; cells about half the length of the diameter, at first nearly filled with chlorophyl which condenses into oblong, or nearly spherical, macrozoospores which then escape. Diameter of filaments including the gelatinous investment, 38–50 μ; cells, 25–28 μ.

Syn. *Hormotrichum speciosum*, Crouan.; *Lyngbya speciosa*, Carm.; *Ulothrix flacca*, Thur.

Brackish and fresh-water.

Plate CXVII, figs. 23–25, parts of filaments in ordinary condition; fig. 26, partly empty cells from which the macrozoospores escaped.

Hormotrichum (*Ulothrix*) *Carmichaelii*, Harv., is very nearly allied to this species.

ULOTHRIX YOUNGANUM, Dillw.

Filaments of a bright green color, 1–3 inches long, erect, straight or curved, slightly gelatinous; cells varying in length from nearly twice as long as wide, to one-half or one-third of the diameter. Filaments of irregular size, from 20–30 μ in diameter. Smaller than the preceding.

Syn. *Conferva Youngana*, Dillw.; *Hormotrichum Youngeanum*, Kg.; *Ulothrix isogona*, Thur.

Plate CXVII, figs. 20–22, parts of a younger filament and two parts of older plants, having undergone two or three divisions of cells.

From submarine waters, Massachusetts.

ULOTHRIX SUBTILIS, Kg.

Denizens of fresh-water, bright or paler green; cells usually as long, to twice as long as wide.

The following have been arranged as varieties of this species:

a.—*typica*, Kirch. Cells, 5-6 μ diameters; as long or slightly longer.

b.—*subtilissima*, Rab. Cells, 44–47 μ diameter; 1–2 times as long, rarely 3–4 times longer.

c.—*variabilis*, Kg. Pale green, cells as long or a little longer, rarely twice as long as wide. Diameter, 5.5–7 μ.

d.—*stagnorum*, Rab. Dirty green, in soft, closely inter woven, floating masses; cells as long or somewhat longer than broad; membrane very thin.

e.—*tenerrima*, Kg. Light green, or dull yellow, mucous; separated from var. *C.* by the brighter green cell contents; cells quadrangular.

f.—*thermarum*, Wartm. Articulations one to three diameters, filaments long, tenacious, affects warm water; flumes of waste water from steam engines and the like.

Plate CXVIII, figs. 9, 10, the typical form; figs. 22–26, an unusual form, found attached to the wooden sides of a trout pond; many of the cells swollen to double and sometimes nearly triple the diameter of the filaments. For something similar see *U. varia*; figs. 27, 28, *U. flaccida*; figs. 11, 12, filament of var. *subtilissima*; figs. 13, 14, var. *stagnorum*; figs. 15, 16, var. *variabilis*; figs. 17, 17, var. *tenerrima*; figs. 18, 19, var. *thermarum*.

ULOTHRIX RIVULARIS, Kg.

Light green, often constricted at joints; rather crisp; cells equal or half as long as wide; diameter 9–10 μ; membrane rather firm.

Usually found attached to grasses and plants near shores of rivers.

Plate CXVIII, figs. 6, 7, 8, parts of three filaments.

Var. *cataracta*, Wolle.

Forming bright yellowish green tufts on small grassy water-falls, furnished with branchlets more or less hooked, serving as tendrils to hold their position in the rapid waters. Diameter of filament, 10–12 μ; articulations one to two times as long as wide.

Plate CXVIII, figs. 29–33.

ULOTHRIX COMPACTA, Kg.

Yellowish green, mucous; cells shorter than the diameter, which ranges from 6–7.5 μ.

Quiet waters.

Plate CXVIII, figs. 20–21, parts of filaments.

ULOTHRIX OSCILLARINA, Kg.

Beautiful green, mucous; diameter of articulations, 10–12 μ, length one-half or one-third as much; membrane thin, colorless.

From lake, Wisconsin.

Syn. *Conferva oscillatoroides*, Ag.

Plate CXVIII, figs. 34–36. The similarity of character between this form, of which we received but few specimens, and such as are represented Plate CXXI, figs. 16, 17, and Plate CXXIV, figs. 11, 13, 15, 16, does not leave the position given to this plant without question of doubt.

ULOTHRIX MURALIS, (Ag.) Kg.

Filaments somewhat rigid, thickish, tortuous, very long, interwoven in a bright, grass green stratum; annuli strongly defined (Harv.). Kuetzing found this plant often furnished with branchlets and called it *U. radicans*. Diameter of filaments 7–9 μ. Articulations equal, to ½ or ⅓ as long as wide.

Found on walls, shaded rocks or in flowing waters. Harvey reports it from pools of fresh water, Whalefish Islands, Davis Straits.

Syn. *Conferva velutina*, Bory; *C. muralis*, Dillw.; *Oscillaria parietina*, Vauch.; *O. muralis*, Ag.

Terrestial forms, on shaded and moist earth; Hormidium, Kg.

ULOTHRIX (*Hormidium*) FLACCIDA, Kg.

Articulations equal, or twice as long as the diameter, membrane very thin, colorless; filaments fragile. Cell contents usually on one side of the walls, hemispherically contracted.

Diameter of filaments, 7–9.5 μ.

On exposed river stones, old straw, etc.

Plate CXVIII, figs. 27, 28, represents this species as well as *U. subtilis*.

ULOTHRIX (*Hormidium*) NITENS, Menegh.

Filaments loosely or densely interwoven, dark green, sometimes forming a somewhat membranaceous, shining stratum.

Diameter of cells 6–7 μ, as long as wide, or slightly longer.

Damp walls; shaded brick pavements, particularly abundant late in the season in cold, wet weather. Have gathered it in fine condition covered with snow and ice. Develops from cells known as *Protococcus viridis*.

Plate CXIX, figs. 1, 2, germinating spores and young filaments.

ULOTHRIX (*Hormidium*) VARIA, Kg.

Yellowish green, filaments somewhat variable in thickness, averaging about 7 μ. Cells as long as wide or a little longer or shorter.

Forms thin strata on moist clay soil; found it also in large pieces, several feet in extent, on moist sandy soil. Filaments have here and there series of larger sporangium-like cells.

Plate CXIX, figs. 3–7, simple filaments, and two with series sporangia, (?)

ULOTHRIX (*Hormidium*) PARIETINA, (Vauch.) Kg.

Bright yellowish green, flexuous and interwoven; cells half as long as broad; cell membrane thin, hyaline, homogeneous.

Diameter of filaments, 10–16 μ.

Syn. *Hormidium parietinum*, Kg.; *Oscillatoria parietina*, Vauch.

Shaded ground, at the base of trees, etc.

Plate CXIX, figs. 8–10, young forms developing from spores, (Protococcus cells,) which usually abound with the filaments. Figs. 11–15, parts of filaments.

ULOTHRIX (*Hormidium*) LENORMANDI, Kg.

Rather dark green, mucous, attains a length of four inches, floating. Diameter of filaments, 17–25 μ, articulation one, to one-fourth diameter long; membrane rather firm, often distinctly lamellate, usually constricted at the joints.

Collected by C. G. Pringle, Beam Lake, Canada.

Plate CXIX, figs. 19, 20.

Have quoted this diagnosis from Rabenhorst's *Flora Algarum*. It describes parts of the plant satisfactorily, but there is a feature not noticed; the filaments divide repeatedly longitudinally. The specimen illustrated shows how a filament of one row of cells may be changed to a filament of more rows; in the mass some had two, some four, some eight rows of cells. Comparing with good specimens of European *Prasiola crispa*, as contained in Wittr. and Nord.'s *Algæ Exsiccatae*, No. 47, filaments with a single row of cells occur which are in perfect harmony with mine; these divide longitudinally, producing threads with two rows of cells, of four, of eight and so on until a leaf-like frond is produced—the matured *Prasiola*. Having had no opportunity to examine specimens of other collections, the question may reasonably be asked, is not the plant an undeveloped form of *Prasiola*, rather than an *Ulothrix?*

There is some analogy between this form and *Schizogonium*, but this is an air (exposed rock) plant, mine a water plant.

Genus 26, SCHIZOGONIUM, Kg.

Filaments as in *Ulothrix*, more or less laterally connate, (duplicate or triplicate) or by cellular division in two directions forming narrow flat bands which are somewhat crispate.

The relation between *Schizogonium*, *Ulothrix*, and *Prasiola* is close and in some stages of development they do not admit of separation. As a rule *Ulothrix* is composed of simple filaments, with one row of cells; *Schizogonium* has two or more filaments connate; and *Prasiola* is frondose. The opinion has been expressed that *Ulothrix* is the young stage of growth; *Schizogonium* a more advanced condition with collateral segmentation, and *Prasiola* the adult stage. However appearances may sometimes favor such opinion, am not yet convinced, nor ready to accept.

SCHIZOGONIUM MURALE, Kg.

Dark green, forming a broadly expanded, soft, velvety stratum; threads sometimes free, sometimes two or three laterally united; cells 2-4 times shorter than the diameter, pectinate, often crowded, sometimes interrupted; cell-membrane rather thick, colorless, slightly undulate and constricted.

Diameter of filaments, 15–18 μ.

Moist cliffs, Colorado; the only good specimens hitherto observed.

Plate CXIX, figs. 16–18.

Genus 27, CONFERVA, Lk., including MICROSPORA, Thur.

Filaments articulate, simple, like *Ulothrix*; the two separated with difficulty in sterile state. Cell walls more robust, cells as a rule, longer, often swollen, and cell contents granular.

Propagation by zoogonidia; copulation has not been observed; microzoospores are produced by the division of the cell contents; very numerous, small, ovate-elliptical, cuspidate and colorless at one end, furnished with two, or rarely three or four ciliae, escaping by small pores, or ruptures of the cells. All denizens of the water.

CONFERVA AMOENA, Kg.

Cheerful yellowish green; cells primarily two diameters in length; after division equal. Cell membrane firm, often finely striate. Filaments frequently three feet or more in length, tenacious. Diameter of cells, 20–25 μ; the largest of our *Confervae.*

Not frequent, but in quantity where it does occur. Streamlets of spring waters.

Plate CXXI, figs. 1, 2, 3, normal vegetative condition in different stages of cell division; fig. 4, older cells in state of dissolution, separating and distributing the cell contents —the microgonidia; fig. 5, microgonidia seen under much higher power.

CONFERVA FLOCCOSA, Ag.

Cells more or less swollen, twice, or nearly twice as long as wide; variable in thickness.

Diameter, 14–18 μ.

Syn. *Microspora floccosa*, Thuret; *Lyngbya floccosa*, Hass.; *Conferva fugacissima*, Dillw.

A common form.

Plate CXX, figs. 21, 22, 24, ordinary condition previous to division of cells; figs. 23, 25, after division of cells; figs. 26, 27, cells of parts of filaments globular, formed into extraordinary sporangial cells; figs. 28, 29, filaments in a state of dissolution, membrane soft, mucous; cells green, assume the form of macrospores; farther development has not been observed. Compare, *Hormiscia*, page 132.

CONFERVA UTRICULOSA, Kg.

Green or yellowish brown in soft mats; cells before division often six times longer than the diameter, distinctly constricted at the joints. After division only one-half or one-third as long.

Diameter, 16–17 μ.

Syn. *Conferva ventricosa*, Kg.

Pools of stagnant water.

Plate CXX, figs. 14–16, filaments in ordinary condition before cell division.

CONFERVA FONTINALIS, Berk.

Bright green, attached; articulation 6–10 times as long as the diameter, slightly swollen, or moderately constricted at the joints; starch granules single, scattered or seriate; cell membrane rather thick, homogeneous.

Diameter of filaments, 15–18 μ.

Hitherto only from fresh water ponds and lakes, Florida.

Plate CXX, figs. 17–20, a usual condition.

CONFERVA FUGACISSIMA, Roth.

Rather pale or yellowish green; cells 4–5 times longer than broad, before division; and 2–2½ times as long after division; not constricted at the joints. Often in large masses; filaments three or more feet in length, rather tenacious.

Diameter of filaments, 10–12 μ.

Quite fresh waters, Florida and northward.

Plate CXX, figs. 31–33.

Var. SALINA, Wolle.

Another very common form from Florida, in brackish waters; is similar in its growth, and features, rather darker green, somewhat thicker, diameter, 12–14 μ, cells average 2–3 diameters, appears nearly related to the typical form, hence recognize it as a variety.

CONFERVA AFFINIS, Kg.

Pale or yellowish green. Cells prior to division often seven times as long as the diameter, later three to four times as long; slightly constricted at joints; cell walls rather indistinctly striate.

Diameter of filaments, 6–11 μ.

Syn. *Conferva subtilis*, Kg.

Plate CXX, figs. 11–13.

Stagnant and sluggish water.

CONFERVA FUNKII, Kg.

Pale or light yellowish green, later of a faded aspect. Cells prior to division about four times as long as wide, later twice as long.

Diameter of filaments, 6–8 μ.

From stagnant waters, Colorado.

Plate CXX, figs. 9, 10.

CONFERVA VULGARIS, Rab.

Bright green, articulations more or less swollen, 2–3½ times as long as wide; cell contents usually very granular; cell membrane firm.

Diameter of filaments, 10–12 μ.

Var. FARLOWII, Wolle.

Cells 2–3 times as long as wide.

Diameter of filaments, 7–9 μ.

Syn. *Conferva bombycina inaequalis*, Kg.; *Microspora bombycina*, Thuret; *Microspora vulgaris*, Rab.

Very common in pools, ditches, trenches of running waters, outlet of springs, etc.

Plate CXXI, figs. 6, 7, the type form; figs. 10, 11, the variety; fig. 12, microgonidia escaping; fig. 13, young developing plants.

CONFERVA BOMBYCINA, Ag.

Yellowish or darker green, soft, silky; articulations oblong-cylindrical, slightly constricted at joints; before division five times as long as the diameter, later about three times as long; cell-membrane rather thin; in drying some of the cells collapse, sometimes alternately. Filaments of irregular thickness.

Diameter, 6–12 μ.

Syn. *Conferva sordida*, Dillw.; *vesciculifera bombycina*, Jenner.

Trenches, ponds, pools, etc., not rare.

Plate CXXI, figs. 8, 9, two vegetative filaments, and one dried, having alternate cells collapsed.

CONFERVA PUNCTALIS, Dillw.

Forms dull green mats; filaments sometimes single or scattered; cells short, not longer than two diameters before division; cell contents granular.

Diameter, 6–7 μ.

Generally in stagnant waters.

Plate CXXI, figs. 20, 21.

CONFERVA ABBREVIATA, Rab.

Small caespitose tufts, attached, green, but often discolored, ferruginous; articulations short cylindrical, not constricted at joints, nor swollen; cells before division not exceeding two diameters; usually as long as broad. Cell membrane thin, hyaline, homogeneous; chlorophyl evenly distributed.

Diameter, 6–7½ μ.

Syn. *Conferva floccosa ochracea*, Kg.; *Conferva ochracea*, Kg.

Character of this species very near that of *C. punctalis*, but as a rule the cells are shorter and slightly thinner. The color, often ochraceous, or ferruginous may be ascribed to the character of the soil of the basin, rather than to a character of the plant.

Plate CXXI, figs. 18, 19; these figures drawn for *C. punctalis* may also represent a state of *C. abbreviata*.

CONFERVA TENERRIMA, Kg.

Usually pale green, often in colorless masses; articulations 1½–2–3 times longer than the diameter.

Diameter of filaments, 3.5–4 μ, (3–5 μ, Kirch.).

Ponds, Florida; and northward, in smaller quantities.

Plate CXX, figs. 1, 2.

CONFERVA GLACIALIOIDES, Wolle.

Very pale green, filaments long, laxly interwoven, primarily attached, thin, floating in cloud-like masses. Diameter of filaments 4–5.5 μ, articulations 4–9 times as long as broad.

Springs, Pennsylvania.

Very near *C. glacialis*, Kg., but articulations average twice as long.

Plate CXX, figs. 5–8.

CONFERVA RHYPOPHILA, Kg.

Green, often ferruginously colored, thin; cells ante-division, 3–4 times as long as wide.

Diameter of filaments, 4.3–5 μ.

Small pools, from Pennsylvania to Florida.

Plate CXX, figs. 3, 4.

Genus 28, CHAETOMORPHA, Kg.

Articulate filaments simple, nearly equally thick, fixed by a discoid, or root-like, divided, base; lower articulations always short; before division equal or somewhat longer, after division shorter than the diameter; upper divisions more or less elongated. Cell-membrane thick, firm subcartilaginous, lamellose. Cell contents green, finely granular.

Species of *Chaetomorpha* are frequent on our Atlantic and Pacific coasts, rarely also in brackish water, but being so evidently marine plants, the names of species are omitted.

Plate CXXV, fig. 11, the natural size and mode of growth of a smaller species; fig. 12, part of a single filament of *Chaet. sutoria*, Berk., magnified; fig. 13, part of a filament of a larger species, (*Chaet. litorea*, Harv.,) enlarged, showing (fig. 14,) the escape of the zoogonidia.

Genus 29, RHIZOCLONIUM, Kg.

Articulate threads, the same as in *Conferva*, but somewhat contorted, having, here and there, short rhizome-like lateral processes, seldom composed of more than three cells, often only one.

RHIZOCLONIUM HIEROGLYPHICUM, Kg.

Vegetative green, or yellowish green, forming thin webs or mats of considerable extent on moist ground. Cells 1½–3 times as long as the diameter.

Diameter of filaments, 20–25 μ, rarely 29 μ.

On moist or wet ground in vicinity of springs.

Plate CXXI, figs. 29, 30.

Var. AMERICANA, Wolle.

Filaments average rather stouter, and cells rather longer and more irregular in outline, than the typical plant.

Forms close and crisped web-like growth on shaded garden soil. Lateral processes unicellular.

Plate CXXI, figs. 31, 32.

RHIZOCLONIUM FONTINALI, Kg.

Bright green, loosely interwoven; diameter of filaments, 13–15.5 μ. Articulations ordinarily twice as long as wide; ante-division four times as long; membrane thin. Rhizome-like processes usually 2–3-celled.

Syn. *Rhizo. fontanum*, Kg.; *Rhizo. rivulare*, Kg.

Springs and flowing waters.

Plate CXXI, figs. 22–25.

RHIZOCLONIUM FLUITANS, Kg.

Caespitose, attached, bright green, filaments often long, three feet or more, in rapid streams. Diameter 18–20 (–32) μ, articulations 1–1½, rarely 2 times longer than wide; lateral processes rather sparse, single or bicellular.

Syn. *Rhizo. lacustre*, var. *fluitans*, Kg.; *Rhizo. Kuetzingianum*, A. Br.

Rapid streams, mill-dams, and the like, New Jersey.

Plate CXXI, figs. 26–28. Filaments of different sizes intermingle. The larger ones (32 μ) much larger than the European form, but probably the same species. The name is appropriate, hence retained.

RHIZOCLONIUM STAGNALE, Wolle.

Dark green, large dense floating masses on stagnant water; primarily attached. Filaments more or less tortuous; many cells irregularly swollen, 25–30–33 μ diameter; 2–2½–3 times as long as wide. Membrane firm; cell contents granular.

Plate CXXII, figs. 8–10.

RHIZOCLONIUM HOSFORDII, Wolle.

Vegetative green, robust; diameter of filaments 36–40 μ. Cell walls thick; articulations 3–4—more rarely 6 diameters. Lateral rhizome-like processes, short, without divisions.

Collected in Erie County, N. Y., by F. H. Hosford.

Plate CXXII, figs. 13–16, four parts of filaments.

RHIZOCLONIUM CASPARYI, Harv.

Yellowish green, often faded, stratified interwoven, curved here and there, and angularly bent; at the angles often emitting short processes, root-like; articulations 1¼–1½–2–3 times as long as wide.

In brackish and salt water, California.

Plate CXXII, figs. 11, 12, processes omitted.

RHIZOCLONIUM SALINUM, (Schleich.) Kg.

Pale or yellowish green, crispate, diameter of cells 20–25–30 μ; length 1–1½–2 diameters, after division; prior to division 2–3–4 diameters; filaments long, in loose or more densely interwoven mats; primarily attached, then floating in submarine waters along the Atlantic Coast.

Absecom, Perth Amboy, and low grounds generally, New Jersey.

Syn. *Rhizo. riparium*, Harv.; *Rhizo. obtusangulum*, Kg.; *Conferva riparia*, Ag.; *Zygnema litoreum*, Kg.

Plate CXXII, figs. 5, 6, 7.

RHIZOCLONIUM MAJOR, Wolle.

Stratum dark green, filaments densely interwoven, somewhat rigid, lateral processes short, numerous, cell contents 3–4 parted; diameter of articulations 33–48 μ, equal, to twice as long; cell membrane firm.

This finely developed, large plant, was found growing on the wooden structure of the docks at Perth Amboy, New Jersey. It is nearest *Rhizo. pannosum*, Aresch., and may be a variety of it. It differs in having twice the diameter, in the character of the rootlets, and in habitat.

Plate CXXII, figs. 1–4.

Order III.—SIPHONEÆ.

Plants in vegetative state, unicellular, often prominently branched, tubular or utricle-shaped; dwellers in water, and in air.

This Order is represented by only two genera, widely different in appearance and in their mode of propagation. The one has sexual fertilization, and asexual zoospores; the other has sexual oospores and asexual zoospores, beside other mode of propagation by microgonidia.

Family X.—VAUCHERIACEÆ.

Filaments caespitose, green, rather robust, unicellular, land and water dwellers.

A plant consists of a single, elongated, tubular filament, ordinarily more or less branched. The chlorophyl rather evenly distributed on the inside of the walls of the tubes with green granules and minute oil drops imbedded.

Propagation either sexual, by oöspores fecundated by spermatozoids, or non-sexual by zoospores.

Sporangium terminal, formed by the globosely clavate swelling of the tip of the thallus, cut off by a septum; contents dark green, at length enclosing one large zoospore.

Oogonium lateral, sessile, or borne on a more or less elongated, simple or partite pedicel; cytioplasm at length converted into a large oospore.

Antheridium lateral, sessile, or cut off by a septum from the upper portion of a lateral branch, in which numerous spermatozoids are generated, which at length become free; spermatozoids oblong, furnished, except in one species, with two unequal cilia.

Genus 30, VAUCHERIA, D. C.

The generative cells, the oogonia and the antheridia are developed in various numbers on the same filament, or tube. They are either sessile or posed on short pedicels, and are usually in close proximity, but in various relative positions. The oogonia are somewhat globular, one side beaked, opening at the apex; the antheridia are more or less cylindrical, curved, horn-like in the upper part, the ends usually so turned that the apices are directed towards the beak of the oogonia.

The spermatozoids are developed in the curves of the antheridia and ejected towards the mother cell and drawn in at the beak; the oosphere is thus fecundated and becomes an oospore.

Zoospores are developed, singly, in the terminal sporangium and ejected from it. They move with a rolling motion by means of cilia with which their whole surface is amply provided, but soon come to rest and germinate.

Microgonidia are developed in large numbers in vegetative cells; they are ejected but remain motionless, at rest, soon to germinate.

The following list is in accord with an arrangement of European species, proposed by Professor Nordstedt, of Sweden.

A.—Antheridia not separated from the thallus by a short empty boundary cell.

a.—TUBULIGERÆ. Antheridia little or scarcely bent, oblong cylindrical, or lanceolate, with an opening at the top. Oogonia and antheridia almost stemless.

Oogonia nearly round.

1. V. dichotoma, *Linn.* Diœcious.
2. V. Thuretii, *Woron.* Monœcious.

Oogonia not round, more or less oval, frequently rather oblique.

3. V. aversa, *Hass.*
4. V. siricea, *Lyngb.*

b.—CORNICULATÆ. Antheridia bent in the form of a horn or a hook, placed on the short and bent side-branches of the thallus. Brown pigment in the middle of the mature oospore.

aa.—Sessiles. Oogonia sessile (or with exceedingly short stems) beside the antheridia on the thallus.

5. V. Dillwynii, *Ag.*
6. V. sessilis, *Vauch.*

bb.—Racemosæ. Antheridia at the end of a fruit branch, which, somewhat lower down, carries the oogonium.

Oogonia turned upward.

Antheridia and oogonia bending in opposite planes, forming an angle with one another. When the oospores fall they are surrounded by the oogonium membrane, which is not changed to mucus.

7. V. geminata, *Walz.*
8. V. hamata, *Walz.*

Antheridia and oogonia (mostly) bending in parallel planes, the oogonium membrane turns to mucus and dissolves.

9. V. terrestris, *Lyngb.*

Oogonia turned downwards.

10. V. uncinata, *Kg.* (Not represented.)

c.—Antheridia straight, with the top covered, and a pair of fruiting tubes standing out at the side.

11. V. DeBaryana, *Woron.* (Not represented.)

B.—Between the antheridia and thallus itself is found a shorter empty boundary cell.

a. — ANDROPHORÆ. Several horn-shaped, bent antheridia placed on a swollen cell containing chlorophyl, which is fixed to the side of the thallus, by means of the boundary cell. (Not represented.)

b.—PILOBOLOIDEÆ. Antheridia bordering immediately on the boundary cell. (Not represented in the United States.)

c.—Place of the antheridia or boundary cell uncertain.

12. V. tuberosa, *A. Br.*
13. V. Pilus, *Mart.*

VAUCHERIA DICHOTOMA, Lyngb.

Large, robust, loosely caespitose, dirty green or becoming brownish. Filaments thick, setaceous, nearly a foot long, remotely dichotomous. Oogonia sessile, globose or ovoid, single, scattered, or two or more approximating. Oospores, when mature, with a triple membrane, spotted with brown. Antheridia single, erect oval, subclavate or acute, on the same or on different filaments.

Diameter of filaments variable, 100–200 μ.
Diameter of oogonia, about 100 μ.

In ditches, marshy places around limestone springs. Good fertile specimens rare.

In similar localities there are other species growing in large dense mats, but short filaments; *V. dichotoma* is distinguished by its much longer filaments, usually 3–6 inches long, and more bushy growth.

Syn. *Conferva dichotoma*, Linn.; *Vaucheria globifera*, D.By.; *Vaucheria salina*, Kg.; *Conferva dichotoma setis porcinis*, Dill.

Plate CXXVI, figs. 1–3, parts of dichotomose branching filaments; figs. 4–6, sessile oogonia; fig. 7, one of the swollen ends ejecting microgonidia.

VAUCHERIA THURETII, Woron.

Forms cheerful, deep olive green, velvet-like mats often feet in extent. Filaments upright, close, from a closely interwoven substratum, in salt marshes along the eastern shores of New Jersey; dried it becomes dark brown or blackish. Size of filaments, 50 μ more or less; oogonia large, globose or ovoid, sessile or subsessile 125–150 μ diameter. Antheridia rare, on same filament with oogonia.

Plate CXXVI, figs. 11–15, sections of filaments from New Jersey specimens.

VAUCHERIA AVERSA, Hass.

Loosely caespitose, sparingly branched, expanding in all directions, filaments thick; oogonia erect or suberect, sessile or subpedicellate; antheridia, cylindrical or subclavate, erect, ends more or less curved. (European forms not erect; sub-horizontal.)

Diameter of filaments, 100 μ more or less.

Syn. *V. ornithocephala*, var. *avers*, Kg.

Plate CXXVII, figs. 5–8, sections of filaments with oogonia and antheridia, as found on thalli recognized as properly belonging to this species, although differing from the European form, in the more erect and regular oogonia and the less inclining antheridia.

Find this species intermingled with aquatic plants near river banks. Compare note, *V. sericea*, Lyngb.

VAUCHERIA SERICEA, Lyngb.

Aquatic or terrestrial, occurring in turfy mats, of a yellowish, dirty, or bright-green color; filaments thin, densely intricate, laxly or vaguely branched; often ascending and erect together with the branches; oogonia sessile or very shortly pedicellate, 1–6 seriate, unilateral, obliquely irregularly oval, their lateral mouths produced into a rostellum or beak; antheridia sessile upon the filament (thallus) near the oogonia; somewhat cylindrical, subclavate, deflexed, especially in age; spermatozoids (according to DeBary) oblong and furnished with a single cilium at each end.

Diameter of filaments, 50–75 μ.

Dr. Wood, in his *Contribution*, page 181, remarks, "I can see no constant differences between *V. sericea*, Lyngb., and *V. aversa*, Hass. The extreme forms differ somewhat, but both are very common about Philadelphia, and everywhere grade into one another. The plant grows in springs and actively running water abundantly in this neighborhood; also on very wet ground, especially on that which is habitually overflowed, such as the face of dams, neighborhood of springs, etc." Evidently the Doctor had but one species, *V. sericea*, in different stages of growth. The plant I figure for *V. aversa* is clearly not the same; distinct in habitat, in form of oospores and in the more erect antheridia.

Syn. *V. ornithocephala*, Ag.; *V. polysperma*, Hass.

Plate CXXVII, figs. 12, 13, a part of a filament thickly set with oogonia; from a specimen from Iowa. The plant is common, but not always so abundant in fruit.

VAUCHERIA DILLWYNII, Ag.

Terrestrial, broadly expanded, forming a rather thin stratum, of bright or dark green color. Oogonia globose, or ellipsoid, rostrate, sessile, usually single, sometimes twin, enclosed in delicately punctate membranes. Mature oospores spotted with brown; sporoderm very thick, composed of several strata. Antheridia somewhat bag-shaped or clavate, located near, or sometimes between two oogonia.

Diameter of filaments and of oogonia, 50 μ more or less.

On damp or wet ground, shaded places, banks of rivers and similar localities.

Syn. *V. pachyderma*, Walz.; *V. Hookeri*, Kg.; *V. Ungeri*, Thur.

Plate CXXVI, figs. 8, 9, 10, three sessile oogonia and three antheridia.

VAUCHERIA SESSILIS, (Vauch.) D. C.

Loosely intricate, pale or dull green. Thallus capillary, sparingly branched; oogonia 2–3, approximate, rarely single, ovate or oblong-oval, more or less oblique, rostrate; antheridia intermediate, either short, hamate or straight and subulate, or a little clavate, sometimes elongated and incurved, rarely circinate. Mature oospores punctate with brown, involved in a triple membrane.

Diameter of filaments about 50 μ.

Rabenhorst describes five varieties of this species.

1.—Var. *sporangifera*. Sporangia terminal, ovate-clavate.

2.—Var. *caespitosa*, (Vauch.) Ag. Oogonia usually twin, ovate, with antheridia intermediate, sometimes shortly uncinate.

3.—Var. *ornithocephala*, Hass. after Ag. Oogonia single or twin, oblique rostrate; antheridia cylindrical-subulate, incurved, intermediate, longer than the oogonia.

4.—Var. *trigemina*, Kg. Oogonia usually by threes.

5.—Var. *sphaerocarpa*, Kg. A marine plant.

Syn. *Ectosperma sessilis*, Vauch.; *Vaucheria caespitosa*, Ag.; *Vauch. ovoidea*, Hass.; *Vauch. Tovarensis*, Karst.

Plate CXXVII, figs. 9–11, three ordinary forms of oogonia and antheridia.

VAUCHERIA GEMINATA, (Vauch.) D. C.

Dark or dull green in dense intricate tufts. Filaments capillary, tough, dichotomous. The fruiting on short lateral branchlets, usually with two oogonia, opposite; the antheridia between and extending above them, more or less recurved. More rarely only one, or more than two oogonia. Mature oospore spotted with brown, sporoderm colorless, composed of three strata. Filaments variable in size, 50–125 μ in diameter. Oogonia vary in proportion. Asexual propagation by gonidia distributed by decay of the cell-membrane.

Var. RACEMOSA, Walz.

Oogonia shortly pedunculate, 3–5, sometimes 8–10, aggregated in a corymbose manner. Antheridia single, scarcely longer than the oogonia.

Syn. *Ectosperma geminata*, Vauch.; *Vaucheria Dillwynii*, Rab.; *Vauch. ovoidea*, Hass.; *Vauch. ovata*, Gray; *Ectosperma ovoidea*, Huds.

In stagnant waters, ditches, ponds, etc.

Frequently peculiar appendages known as *Vaucheria* galls occur on filaments of this and other species; somewhat urn-shaped excrescences, cylindrical cells, outgrowths of the plants; swollen below the middle, contracted at the base and distended at the truncate apex. They measure 200–350 μ in diameter, length three times greater. These are *Rotifer* nests produced probably by a sting or other irritation. The living creature is always seen in proper season near the bottom of the cell together with 10–20 or more, dull rose colored eggs. *Rotifers* (?) frequently make a home in the filaments of *Vaucheria*. G. Benko calls the parasite *Notommato Werneckii.*

Plate CXXVIII, figs. 1, 2, 3, parts of plants of true *V. geminata*; figs. 4, 5, forms of variety *racemosa* from specimens from Iowa and Pennsylvania; fig. 6, an abnormal but not rare form of fruiting; fig. 7, a gall, or *Rotifer's* nest.

VAUCHERIA HAMATA, (Vauch.) Lyngb.

Aquatic or terrestrial, thallus rather rigid, vaguely branched. Oogonia single or double, seated on short segments of the divided end of branchlets; when two oogonia, then a third intermediate segment develops the antheridium, which elongates and recurves. Mature oospores are involved in a sporoderm, formed of three or four membranes.

Syn. *Ectosperma hamata*, Vauch.; *Vaucheria hamulata*, Kg.

The only satisfactory specimens hitherto discovered are from California.

Plate CXXVIII, figs. 8–10, drawn from California specimens; single and twin oogonia.

Vaucheria terrestris, Lyngb.

Forms densely interwoven, thin, rather dark green strata, on moist soil. Oogonia usually single, sometimes in clusters, pedunculate, attached by a flattened base on the back of the incumbent, elongated, curved, antheridium. Mature oospore enclosed in a hyaline colorless sporoderm, composed of several membranes, considerably inflated.

Syn. *Ectosperma terrestris*, Vauch.; *Vaucheria circinata*, Kg.; *Vauch. polymorpha*, Wood.

Damp ground, clayey soil, green-houses, etc., often forming considerable patches.

Plate CXXIX, figs. 1–5, parts of fruiting filaments variously developed with one, two and more oogonia on a peduncle; figs. 6–8, oospores germinating.

Vaucheria velutina, Ag.

"Filaments exceedingly tough, interwoven into a dense, velvety, green stratum, pellucid below and creeping over the mud; branches near the extremity erect fastigiate, and more or less crooked; oogonia solitary, globular, on short lateral peduncles."—*Carmichael.*

Diameter of oogonia, 57–68 μ.

North Carolina, Schweinitz; West Point, New York; Waterville, Maine; Culpepper, Va., Bailey.

Have quoted the above from Wood's *Contribution*, p. 180. I have not recognized a plant to correspond in all particulars; appears to be near *V. sericea* in general character and also near *V. Dillwynii* in fruit.

Vaucheria Pilus, Martens.

Has the habitat and form of a very robust *V. dichotoma.* Filament simple or sparsely branched; diameter 180–200 μ; long; often hyaline, and mucose to the touch; apex rounded, sometimes slightly inflated; cell contents mucilaginous, granular, dull green. When dried, ash-gray, silky. Oospore nearly twice the diameter of the filament. The only specimens of this form of extraordinary size are from a ditch near Charlotte, Vermont.—*Coll. F. H. Hosford.*

The value of the species may be somewhat doubtful, as suggested by Rabenhorst. The specimens received were too limited and incomplete for a decided opinion; nevertheless the parts examined were of gigantean proportions.

Plate CXXVII, figs. 1–4.

VAUCHERIA TUBEROSA, A.Br.

Flagella subterranean, apices swollen, tuber-like. Filaments dichotomous, three or four, or more times divided; branches regularly constricted at the base of the divisions and often intermediately; lateral stolons not infrequent, repeatedly constricted, bead-like, much enlarged at the ends. Neither oogonia nor antheridia have been observed.

Have three distinct varieties of this strikingly peculiar plant. The type, Plate CXXX, was dredged in Lake Michigan by Prof. S. A. Forbes, four miles from Chicago, from a depth of six fathoms. It accords well with plants collected in Swiss lakes.

Var. INTERMEDIA, Wolle.

Plate CXXIX, figs. 9–11. This form has not, as far as observed, the tuberose swellings of the type, but has the distinct manner of branching and the constrictions at the bases of the *pseudo*-branchlets. It is bright green. The former is duller green, tinted with red at the constrictions; the swollen ends very dark, or bluish green.

Was found in marshes in Georgia by Capt. J. D. Smith.

Var. MINOR, Wolle.

Plate CXXIX, figs. 12–14, another form with only about half the diameter of var. *intermedia*, light green color; parts between the constrictions proportionately much longer and the dichotomous branching not so regular.

From small pools on the banks of the Susquehanna, Harrisburg, Pa.

Family XI.—BOTRYDIACEÆ.

Small unicellular plants, green, globose; on the surface of moist earth, with a system of colorless radicles, much divided, descending from the base of the cell into the earth.

Propagation takes place by means of sexual zoospores; these copulate and produce zygospores, which quickly develop and produce vegetative plants; the cell contents of these finally divide into an indefinite number of resting spores. These ejected, in turn germinate and again produce sexual microzoospores.

Asexual multiplication takes place also, by means of macrospores.

Genus 31, BOTRYDIUM, Wallr.

Vegetative plants unicellular, multiplying by division of cells and by development of zoospores. Asexual zoospores furnished with one, and sexual zoospores with two cilia. Sexual isospores, sometimes globular, sometimes compressed, alike capable of germination, are clothed with several tuberculate thickenings.

Rostafinski and Woromin's careful researches into this genus show that this plant has various modes of multiplication. Zoospores are produced in a fourfold way. 1. From the vegetative plant; 2. from the ordinary zoosporangia; 3. from the root cell, and 4. from the hypnosporangia. Further modes of increase are; 5, by cell division; 6, by formation of macrospores; 7, by formation of zoospores.

The plant possesses also fivefold resting stages: 1, of the asexual zoospores laid in water for months; 2, of the root cells; the year throughout in which they originated; 3, of the hypnosporangia; the year throughout in which they originated; 4. of the macrospores; for years; 5, of the isospores; at least over the year in which they originated.

In dry seasons, unfavorable to development, the cell contents are often scattered, and seemingly transmuted into forms which have been erroneously called *Protococcus coccoma; P. palustris*, and *P. botryoides*. In proper and favorable season, the same cells reproduce sexual microzoospores and these again the original form.

BOTRYDIUM GRANULATUM, Linn.

Usually gregarious, often aggregated, rarely confluent, cells globose-pyriform, size of a poppy seed, or more usually of a mustard seed, or larger; leek-green, sometimes pulverulent.

Syn. *Hydrogastrum granulatum*, Rab.; *Lichenoides fungiforme*, Ray Syn.; *Tremella palustris*, Dillen.; *Botrydium argillaceum*, Grev.; *Vaucheria radicata*, Hook.; *Ulva granulata*, Huds.

Plate CXXXI, figs. 1, 2, cells (plants) about twice the natural size; fig. 3, two empty cells with tops fallen in; figs. 4–7, cells magnified, with the system of subterranean radicles; fig. 8, the cell contents passing down into the radicles; fig. 9, the radicles developing zoospores; fig. 10, cell (zoosporangium) contents dividing and developing and scattering microzoospores; fig. 11, zoospores highly magnified, sexual; fig. 12, asexual macrospores; fig. 13, zoospores developing in the radicles, matured and ready to escape; fig. 14, radicle cells, more highly magnified, producing zoospores under culture in water; figs. 15, 16, zoospores 4–6 days old; figs. 17, 18, seven to eight days old; fig. 19, zoospores in radicles germinating, direct, on soil; fig. 20, zoospores developing into vegetative plants; figs. 21, 22, zoospores enlarging and producing sexual zoospores; figs. 23, 24, zoospores copulating; fig. 25, isospores, the result of the copulation of zoospores; fig. 26, after a few days the same become stellate.

Order IV.—PROTOCOCCOIDEÆ.

Strictly unicellular algæ, green, without terminal growth or ramification and without a vegetative generation of cells. Either single, segregate, or associated in families. Cells of the families either indefinitely increasing in number, then forming daughter *families*; or of a definite number, then forming a *coenobium*, sometimes parenchymatously united, yet *unicellular* because each cell is possessed of power of reproduction.

Propagation sexual by means of oogonia and antheridia, or by copulation of zoospores, bi-ciliate *macrospores*, or microspores. The life-history of many forms belonging to this Order of plants is not yet fully understood, but as far as known they develop zoospores of one or the other kind, or both, and are thereby separated from the CONJUGATÆ.

Family XII.—VOLVOCACEÆ.

Coenobia mobile during the entire period of life, each cell being furnished with two cilia. Cells green; common tegument of the coenobium more or less ample, usually hyaline.

Propagation sexual or asexual.

SEXUAL FORMS.

Coenobia spherical which by means of the cilia of the individual cells are mobile with more or less of a revolving motion. Sexual propagation by means of oogonia and antheridia. The latter are developed from a vegetative cell of the coenobium; this enlarges, the contents of the cell divide and form a cluster of small cells developing spermatozoids; the cell-membrane breaks and these escape. The oogonium in like manner is developed from a vegetative cell; this enlarges, and being enclosed by a single membrane, the spermatozoids perforate and enter it; thus fertilized the membrane increases in thickness, and the spore becomes a resting spore which in due time germinates.

Asexual propagation takes place by the division of larger vegetative cells (Parthenogonidia) which produce new families; these when sufficiently advanced separate from the mother cell and enter upon independent life.

Genus 32, VOLVOX, Ehrb.

Coenobium spherical, continually gliding along with a rotating motion; looking like a hollow globe, the surface composed of very numerous cells, gonidia, estimated as high as 12,000, arranged on the periphery at regular intervals, connected by a matrical gelatin, having the appearance of a membrane in which the gonidia are imbedded. Each gonidia is globose with an outwardly-directed process bearing on the apex two long exserted cilia extending beyond the common gelatinous envelope by which the coenobium is circumscribed. By the waving of the cilia the coenobium is kept in constant motion. The contents of the gonidia are chlorophyl-green including starch granules and often a red pigment spot.

The *oogonia* are larger flask-like cells (gonidia) extending from the periphery inwardly—they are sustained by the neck-like process bearing the cilia. The *spermatozoids* are produced in cells similar in appearance and similarly located, as already described; the spermatozoids are spindle-shaped, furnished with two cilia; they fertilize the oogonium by penetrating the membrane. The oogonia after a resting period, produce usually eight zoogonidia; the number is not regular, sometimes more or less.

Asexual propagation takes place by the division of the larger and darker flask-like cells, the larger end visible on the inner surface of the walls of the coenobia; the smaller neck-like end extending outwardly bearing the cilia. These divisions averaging about eight in number, soon round themselves and develop the young Volvoxes in the mother cell.

Within these young spheres, almost immediately after their production, may be seen the selected gonidia for another generation, they being the larger gonidia, of darker green color than the surrounding ones seen on the inside of the young coenobia.

Viewing the vast multitude of the gonidia on the surface of the sphere they appear to be detached, but upon a very close observation under a high power and a carefully adjusted light, it appears that from each gonidium there runs to each of the six surrounding ones a fine thread, sometimes double, always of extreme tenuity, and often so delicate as not to be seen at all, except by the use of reagents which often bring these lines into view, where it had been impossible to detect them.

VOLVOX GLOBATOR, Linn.

Larger coenobia with very numerous cells, (gonidia) always with daughter-coenobia enclosed within the maternal one, evolved without sexuality; fructification monœcious; oogonia and antheridia developing in the same coenobium. The oogonia are often numerous.

Diameter of well developed coenobia, often 650 μ.
Diameter of vegetative cells, 2–3 μ.
Diameter of oogonia about 50 μ.
Diameter of antheridia about 35 μ.
Diameter of spermatozoids, 4–6 μ long.

Plate CLI, figs. 1–4, different stages of development, the latter with encysted resting spores.

Plate CLII, fig. 1, coenobium showing the fine threads connecting the gonidia; fig. 2, enlarged figure of connecting threads; fig. 3, an ideal section of the wall of a coenobium, showing the gonidia, flask-like, imbedded, with ciliated ends; basal parts often developing oogonia and antheridia; fig. 4, coenobium with three stellate resting spores; fig. 5, a stellate oogonium or resting spore; fig. 6, an exaggerated ideal of a section of a coenobium illustrating the ciliated ends of the gonidia extending through the gelatinous envelope; two oogonia dividing, a stellate resting spore and two undeveloped oogonia; fig. 7, a complete antheridium, after Wills; figs. 8, 9, spermatozoids.

Much disparity of opinion and uncertainty prevail regarding the mode of fructification; some maintaining they are monœcious and others diœcious.

VOLVOX AUREUS, Ehrb.

These are larger spherical cells, surrounded by a thick, smooth, colorless, often lamellate epispore, found within a mother coenobium; probably merely resting spores.

Plate CLI, fig. 4, six such resting spores.

VOLVOX STELLATUS, Ehrb.

Stellate forms are sometimes very numerous in a coenobium, varying in number from ten to one hundred and more in a single sphere. These are supposed to be fecundated oospores, originated in a female coenobium.

Plate CLII, fig. 4, three stellate forms; fig. 6 has one included; fig. 5, one separated from the coenobium.

SPHAEROSIRA VOLVOX, Ehrb.

Some authors consider this form related to *Volvox;* others regard it as the male form; that it is related to *Volvox* is certain, but whether any distinct functional relation exists between them has not been satisfactorily determined. Probably it is merely a peculiar condition of dissolution, cells enlarging somewhat after separation from the walls of the coenobium.

A form by no means rare in ponds in which the *Volvox* prevails. It may be obtained also in vessels in which *Volvox globator* is kept for cultivation.

Plate CLI, fig. 5, a part of a coenobium of *Sphaerosira volvox.* Description after Williamson in Cooke's *British Fresh-water Algæ;* fig. 6, protoplasmic mass from the coenobium containing granules; fig. 7, mass divided into two; fig. 8, mass divided into four parts, and fig. 9, into thirty-two parts, each with movable cilia; fig. 10, discoid family revolving in the mother sphere.

These discoid families have come under my observation, not in the sphere, but outside; they were evidently parts of a broken, or partially decayed coenobium.

Volvox globator is distributed over the whole length and breadth of the United States; it is found in ponds and pools, most abundant in warm weather, but in good condition, also in midwinter. The specimens examined from many localities, from Maine to Florida and westward, appear to be one and the same species.

VOLVOX MINOR, Stein.

I judge to be merely a variety of uncertain value.

Genus 33, EUDORINA, Ehrb.

Coenobium somewhat ovate or spherical, involved in a more or less gelatinous hyaline tegument, composed of 16–32 globose green cells arranged around the colorless sphere at subequal distances; each cell furnished with two vibratile cilia protruding through the tegument. Usually four of the thirty-two cells develop antheridia and others oogonia. In each antheridium sixty-four spindle- or pear-shaped spermatozoids are developed of light green tint with colorless beak bearing two cilia, (Kirch.).

Asexual propagation takes place by the division of the cells into 16–32 parts, each of which produces a new coenobium.

EUDORINA STAGNALE, Wolle.

Coenobium spherical, usually composed of thirty-two globose cells arranged more or less regularly around the inside of the walls; the cilia pass through the tegument and by constant vibration the coenobium is kept in activity. They are very variable in size, due to age, reckoned by hours, from their escape from the mother cell.

Diameter, 25–200 μ.

Diameter of cells, 5–18 μ.

This plant is easily confounded with *Pandorina morum.* The feature mainly to be relied upon is the arrangement of the cells; in *Eudorina* they are more or less regularly placed around the inside of the walls; in *Pandorina* they are more densely clustered, often grape-like, nearly filling the cavity to the center.

Found this plant repeatedly in pools filled by rains; the water was green with the multitude of coenobia it contained, all spherical, ranging in size as indicated above. The multiplication is asexual and very rapid.

The plant is unlike the only European species *E. elegans*, Ehrb., in that it is not oval in form, and the cells are much smaller.

Plate CLII, figs. 11–21. Fig. 11, a coenobium of sixteen cells; fig. 12, cells dividing, making thirty-two; fig. 13, a matured sphere, ready to break and scatter the cells, developing young coenobia; figs. 14–21, various stages of development of cells, all in active motion; figs. 22, 23, spermatozoids.

Genus 34, PANDORINA, Ehrb.

Coenobium globose, or subglobose, invested by a colorless, gelatinous tegument; cells green, granulose, globose; 8–16–32–64 in a coenobium, each enclosed in a thin membrane and furnished at maturity with two cilia; often crowded in the coenobium and for the time polygonal.

Propagation sexual, by the conjugation of zoospheres. Cells of a coenobium divide into eight daughter cells, these are scattered and conjugate with similar cells from other coenobia; they flow together and produce a zygospore, which after a season of rest develops 1–3 large bi-ciliate macrospores, and these in turn develop new coenobia.

PANDORINA MORUM, Bory.

Coenobium spherical or somewhat oval, usually composed of sixteen cells; may vary by multiples of 8, from 8–64. Zygospore with a smooth epispore.

Diameter of coenobia up to 220 μ.

Diameter of vegetative cells, 9–15 μ.

Plate CLIII, figs. 1–5, the most frequent condition observed; figs. 6, 7, coenobia with more numerous cells densely clustered; figs. 8, 9, very fugacious coenobia; placed to this species with some hesitancy; fig. 10, a matured coenobium; the cells in condition for independent existence—ready to escape from the maternal tegument.

In larger or smaller pools of stagnant water.

Genus 35, EUGLENA, Ehrb.

Cells more or less fusiform or elongate, mobile, exceedingly flexible and changeable in shape, terminating posteriorly by a more or less developed tail-like prolongation; anteriorly furnished with a long flagellum by means of which they keep up a forward and rolling or rocking motion. Increasing by longitudinal division, and by the production of germs through the subdivision of the cell contents. Usually they have a red eye-spot.

EUGLENA VIRIDIS, Ehrb.

Cells elongate, subcylindrical or fusiform, exceedingly flexible and variable in shape, mostly rounded anteriorly, and with a short transparent tail-like posterior prolongation; cell contents usually bright green, but sometimes changing to dark orange or red. Flagellum slender, exceeding the body in length; a red pigment spot generally present at the anterior extremity. After a longer or shorter period of activity the cells come to rest, contract and assume a spherical form and throw around themselves a gelatinous envelope which gradually becomes indurate. These cells under favorable circumstances divide into two and then into four green cells; finally the *Euglena* form is reproduced.

Cells 40–62 μ long.

Common in stagnant waters.

Plate CLV, figs. 1–8, normal forms capable of polymorphic contours at will; figs. 9–15, cells contracting and coming to rest, forming encysted sporular bodies; figs. 16–19, encysted bodies in more advanced stages, dividing into two and four parts; figs. 20, encysted forms often in great numbers; figs. 21, 22, sporangial bodies ejecting microzoogonidia.

The encysted forms are often very abundant, forming a thick scum, or floating crust. In this quiescent state the cells have been mistaken for independent forms of algæ. *Microcystis olivacea; M. Noltii;* also *Protococcus turgidus* and *P. chalybius*, of Kuetzing, are now regarded as representing variable phases of this resting condition of *Euglena viridis.*

The forms included in this genus have been most commonly classified with the *Infusoria*, but not without dissent. Such authorities as C. A. Agardh, Kützing, also Perty, Bergmann, Lenkhart and Carter, and more recently Cienkowski, Hansgirg and others, refer them to plants, the Fresh-water Algæ. Stein, the distinguished German authority on *Infusoria*, recognizes organs he takes for mouth and pharyngeal tract, which are essential to animal existence, but acknowledges that no solid food has been seen to pass through these organs. Dr. Hansgirg thinks the organs observed are not really mouth and throat, but serve a respiratory office (respiration of water). They stand in connection with the contractile vacuoles and serve the function of osmose and exosmose which in other algæ, particularly some of the *Oscillarieæ* are supposed to facilitate the power of locomotion.

Euglena have generally (not invariably) a red eye-spot which has been taken to indicate animal life, but such is not necessarily the case; the same red pigment spot is found more or less frequent in most of the forms of *Volvocaceæ.*

Am aware that Kent in his Manual of the *Infusoria*, tells of some of the latest and perhaps most exhaustive examinations made by himself, by keeping *Euglena* specimens for a prolonged interval in water with finely pulverized carmine, and then discovered, by submitting them to a magnification of 800 diameters, very small particles of carmine in the body; but the question arises, could not these have found entrance by absorption through the respiratory organs, as suggested by Dr. Hansgirg?

However this may be, they are so frequently observed with recognized algæ forms, we place them here until a more unanimous opinion may be formed regarding them.

Genus 36, GONIUM, Mueller.

Coenobium composed of 4–16 cells, so arranged in a single flat stratum to produce a quadrangular, tabular form, with angles rounded. The whole enclosed in a colorless tegument. Cells globular or by mutual pressure somewhat polygonal, bright green, becoming with age disordered, granulose, connected by the produced angles; chlorophylose vesicles central, furnished with colorless contractile vacuoles, and two long exserted cilia.

Propagation by repeated division of the cytioplasm.

GONIUM PECTORALE, Mueller.

Coenobium flattened, quadrangular, composed of sixteen green cells, furnished with vibratile cilia, usually four cells in the center, and three on each side.

Diameter of coenobia, 23–90 μ.

Diameter of vegetative cells, 5–15 μ.

Stagnant waters, rare.

The above diagnosis applies to the European plant. The very few specimens found, from New Jersey and Pennsylvania, were too limited for definite description; they appear to be the same.

Plate CLI, fig. 15, lateral view of a coenobium; figs. 16, 17, two coenobia in front view; fig. 18, a coenobium before division.

Genus 37, STEPHANOSPHAERA, Cohn.

Coenobium throughout its whole life rotating and moving, composed of eight green cells, bearing two vibratile cilia, disposed at equal distances around a circle, enclosed in a common colorless hyaline, globose vesicle.

Propagation, both by macrogonidia arising from eight-fold division of the green cells, bearing two cilia, with a lateral red spot, congregated in families of eight; and by microgonidia, very much smaller, produced by multiplied division, at first revolving within the common vesicle by the action of four cilia, afterwards free, escaping singly.

STEPHANOSPHAERA PLUVIALIS, Cohn.

Cells globose, elliptic or fusiform, often at each extremity spreading out in mucous rays.

Diameter of coenobia, 30–60 μ.

Diameter of vegetative cells, 7–12 μ.

In hollows of rocks, and in pools after rain.

This interesting little plant was first observed in Germany in 1850, and since in many places including the British Isles. Presumably it will be discovered in this country also. In anticipation, have quoted the above from European works. Prof. Cohn made exhaustive examinations and studies of the life-history of *Stephanosphaera* and has prepared able memoirs, the first of which appeared in Liebold & Kolliker's *Zeitschrift für Zoologie*, 1852; the other in Nova Acta Acad. Leop. Cur., 1857, part I, vol. XXVI, to which the student is referred for full particulars. The same author has also given an excellent paper on the previous genus, *Gonium*, in the *Nova Acta*, vol. XXIV, p. 169.

Plate CLI, fig. 11, polar view of family with globose primordial cells; fig. 12, lateral view, with fusiform primordial cells ending in mucous filaments; fig. 13, commencement of formation of macrogonidia; fig. 14, division of macrogonidia advancing so that each cell consists of eight cuneate segments.

Genus 38, CHLAMYDOCOCCUS, A. Br.

Cells globose, or subglobose, (4–8 joined in a very fugitive coenobium) cell membrane thickish, firm; cell contents granular, brownish red or vermilion, in certain stages changing into green, or partially green with red center. Macrogonidia 2–4–8 rounded, the frontal extremity bearing long cilia, containing 4–6 starch granules, (not always visible,) involved in an ample, hyaline, mostly ovoid tegument. Microgonidia much smaller, numerous, yellowish or dull green, the apex reddish, biciliate, moving actively within the mother cell, and at last escaping by rupture of the membrane.

CHLAMYDOCOCCUS PLUVIALIS, A. Br.

Cells subglobose, very variable in size; brownish red, changing in some conditions to green.

Diameter of cells, 7–40 μ.

Perhaps no plant is more *Proteus*-like than this little form; normally sometimes like a plant, and sometimes like an animal; ordinarily it presents the appearance of small globules, with a thick, tough, granular or punctate cell-membrane; cell contents opaque, of a brown, reddish-brown, or red color; found in small pools of rain water.

Dr. F. Cohn devoted two years of his time to a full comprehension of the life-history of this species; he, adopting the name of *Protococcus pluvialis*, prepared an elaborate memoir, filling 160 pages in the Nova Acta Acad. Caes. Leop. Carol. Nat. Cur. Vol. XXII, P. II, to which the student is referred for the full, original details. Translations may be seen in A. Braun's *Rejuvenescence*, pp. 206–214, and "Memoirs," by the Ray Society, 1853. Dr. Cohn expresses surprise that so simple a form should have evoked so many different views. Almost every botanist who made the plant a study suggested a new generic name. It is found in the writings of different specialists under the following terms, *Chlamydomonas*, *Astasia*, *Gyges*, *Disceraea*, *Protococcus*, *Gloiococcus*, *Haematococcus*, *Palmella*, *Sphaerella*, *Microcystis*, *Uredo*, *Torula*, *Dematium*, *Byssus*, and *Lepraria*. It would not be in accord with the design of the present work to enter upon lengthy details of the life-history of the plant under consideration, but for illustrating a few of the many forms a plant may assume in the round of its development, we copy some of Cohn's illustrations, and add very brief explanations. After a contemplation of these figures, the diversified ideas expressed by the many generic names as above applied to this plant may not seem so strange.

Plate CLIII, figs. 11–26, cells of resting forms of *Chl. pluvialis;* figs. 11, 12, two cells, carmine red, as they appear after being dried for some time; fig. 13, a large cell, lighter red around the margins with a light central spot; fig. 14, a cell similar to last gradually changing to green with a light central spot; fig. 15, cell chlorophyl green, with illuminated spot surrounded by a halo of red; fig. 16, a reddish brown cell, with the middle changing to green, membrane thin; fig. 17, a cell kept for six years in a dried state, restored with moisture; it divides, one-half being green, the other half reddish brown; fig. 18, cell red, changes its form preparatory to division; fig. 19, division progressing; fig. 20, the same cell divided. The two daughter cells have a thin membrane each, and still enclosed in the maternal membrane; fig. 21, cells divided a second time, producing four, partially green cells; fig. 22, a cell divided at once into four spherical brown cells, somewhat motile in the maternal membrane; fig. 23, similar to fig. 22, showing only three cells; fig. 24, resting cell red and green within a wide colorless envelope; fig. 25, a green cell, red in the center, at the point of changing into a mobile body; fig. 26, another cell like the last, with light green margins, middle red, preparing for mobility; figs. 27–29, zoospores without envelope, green; figs. 30–32, three forms of zoospores, each enclosed in a wide membranous envelope; fig. 33, commencement of a division of a green cell into four parts; fig. 34, completion of the division of a green cell into four, each part developing a complete zygospore with two cilia; fig. 35, an abnormal division of a cell into six parts, producing four cells of normal size and two smaller ones; fig. 36, same as last; fig. 37, a vegetative green primordial cell; fig. 38, cell dissolving, the primordial cell breaking up into green and red granules; fig. 39, a resting cell developing a colorless end; commencement of germination; fig. 40, division of a resting cell into two somewhat elliptical cells, center red, surrounded by light and then darker green; fig. 41, elliptic cell, middle red, margins lighter or darker green; fig. 42, division of a resting cell into eight. The maternal cell dissolves into a gelatinous mass containing eight cylindrical, red, motile cells; fig. 43, two cylindrical cells developed from the young forms in fig. 42, red, with margins green; fig. 44, green cell, center red; fig. 45, eight small, light green cells with red centers resulting from the division of a single cell; fig. 46, grape-like cluster developed from an unsheathed form, resting without having passed through the usual swarming period of life; fig. 47, a large, deep green cell developed from a sheathed resting spore, containing many green granules; fig. 48, cell similar to the last, but red, which during observation broke up into eight small subcylindrical parts, which soon broke through the membrane as active zoospores; fig. 49, similar to the preceding (48), breaks up into more numerous parts, but in consequence of previous dried condition the parts become resting spores; fig. 50, large resting spore, red, breaks up into a larger number of smaller parts; fig. 51, zoospore with hyaline membranous envelope, dark red.

These 41 are selected from Cohn's 114 figures. Each a different condition of the same plant.

CHLAMYDOCOCCUS NIVALIS, A.Br.

Cells globose, red, at first with a hyaline border, which is the thickened epispore, but gradually disappears with age.

Diameter of cells, 10–35 μ.

Syn. *Haematococcus nivalis*, Ag.; *Protococcus nivalis*, Ag.; *Palmella nivalis*, Hook; *Coccophysium nivale*, Link.; *Tremella nivalis*, A.Br.; *Uredo nivalis*, Bauer.

This plant, familiarly known as RED SNOW, is frequently found on the higher peaks of the Rocky Mountains. It is upon the snow and ice of the Arctic regions, the snow-capped peaks of the Alps and similar localities, that this little plant prevails. The notice of botanists was first drawn to it by Capt. Ross, 1819, on his return from Baffin's Bay, where it was found extending for miles giving a red tinge to the snow. Dr. Kane and other later explorers, report its frequent occurrence. Judging by the descriptions given, the arctic plant does not differ essentially from the form found on the high peaks of our Western chain of mountains. If brought to a lower temperature and cultivated, it may be questioned whether it would prove specifically distinct from *Chl. pluvialis.*

The plants as we receive them from the Rocky Mountains, or from the Arctic regions, are in a quiescent state (resting spores) which multiply rapidly by the simple process of division of cells and would seem to belong to the genus *Protococcus*, but A. Braun and others who had more facilities to observe the whole process of propagation, find they pass through the various stages of a *Chlamydococcus*, forming fugitive coenobia, macrogonidia and microgonidia furnished with two cilia, etc.

Plate CLIV, figs. 1, 2, simple cells; figs. 3, 4, two cells dividing into two, and into four parts.

Genus 39, CHLAMYDOMONAS, Ehrb.

Macrogonidia ovate or oblong-rounded, green, delicately granulated, involved in a rather narrow hyaline tegument, frontal extremity very obtuse, or somewhat truncate with a contractile vacuole, and two cilia; posterior extremity with a large chlorophylose vesicle and with or without a red lateral spot. Microgonidia arising from repeated division of the cytioplasm of the macrogonidia; oblong or ovate, numerous, pale green or yellow, becoming brownish; oospores globose, red or brownish; contents firm, colorless, hyaline.

CHLAMYDOMONAS TINGENS, A. Br.

Macrogónidia small, ovate or oval, light green without a red pigment spot, membrane close.

Diameter of cells, 7–8 μ; length, 14–25 μ.

Pools and ditches.

Plate CLIV, figs. 5, 6, a variety of sizes of macrogonidia.

CHLAMYDOMONAS PLUVIALE, Wolle.

Macrogonidia spherical or nearly so; bright-light green;

polar vacuole often indistinct; membrane thin and close, cytioplasm divides into two, or more rarely four parts.

Diameter of cells, 4–8 μ.

Pits of rain water, often in large numbers.

Plate CLIV, figs. 7, 8, the normal appearance.

CHLAMYDOMONAS HYALINA, Cohn.

Macrogonidia oblong elliptical, ends more or less rounded, thin-green, or whitish-green, anterior end furnished with two long cilia.

Diameter of macrogonidia, 14–22 μ; length fully equal to two diameters.

Found countless myriads in lake, Wayne County, Pennsylvania, near the shore and extending outward, giving the water a thin milky-green appearance. Dipped with the hollow of the hand, the motile cells were distinctly visible without the aid of glasses.

Plate CLIV, figs. 9, 10, drawn too small in comparison with figs. 7, 8.

CHLAMYDOMONAS PULVIUSCULUS, Ehrb.

Macrogonidia ovate, nearly twice as long as broad; deep green, with a bright red lateral spot.

Diameter of macrogonidia, 6–13 μ (Rab.); 12–19 μ long (Kirchner).

Syn. *Diselmis viridis*, Dujard.

I quote this species so common throughout Europe, certain it must be found here, although hitherto escaped my notice. In size and form it is almost identical with *Chl. hyalina*, but deep green in color and possesses a distinct red, lateral pigment spot.

Plate CLV, figs. 23, 24, a usual appearance of this species, the latter a zoospore indicating much activity by means of two cilia; fig. 25, an encysted form divided into two; figs. 26. 27, a similar form divided into four parts; fig. 28, cell divided, forming new encysted cells; fig. 29, two red resting cells; fig. 30, a macrozoospore, contents dividing; fig. 31, a cell with contents divided; parts escaping as microzoogonidia.

Family XIII.—PROTOCOCCACEÆ.

Vegetative cells not provided with cilia, either single, or united, forming coenobia.

Propagation by copulation of zoogonidia; or by asexual zoospores. Division of vegetative cells does not occur.

The plants of this Family may be divided into three sections.

I. Cells which form coenobia.
II. Cells which form *pseudo*-coenobia.
III. Cells which remain detached.

I. Coenobia.—Single cells unite into regular, definite forms called coenobia. These are developed primarily from single cells, daughter cells from the same maternal cell. They are separated from multicellular plants by the fact, that the single cells are incapable of division and that each may develop the original form.

Genus 40, PEDIASTRUM, Meyen.

For the plants of this genus, refer to *Desmids of the United States*, page 152.

Genus 41, HYDRODICTYON, Roth.

Coenobia formed by oblong-cylindrical cells united at the ends into a reticulated structure; primarily saccate, later simple net work; cells all fertile, some producing macrogonidia, which join themselves into a coenobium within the mother cell, others producing microgonidia, which are furnished with two or four vibratile cilia, and a lateral red spot. These are motile for a time in the maternal cell and then escape through a pore in the cell wall. They continue active for a short time during which they copulate, then rest, assuming a spherical form and a firmer cell membrane; they lie dormant, may become perfectly dried, but after being restored by moisture they develop 2–5 biciliate zoospores, which in turn, after a short season of mobile life, come to rest, develop into large irregular, somewhat square cells, cuspidate angles, which soon cast off the membrane and yield young saccate coenobia.

Hydrodictyon utriculatum, Roth.

Size of the coenobia very variable, differing mainly according to age; the younger ones so small that fifty or more could be arranged within the compass of a single mesh of an older plant.

Often very abundant in sluggish, and stagnant waters.

Plate CLIV, figs. 11–14, parts of coenobia of various degrees of development; figs. 15, 16, very young coenobia; fig. 17, cell with microgonidia; fig. 18, cell with macrogonidia; fig. 19, free macrogonidia; fig. 20, active macrogonidia or zoospores. The latter four are taken from Cohn.

Genus 42, COELASTRUM, Naeg.

Coenobium globose, hollow within, formed of a single stratum of green cells, primarily globose; later the coenobium appears reticularly pierced; in older growths the cells are sometimes polygonal from mutual pressure on the sides.

Macrozoospores develop daughter coenobia within the maternal cell, which escape by the rupture of the membrane of the latter.

Coelastrum microporum, Naeg.

Coenobium spherical, diameter, 40–100 μ, consisting of eight, sixteen or thirty-two globose cells, with interstitial openings through which the interior of the coenobium may be penetrated. Diameter of the globose cells varies according to age; sometimes as much as 25 μ.

Var. speciosum, Wolle.

A large and beautiful variety in which the green spherical cells appear to be joined in the center of the coenobium by gelatinous cords. Diameter of cells and of coenobium rather larger than the type-form.

This beautiful form may be a distinct species, but have hitherto seen too few perfect specimens to pronounce it such.

Ponds and pools.

Plate CLVI, figs. 1–3, a fully developed form and two younger specimens; fig. 4, var. *speciosum.*

Coelastrum cambricum, Arch.

Coenobium spherical; cells angular, rounded on the exterior margin, each bearing a single truncate tubercular process; sometimes with, but often without interstices.

The only description of this species at my command is very brief and without illustration. I infer my plant is the same and hence adopt the name provisionally. The plant is entirely unlike *C. sphaericum* and *C. cubicum*, Naeg.

Diameter of well-grown specimens about 70 μ; often much smaller, cells of a coenobium in view, usually only ten. Color light yellowish green, or colorless, except the young coenobia in each cell, bright green.

Ponds, not infrequent.

Plate CLVI, fig. 5, a coenobium near maturity, the time for yielding up the young plants.

Genus 43, SORASTRUM, Kg.

Coenobium globose, solid within, free swimming, composed of four, eight, sixteen or thirty-two compressed wedge-shaped cells, which are sinuate, emarginate, or bifid at the apex and radiately disposed.

Propagation unknown.

SORASTRUM SPINULOSUM, Kg.

Coenobium globose, spinulose; apex slightly emarginate, angles obtusely rounded with two spines at each rounded angle. Coenobia vary in diameter from 25–75 μ. Cells 12–22 μ wide.

The distinctive feature between this plant and those of the last preceding genus is, that this forms a solid coenobium, the others are hollow.

More frequent than *Coelastrum*.

Plate CLVI, figs. 6–10, smaller and larger coenobia, as they differ in age; fig. 10, differs more than the others, but not sufficiently distinct for another species.

Genus 44, STAUROGENIA, Kg.

Coenobium cubical, hollow within, composed of four or eight or sometimes sixteen subquádrate cells.

Propagation by quiescent gonidia, produced after the subdivision of the cell contents.

Syn. *Crucigenia*, Morren.

STAUROGENIA CRUCIATUM, Wolle.

Coenobium consisting of four equilateral rhomboidal cells, sides incurved, angles rounded, together forming a somewhat square or rhomboidal figure. Cells united by a mucilaginous deposit around or between them; measure of coenobia, 22–24 μ each way; cells about 10 μ; each with a cruciform marking on the surface.

Small pond, near Bethlehem, Pa.

Plate CLVII, figs. 9, 10, 11, three different forms; fig. 11 having dropped one cell.

Genus 45, SCENEDESMUS, Meyen.

Cells elliptic, oblong, cylindrical, ovate, or spherical, equal or unequal at the ends; often produced with a longer or shorter spine. Cells most frequently laterally united, forming coenobia. Propagation by means of the repeated segmentation of the cell contents into one or more brood families set free by the rupture of the maternal cell membrane.

Cells armed, or unarmed.

SCENEDESMUS CAUDATUS, Corda.

Cells oblong-cylindrical, each extremity obtusely rounded, 2–4–8 closely united in a simple series (rarely also in double series) the outer cells of a series armed at each extremity with a recurved spine. Length of cells about 22 μ.

Kirchner makes the following varieties, which occur freely with us also:

Var. TYPICUS, Kirch. Spines on the end cells only.

Var. SETOSUS, Kirch. Spines on intermediate cells also.

Var. HORRIDUS, Kirch. Spines on all the cells of a series.

Var. ABUNDANS, Kirch. Spines in the middle of a cell, beside those on the ends.

Syn. *Scenedesmus quadricauda*, Breb.; *S. quadricaudatus*, Ralfs.

Plate CLVI, figs. 11, 12, var. *typicus;* figs. 13, 14, smaller forms; fig. 15, var. *horridus.*

SCENEDESMUS ANTENNATUS, Breb. Var. RECTUS, Wolle.

Cells fusiform, 2–4 usually joined in a single series; rarely a double series. Cells all somewhat curved and cuspidate at the apex.

Var. RECTUS is separated from the typical form by its universally straight cells and straight spines, not recurved.

Diameter of cells, without spines, 13–14 μ.

Diameter of cells of variety, 14–16 μ.

Exposed moist white sand, Florida. Sometimes made green with this variety. Have not identified the type-form; have quoted the diagnosis from Rabenhorst's *Flora Algarum.*

Plate CLVI, figs. 16, 17.

Scenedesmus dimorphus, Kg.

Cells fusiform, acute, four to eight placed evenly in a single row; inner cells fusiform with ends often drawn out, thin and long; outer cells externally lunate.

Syn. *S. bilunatus et geminatus*, Kg.; *S. pectinatus*, Meyen; *Achnanthes dimorpha*, Turp.; *Arthrodesmus pectinatus*, Ehrb.

Smaller stagnant pools.

Plate CLVI, figs. 18–21, four forms. Sizes about the same as the preceding species—all are liable to some variation.

Scenedesmus acutus, Meyen.

Cells fusiform, acute at each end, spineless, two to eight united in a series, either single or double, straight and irregularly alternately locked together. Three to six times as long as wide. Transverse diameter of cells, 4–6 μ.

Ponds and pools.

Syn. *S. fusiformis*, Menegh.; *Arthrodesmus acutas*, Ehrb.

Plate CLVI, figs. 25, 26, two series of cells.

Scenedesmus obtusus, Meyen.

Cells oblong or ovate, obtuse at the ends, four to eight loosely connected in a simple series, or two series side by side, the thinner ends of the cells interlocking. Cells three to five times as long as broad.

Diameter of cells, 6–7 μ.

Ponds and pools; not as frequent as some of the other forms. There is however a small form of cells, 6–7 μ long, in series of two to four or more, in basins of fountains, which may belong here. These occur in quantity.

Plate CLVI, fig. 22, the typical form; figs. 23, 24, the forms from fountain basins.

Scenedesmus polymorphus, Wood.

Cells fusiform, or oval or elliptic or globose, single or two to seven conjoined, furnished in most cases with a single spine, sometimes two at each end; ends obtuse, subacute, or very acute; spines exceedingly slender and acute, straight, moderately long, inclined.

Diameter of cells, 4–12 μ.

Dr. Wood remarks, "This plant was found in a quiet pool, filling the water in such numbers as to make it opaque and very green."

To the present author this appears more like a heterogeneous mixture than a species.

SCENEDESMUS ROTUNDATUS, Wood.

Cells globose or subglobose, armed with three to five very long, slender, acute, straight spines, single or in pairs, or three to four closely conjoined in a two-fold rank.

Diameter, 4–8 μ.

Plate CLVI, fig. 27.

Dr. Wood's remark to this form, "It seems scarcely correct to place this plant in the genus *Scenedesmus*, but I do not know any other genus to which it is more closely allied." Wood's *Contribution*, p. 91.

This form is not infrequently intermingled with other species of *Scenedesmus;* it certainly appears related, but whether a distinct species, or merely connected in some way in a process of development, has not been made clear.

II. PSEUDO-COENOBIA.—The single cells united into a coenobium-like family, but separated from a true coenobium by the cells not all belonging to the same generation.

Genus 46, SCIADIUM, A.Br.

Family is composed of a number of cylindrical cells, each contracted at the base into a short slender stem by which they are united, causing the long cells to spread above. Gonidia six to eight, resulting from the division of the cell contents; at length protruding from the ruptured apex, retained at the mouth and extending in the form of an umbel. This process is repeated to a third, or sometimes a fourth generation. Ultimate cells produce free biciliate zoogonidia.

SCIADIUM ARBUSCULA, A. Br.

Umbellate, cells straight, rarely falcate, obtuse at the apex; contracted at the base into a short stem whose length is about the same as the diameter of the cell.

Diameter of cells 4 μ, with exceptions 3–5 μ.

Syn. *Ophiocytium arbuscula*, (Naeg.) Rab.

Rather rare, but had single specimens from three or four States. In small pools.

Plate CLVII, figs. 1, 2, young cells; fig. 3, commencement of the first generation of daughter cells; fig. 4, farther progress of the progeny; fig. 5, a second generation being evolved from the first; fig. 6, a third generation developing from the last.

SCIADIUM GRACILIPES, A. Br.

Simple umbels, in connection by means of a cell; usually floating; a loose and vague growth; cells cylindrical, straight, rarely slightly curved (foreign plants sometimes spirally twisted); apices obtuse; stems slight, with stipe nearly twice as long as the diameter of the cell.

Diameter of cells, 4–5 μ.

Only locality hitherto discovered, pool, Minnesota.

Syn. *Ophiocytium gracilipes*, A. Br.

Plate CLVII, figs. 7, 8, from a specimen, Minnesota.

III. EREMOBIA.—The single cells do not remain together, but scatter, and live independent of one another; if not widely separated they may form clusters of irregular forms, but no coenobia.

Genus 47, OPHIOCYTIUM, Naeg.

Cells cylindrical, straight, variously curved or circinate, attenuate at one end into a thin, short stem or mucro; sometimes both ends rounded bearing each a longer or shorter spine, and sometimes without spines.

Foreign authors seem unanimous in declaring "One or the other pole attenuated into a thin, short stem; the other pole rounded." Our forms, evidently belonging to the same genus, differ in this regard.

Propagation by means of zoospores as in *Sciadium* with this difference, that the daughter generations of the former remain attached, in the present they are set free.

OPHIOCYTIUM COCHLEARE, A. Br.

Cells cylindrical, slender, pale-green, often very long, filiform, variously curved or circinate, one end attenuated into a spine-like process acute or truncate; other end rounded; contents homogeneous.

Diameter of cells, 5–8 μ.

Frequent in ponds of stagnant water.

Syn. *Ophiothrix apiculata*, Naeg.; *Spirodiscus cochlearis*, Eich.

Plate CLVIII, figs. 8–14, the usual appearance of the plant.

Ophiocytium capitatum, Wolle.

Cells short, five to six times longer than broad, nearly straight, or arched, with both ends more or less incurved and most frequently somewhat enlarged, rounded, a spine on each end.

Diameter of cells, 6–9 μ.

Not infrequent in ponds, East and West.

Plate CLVIII, figs. 3–7, different forms.

Ophiocytium parvulum, (Perty) A.Br.

Cells small, variously curved, and often interwoven into masses, both ends rounded, no spines. Near *O. cochleare*, but smaller and spineless.

Syn. *Brochidium parvulum*, Perty.

Ophiocytium circinatum, Wolle.

Cells cylindrical filiform, long, circinate, repeatedly coiled, ends obtusely rounded, no spines.

Diameter of cells, 10–13 μ.

Specimens frequent in pond near Minneapolis, Minn.—*Coll. Miss E. Butler.*

Plate CLVIII, figs. 15–18, four cells of ordinary appearance.

Ophiocytium cuspidatum, (Bailey) Rab.

Cells large, smooth, crescent-shaped, *Closterium*-like, ends mucronate. Four to five times longer than broad.

Diameter 50 μ; length 150–165 μ; length of spines, 15 μ.

Syn. *Closterium cuspidatum*, Bailey.

Rather rare—Bailey found it in several localities; personally collected it only in Gilder Pond, Massachusetts, but received specimens from Minnesota and from California.

Plate CLVIII, figs. 1, 2, after specimens from Gilder Pond, Massachusetts.

Genus 48, CHARACIUM, A. Br.

Cells always attached; at one end usually distinctly stipitate, variable in form; oblong, ovate, pyriform, fusiform, etc. Cell contents green, homogeneous or granular; zoogonidia succeeding division of the cytioplasm, more or less numerous, occupying the whole of the cell, at length greatly agitated, escaping by a lateral, more rarely terminal, pore or rupture; oblong with two vibratile cilia.—*A. Br.*

CHARACIUM SESSILE, Herm.

Cell globose or broadly ovate, with apex somewhat produced; one-half longer than broad, green; cytioplasm often concentrated or contracted in the middle.

Diameter, 7–9 μ.

Frequent on filamentous algæ.

Plate CLIX, fig. 1, five cells nearly matured.

CHARACIUM ACUTUM, A. Br.

Cells straight, usually erect, ovate, tapering gradually at both ends, producing a short neck at the apex and a stipe at the base; apex at first acute and closed, later open to admit the escape of the zoospores; stipe short, dilated at the end, cytioplasm homogeneous, or granular, pale-green, contracts and then divides producing zoospores.

Diameter of cells, 7–10 μ.

Syn. *Hydrianum acutum*, Rab.

Parasitic on larger forms of the algæ; ponds.

Plate CLIX, fig. 2, four cells scarcely separable from the preceding, *C. sessile*, except that it is shortly stipitate.

CHARACIUM PRINGSHEIMII, A. Br.

Cells erect or suboblique, upper end drawn out into a rather thick neck; stipe brownish yellow, dilated at the base. Diameter of cells, 10–15 μ; about twice as long as wide; cell contents green, granular.

Differs from the last two in larger size and longer stipe.

The features of the last three forms are so similar, the propriety of separating them as species may be questioned. Farther observations are desirable.

Plate CLIX, fig. 3, three cells on filament of *Oedogonium*.

CHARACIUM AMBIGUUM, Herm.

Cells erect, more or less oblique, narrow lanceolate, somewhat sword-shaped, 4–6 times longer than broad, each end attenuated, apex cuspidate and sometimes curved; cytioplasm bright green.

Diameter, 5–8 μ.

Ponds and pools, rare.

Plate CLIX, fig. 5, six cells on filament of *Conferva*.

CHARACIUM NAEGELII, A. Br.

Cells elliptical or inverted egg-form when fully developed, 2–3 times longer than broad, always with rounded apex, stipe short, not dilated at the base. Cytioplasm bright green, granular.

Diameter of cells, 7–18 μ.

This form approaches very nearly to *C. Sieboldi*, also of A. Br. Can scarcely be separated except by size. Thus governed, it is *C. Naegelii*.

Ponds, not frequent.

Plate CLIX, fig. 4, filament of *Oedogonium* full of the plants; two of them more fully matured than the rest.

CHARACIUM HETEROMORPHUM, Reinsch.

Cells at first globose-elliptical, attenuated below into a thin hyaline stem; contents granular, then contracted in preparation for formation of the gonidia; zoogonidia elongated, escaping at the broadly opened apex.

Diameter of cells, 8–10 μ; 2–3 times as long as broad.

Syn. *Hydrianum heteromorphum*, Rab.

The distinction between the present genus and *Hydrianum*, Rab., being somewhat uncertain in the progress of development, I have followed the example of Dr. Kirchner by uniting the two. *C. heteromorphum* would be a decided *Hydrianum*, but the first three on the list, *C. sessile*, *C. acutum* and *C. Pringsheimii* would hold a more questionable position between the two genera.

Genus 49, PROTOCOCCUS, Ag.

Spherical forms not attached, not branched, in the strictest sense unicellular, single or gathered into irregular clusters, primarily always filled with chlorophyl-green cytioplasm, often changes to red by exposure and other circumstances.

They multiply rapidly by the process of cell division.

As plants they have no value in the system of classification. More modern observations show that, as a rule, they are merely an intermediate condition of growth of higher filamentous plants. Have included under this head also the old genus of *Chlorococcum* and *Pleurococcum*, thus embracing a heterogeneous variety, all with hyaline cytioderm, mostly without tegument, swimming free, forming a scum on stagnant waters; or out of the water, on trunks of trees, old wood, moist or shaded rocks, or compact shaded earth, forming a pulverulent stratum. The cells are more properly macrospores or microspores.

Such *Protococcus* forms occur, however, not only in the process of development, but also in conditions of decay. Large masses are sometimes observed, resulting from the dissolution of filamentous algæ. Have observed this process, particularly in *Spirogyra*, how cell walls fall to pieces and waste away; the cell contents, *Protococcus*-like, are set free for a longer existence and possibly for an asexual mode of reproduction. Cienkowski, a close observer, made similar observations on *Cladophora*, *Ulothrix*, *Hydrodictyon*, *Botrydium*, and others.

As far as our present knowledge goes there is no appreciable distinction between the macrospores or microspores of different genera of *Chlorophylous* filamentous algæ, particularly in the early stages, after separation from the maternal cells; later changes may and do occur.

I repeat some of the thoughts already expressed in the Introduction (v. p. xiii) about the life-history of various genera of Fresh-water Algæ; they have an intermediate, or arrested existence. In this stage they not only exist, but multiply very rapidly. The unicellular forms, (*Protococcaceæ*) under consideration belong to this class, and are among the most common, because some of them can be found everywhere and at all seasons of the year; they exist equally well during the scorching heat of Summer and the frigid cold of Midwinter, but the multiplication of the cells may be arrested during the extremes of temperature. Damp, warm weather is most favorable to increase. They multiply, ordinarily, by cell division in one or two directions, not only one or two or even ten times over, but hundreds of times. One cell, in the course of ten days has produced a family of twice 600,000 cells, under my observation; I say *twice*, because a single layer on the glass on which they grew contained 600,000 cells by liberal calculation, but the clusters had the cells more or less piled two or three fold.

In this condition they may exist for months forming green crusts on the trunks of trees, etc., as already indicated. Some of these under favorable circumstances, preferring cool and wet weather, suddenly develop into filamentous algæ, the same as those from which they originated. Every cell may not develop, just as little as every seed from the pods of wild flowers, or the ears of grasses, or the spores from the capsules of mosses or other cryptogamous plants; how many millions of these are grown to die unseen; few ever come to perfection. These spores possess, however, a peculiarity entirely distinct from seeds and spores of other plants; they multiply and remultiply and yet retain the character of spores. The provision appears to be to prepare a bed, or soil, to sustain and nourish the forthcoming comparatively few which do develop.

In a paper read before the New York Microscopical Society, by E. B. Southwick (See Jour. of the Socy., Vol. 2, No. 1), the writer observes on the frequency of *Protococcus viridis.* He gathered it from the trunks of a hundred different species of trees in Central Park, New York, some of the woods appearing more favorable to the multiplication of the cells than others; in some cases the green coating, mostly on the north side of the trees, extended up the trunk some distance; on others it was confined to the base; some had very little, because not so well adapted to its growth. He observes, "on the American Elm the growth is most luxurious, extending to a great height." "On the Hibiscus the growth was of the finest character, and hyphae were observed in a budding process having from 2–6 branching cells; below, the hyphae were the large masses of *Protococcus* cells which had been produced by fission, mostly in twos and fours, standing out in projecting clusters.

On the Hemlock it was very abundant and of a bright yellowish green, and the gelatinous mass was so strong that when placed under the cover-glass of a slide, in water, they were with difficulty separated."

Have quoted these words to indicate some of the different conditions in which this arrested form of growth is found, and also to indicate how a commencement of development into filaments takes place. Had Mr. Southwick continued his observations on the hyphae at the base of the Hibiscus, where there is more moisture, he would no doubt have discovered a development of *Ulothrix parietina*, Kg.

These polymorphic (dimorphic) forms of arrested growths, PROTOPHYTA, may, if at all deserving of a place in a system of classification, be divided into two sections; the AERIAL and the AQUATIC forms.

It seems but natural that a plant-form developed in the water will assume features differing more or less from those growing out of the water. The land forms have usually thinner or sometimes crustaceous membranes, but even these after a rain or during moist weather become gelatinous, thus indicating a character which, when in the water, often produces a wide hyaline envelope. All the aquatic forms are larger than the aerial varieties.

As a matter of historical interest we record a few of the more prominent forms with the names, partly as varieties, which obtained hitherto.

I.—Aerial Forms.

PROTOCOCCUS VIRIDIS, Ag.

Cells small, segregate, accumulated in broadly expanded strata of yellowish or darker green color, usually pulverulent, but during moist weather and after rain somewhat gelatinous.

Diameter of cells, 3–13 μ.

Common everywhere, on trunks of trees, moist rocks, walls, timbers of shaded buildings, old fences, etc.

Syn. *Pleurococcus vulgaris*, Menegh.; *Protococcus communis*, Kg.; *Chlorococcum vulgare*, Grev., etc.

Plate CLXI, fig. 1, a simple cluster of cells evenly distributed.

Plate CLXII, fig. 2, the same, but often clustered by twos, fours, and more, the result of division in one or two directions; the *Pleurococcus* form.

Plate CLXIII, figs. 1–5, show modes of development into filaments of *Ulothrix*.

b.—Var. ANGULOSA. *Pleurococcus angulosus*, Menegh.

The same as the last, but in different condition; in the process of decay rather than of multiplication; effected by alternate moisture and dryness; the cells sometimes form around themselves gelatinous envelopes; they divide distinctly; becoming angular by crowding.

Plate CLXII, fig. 3, cells very gelatinous.

c.—Var. DISSECTUS. *Pleurococcus dissectus*, Naeg.

Another condition of the same, being a dark green vegetative, developing form, with cells decussately dividing; membranes thin.

Diameter of cells, 5–11 μ.

Usually on old and moist wood.

Plate CLXII, fig. 4. Plate C, fig. 5, cells commencing to develop.

d.—Var. MINIATUS. *Pleurococcus miniatus*, (Kg.) Naeg.

Cells often of an orange yellow, or reddish brown color, (more frequently yellowish green); cell membrane rather thick, colorless.

Diameter of cells variable, 5–15 μ.

This may be termed the conservatory form. It is common on flower pots, walls, and ground floors of green-houses.

Porphyridium cruenta is merely another form of the same polymorphous, arrested, growth. Compare *Porphyridium*, page 194.

The change of color is due to abnormal conditions rather than to a normal characteristic.

Plate CLXII, fig. 5. The usual condition of single cells; sometimes 2–4 are seen in a family.

II.—Aquatic Forms.

e.—Var. INFUSIONUM. *Chlorococcum infusionum*, Rab.

Cells spherical, very various in size; mostly 5–15 μ in diameter, but larger ones are intermingled; the largest measuring 75–100 μ.

Sometimes very abundant in early Spring in meadow pools, largely intermingled with filaments of *Ulothrix;* evidently the two are closely related.

Syn. *Protococcus Meneghinii*, Kg.; *Embryosphaera Meneghinii*, Trevis; *Lepraria infusionum*, Schrank.

Plate CLXI, figs. 2, 3, a range of sizes from the smaller to the largest cells. Normally the smaller cells greatly outnumber the larger sizes.

f.—Var. HUMICOLA. *Cystococcus humicola*, Naeg.

Stratum effused dark green; cells globose, variable in size, sometimes many united in families, involved in a common hyaline tegument; cell membrane thin; cell contents at first homogeneous, later granular.

A form recognized as belonging to this variety occurred in cask of rain water around the water line. Diameter of larger cells, 16–18 μ. General appearance very near Plate CLXI, fig. 1, *P. viridis*.

g.—Var. BOTRYOIDES. *Chlorococcus botryoides*, Rab.

Cells spherical, irregularly clustered, somewhat grapelike. Cell membrane thin, hyaline, homogeneous, green; with age often brownish; cells average 12 μ.

Not rare in pools. Not a normal form—merely an adventitious condition.

h.—Var. GIGAS, Kg. *Chlorococcum gigas*, Rab.

Cells green, mucous, globose, large, either single or associated in small families, always involved in a broad, more or less lamellose, hyaline, tegument.

Diameter of cells, without the hyaline membrane, 12–18 μ.

Frequent in small ponds.

Plate CLXI, fig. 4, single cells without tegument; figs. 5–11, cells divided into two; redivided into four or eight cells in a wide tegument; fig. 12, four cells dividing; fig. 13, a large tegument with sixteen cells, each redivided into four.

i.—Var. WIMMERI. *Chlorococcum Wimmeri*, Rab.

Cells single, globose with rather thick membrane, often lamellate, colorless; contents of cells often yellowish red; primarily green.

Diameter of cells, 45–55 μ.

Occurs occasionally in stagnant waters. Not a normal condition; only another phase of the polymorphous forms of the present genus.

Plate CLXI, figs. 14–20, two of the cells dividing.

j.—VESTITUS. *Pleurococcus vestitus*, Reinsch.

Cells solitary or in small loose families; green, or later orange yellow; cell membrane thick, densely invested with small hairs, or spines.

Diameter of cells, 12–22 μ.

Not rare in ponds.

Syn. *Acanthococcus vestitus*, Lagh.

Plate CLXII, fig. 1, a cluster of cells of this form.

Genus 50, POLYEDRIUM, Naeg.

Cells single, segregate, free swimming, compressed, 3–4–8 angled; angles more or less produced, sometimes radially elongated, either entire or bifid, mostly armed, rounded or rather truncate at the ends. Cell membrane thin, even. Cell contents green, mostly granular, sometimes with one to four reddish oil drops.

Propagation by means of gonidia, of which usually three or more are formed in a maternal cell; they escape through a fissure in the membrane.

Not unlikely that some of the forms under this head also belong to the arrested stages of development of higher forms. Pringsheim observed resting spores in the development of *Hydrodictyon* of polyhedron form, from which young *Hydrodictyon* plants were developed.

POLYEDRIUM TRIGONUM, Naeg.

Cells somewhat compressed, three to five-angled; angles obtuse mucronate, sides more or less concave.

Kirchner suggests the following as names for varieties:

a.—*typicum*, Kirch. Three-angled, mucronate.

b.—*minus*, Reinsch. Three or four-angled, sides concave, smaller than the last.

c.—*tetragonum*, Rab. Four-angled, ordinarily one mucro at each angle, rarely two or more.

d.—*pentagonum*, Rab. Five-angled, otherwise as "c."

e.—*punctatum*, Kirch. Four-angled; each angle with a short obtuse process, membrane granularly roughened.

f.—*bifurcatum*, Wille. Four-angled, angles bifurcate sharply tipped.

Diameter of cells, 13–36 μ.

More or less frequent in pond waters. Of the six varieties only such were identified as are illustrated.

Plate CLIX, figs. 7–10, *tetragonum;* figs. 15–18, *bifurcatum*; figs. 25–27, *minus*.

POLYEDRIUM GIGAS, Wittr.

Cells irregularly four or five-angled; angles obtuse, sides concave.

Diameter of cells, 35–70 μ.

Have reason to question whether this is not the form recognized by Pringsheim as related to *Hydrodictyon*—see note above, with generic character.

In ponds where *Hydrodictyon* prevails.

Plate CLIX, figs. 11–14, typical forms.

POLYEDRIUM ENORME, (Ralfs) Rab.

Cells irregularly four-angled, with the angles produced, hyaline, deeply bilobate; sometimes repeatedly bilobed, with the ends of lobes acute, or mucronate.

Diameter of cells, 25–40 μ.

Syn. *Staurastrum enorme*, Ralfs.

A very variable plant, not rare in ponds, but every new cell found is somewhat unlike the previous one observed.

Plate CLIX, figs. 19–23, five varieties.

POLYEDRIUM MINIMUM, A. Br.

Cells quadrangular; angles obtuse, sides more or less deeply sinuate; lateral view oval. Cells break in the middle and discharge gonidia.

Diameter of cells, 8–10 μ.

Often in large numbers in small pools.

Plate CLIX, figs. 28–31, six cells in different positions; figs. 32–34 cells discharging gonidia.

POLYEDRIUM LONGISPINUM, (Perty) Rab.

Quadri-radiate, radii thin, elongated; scarcely thickened into a body in the center.

Length of arms, 30–45 μ.

A rare and peculiar species; seems scarcely related to the other forms described.

Stagnant pond waters, the habitats of Desmids.

Syn. *Phycastrum longispinum*, Perty.

Plate CLIX, figs. 35–38.

POLYEDRIUM MUTICUM, A.Br.

Cells triangular, somewhat compressed, angles rounded, spineless, sides moderately compressed, membrane smooth.

Diameter of cells, 12–15 μ.

Here and there in ponds.

Plate CLIX, fig. 24, three cells.

Family XIV.—PALMELLACEÆ.

Unicellular algæ, cells either single, or numerous, constituting families, imbedded in a jelly to form a gelatinous stratum which is amorphous; tubular shaped (Hormaspora); variously divided and perforate, (Tetraspora); falsely branched, (Hydrurus); or sometimes the jelly or mucus is wanting, (Rhaphidium, Dactylococcus). Cytioderm mostly thin, often furnished with a gelatinous, or homogeneous, or lamellate tegument. Cytioplasm homogeneous, mostly at maturity distinctly granular, green, or reddish or fuscous, always furnished with a chlorophylous vesicle, except *Rhaphidium.*

Multiplication takes place by a vegetative division of the cells; propagation by transitory gonidia arising by various divisions of the protoplasm from the last vegetative generation; gonidia without integument, mostly furnished with two cilia at the anterior end, and moving about actively.—*Rabenhorst.*

Genus 51, DICTYOSPHAERIUM, Naeg.

Cells green, egg or kidney-shaped, united into a somewhat globose, hollow family, involved in a gelatinous, more or less liquid tegument; sometimes wanting; swimming free. Cells furnished with a single chlorophylous vesicle and a lateral transparent spot, surrounded with thick coats which are confluent into a homogeneous jelly; united by very fine filament, which are dichotomously divided and radiate from the center to the peripheral families. Division of the cells occurring primarily in all directions, later only radiately.

Dictyosphaerium Ehrenbergianum, Naeg.

Family subglobose or suboval; cells somewhat ovate or subglobose, with thin smooth membrane.

Diameter of cells, 4–7 μ.

Diameter of family about 15–18 μ.

Not infrequent in ponds.

Syn. *Dictyo. pulchellum*, Wood.

A form not to be separated from *Dictyo. Ehrenbergii*, as illustrated and described by Naegeli. It is indeed more like the typical form than the plant which has frequently occurred to me.

Plate CLVI, figs. 29, 30, two families; fig. 31, a family after Naegeli's figures.

Dictyosphaerium reniforme, Bulnh.

Cells reniform, nearly twice as broad as long. Families somewhat oval or irregular.

Diameter of cells, 6–9 μ by 10-20 μ.

Diameter of families, 40–70 μ. Very variable.

Ponds, now and then.

Plate CLVI, fig. 28, a regularly shaped family.

Dictyosphaerium Hitchcockii, Wolle.

Cells green, broadly oval, nearly one-half longer than broad; often constricted in the middle indicating the process of division of the cells. Families irregularly spherical; cells arranged in radiating branched series, held by slender, colorless, gelatinous threads; cells with a central many-rayed chlorophyl body containing a large starch granule.

Diameter of cells, 10–13 μ; length, 18–20 μ.

Frequent in Denmark, and Splitrock ponds, New Jersey, September, 1885.

A distinct form, but whether a plant strictly of this genus or a mere condition of plant development may be questioned. The cells are larger than those of other species, the form is different, the longer axis of the cells is parallel with the radiating series, not the shorter one as in other species; the large central nucleus is another peculiarity, and the cells are not so entirely confined to the periphery.

Plate CLVII, fig. 12, a normal, well-developed specimen.

Genus 52, HYDRURUS, Ag.

Thallus gelatinous, fixed at base, cylindrical or compressed, elongated, 2–12 or more inches long; often variously divided, sticky, surface naked or densely covered with delicate gelatinous, at times fasciculate, fibers. Cells in the beginning globose or subglobose, afterwards elongated or elliptic, one or the other pole colorless, arranged more or less regularly in longitudinal families; tegument thick, at length diffluent; cells divide first in one and then in two directions.

HYDRURUS FOETIDUS, (Vill.) Kirch.

Fronds gelatinous, attached at the base, about twelve inches long, one inch wide in the middle, tapering both ways; very much and irregularly branched; branches scattered or crowded, simple or divided, gelatinous at first, later more firm and elastic. Thallus solid, or rarely hollow, semipellucid, light green, olivaceous, or ochraceous, the end simple or penicillate. Cells primarily globose or subglobose; later somewhat conoid or elliptic.

Diameters of cells range from 6–9 μ, with exceptions larger and smaller.

Syn. *Conferva foetida*, Villars, 1789.
Ulva foetida, Vauch., 1802.
Rivularia foetida, DeCandolle, 1805.
Tremella myosurus, Lyngb., 1804.
Hydrurus penicillatus, Ag.
Hydrurus Ducluzelii, Ag.

Have selected only these six synonyms out of a list of thirty-three by almost as many different authors. It is very evident that the credit of first naming this plant is due to Villars (1789), not to Vaucher, because he in his *Histoire des Conferves*, 1803, p. 245, quotes Villars as the originator of the name *foetida*. Most authors, since 1824, to within a few years, call the plant *H. penicillatus*, after Agardh. However more expressive this name may be, it has no claim to priority. Dr. O. Kirchner, of Breslau, Prussia, 1878, and Dr. J. Rostafinski, of Cracow, Poland, 1882, have restored the original name. The following are given as varieties:

a.—Var. PENICILLATUS, Ag.

Thallus long, three to twelve inches, tubular, simple at base, wider and much branched above. Branches slender and long as the main stem, thickly set with short branchlets of dull green color.

The most usual form.

b.—Var. OCCIDENTALIS, Harv.

Thallus very long, one to two feet or more, much branched; branches very irregular, scattered or crowded, worm-like, tapering to a fine point, naked or clothed with feathery, villous ramuli; cells ellipsoidal or pear-shaped, twice as long as their diameter.

On the rocky bottom of rivers and streams in a strong current, Santa Fé, New Mexico.

Forma, CALIDARIUM, (Wood) Wolle.

Wood in his *Contribution*, p. 34, describes *Nostoc calidarium*, from Benton Springs, California, developed in a temperature of 100°–120° Fahr., growing to a length of over two feet, and looking like bunches of waving hair of the most beautiful green, etc. He saw dried specimens only, and those very limited, and was evidently misled by them. There is no doubt the plant is the same as described by Harvey, but dwelling in warm water.

c.—Var. IRREGULARIS, Kg., forma CONFUSA, Rab.

Smaller confluent masses, gelatinous, obsoletely branched; thin branchlets almost entirely wanting.

Found it to occur on the margins of turbulent waters, at waterfalls, and margins of rapid mountain streamlets over rocky beds. Appeared more like olive green or brown confluent masses than like a filamentous plant.

d.—Var. DUCLUZELII, Ag.

Thallus 1–3 inches long, slightly branched, but clothed with shorter or longer thin branchlets, the latter often extending from the base to near the apex, color light brown or dull green.

Sometimes in abundance in exposed, stony, rapid mountain streamlets.

Plate CLXIV, figs. 1, 2, thallus of *H. penicillatus* about half of normal size; figs. 3, 4, small part of a branchlet greatly enlarged showing the scattered cells; figs. 5, 6, two young plants; figs. 7, 8, 9, three cells taken from branchlet (4, 5), much enlarged; fig. 10, first condition of development; figs. 11, 12, progressed condition, cells dividing in one direction; fig. 13, cells dividing in two directions. After Rostafinski, figs. 14, 15, two small fronds of *H. irregularis*, forma *confusa*; figs. 16, 17, two thalli of *H. Ducluzelii.*

Genus 53, PALMODACTYLON, Naeg.

Cells dull green, small, globose, enclosed in a colorless cylindrical bladder-like membrane, often diffluent; sometimes with transverse septae, making a series of small cells. Two, four or many of these tubular bladders with rounded apices, connected at one end, spreading radiately. Division of internal cells at first in one direction, later in two. One, two or four series of cells in each membrane.

Palmodactylon varium, Naeg.

Family composed of numerous cylindrical bladder-like cases, radiately disposed by being connected at one end, each containing one, two or more rows of small cells. Diameter of cells 4–7 μ; cylindrical sacks average about 36 μ wide and 100 μ long.

Stagnant ponds.

Plate CLXXXVII, figs. 8, 9.

Palmodactylon simplex, Naeg.

Family simple, without branches, more filamentous structure, otherwise like the last. Habitat the same.

Can not reconcile my mind to the value of these forms. They occur now and then, but always leave the impression of their valuelessness as true plants.

Genus, HORMOSPORA, Breb. (A *pseudo*-genus.)

To this genus were reckoned a number of forms with oblong cells arranged in a single series, surrounded by a wide, colorless tegument, floating in families or clusters. It has been shown that filaments of this kind are more or less frequently intermingled with *Ulothrix*, *Cylindrocapsa*, *Conferva*, and others. The cell membranes soften and diffuse, producing wide colorless envelopes, such as were made characteristic of this genus. Compare descriptions of these genera, and particularly the illustrations.

Plate CLXXXVII, figs. 10–23.

Genus 54, TETRASPORA, Ag.

Cells green, spherical, contained in a thick, gelatinous or submembranous thallus, which in the beginning is short, sack-like, afterwards expanded. Cells more or less by twos or fours, as they divide in one or more directions; afterwards scattered. Tegument thick, very rapidly diffluent into a homogeneous mucus. Zoospores are developed singly, one in a maternal cell.

These gelatinous structures are of questionable value, as true, fully developed plants; they are evidently a mere condition of growth, but having hitherto failed to detect, with certainty, their relationship, they are allowed to retain their nominal positions.

Older thalli often contain developing forms of filamentous plants, such as *Scytonema*, *Sirosiphon*, *Hapalosiphon* and others. One variety *T. gelatinosa*, as found several times, two or three years apart, contained filaments of *Oscillaria cruenta*, Grun., scattered through the very large gelatinous masses.

Other varieties appear to be more nearly related to *Spirogyra* and other *Chlorophyceæ*.

TETRASPORA CYLINDRICA, Ag.

Thallus attached, attains a length of 6–10 inches; 2–10 μ thick, tubular cylindrical, simple, ends tapering to a fine point, rather firm, gelatinous, dull or brighter green color.

Diameter of cells about 16 μ.

Syn. *Ulva cylindrica*, Wallenbg.

Trenches of spring water.

Plate CLXV, figs. 7, 8, *T. cylindrica* half the natural size, and cells magnified.

TETRASPORA BULLOSA, (Roth.) Ag.

Thallus membranaceous, saccate, obovate, sinuate, bullose, one to six inches long, dark green, smooth or more or less verrucose; cells nearly spherical, geminate, or quaternate, crowded, granular.

Diameter of cells, 6–12 μ.

Syn. *Ulva bullosa*, Roth.; *Tetraspora minima*, Desv.; *Monotrema bullosum*, Thur.

In sluggish, shallow streams, attached to stones.

Plate CLXV, figs. 1–6, three forms; 1–4 about natural size; fig. 5, about half, or quarter natural size; fig. 6, the cells magnified.

TETRASPORA LUBRICA, (Roth.) Ag.

Thallus elongated, tubular, erect, two to twelve inches long; splitting, undulate, sinuous, between gelatinous and membranaceous, yellowish green, cells globose, or somewhat angular, green, tegument very thin.

Diameter of cells, 8–10 μ.

Syn. *Ulva lubrica*, Roth; *Tetrasporella lubrica*, Gaill.

In rather quiet spring water, sometimes in large quantity.

Plate CLXV, fig. 9, only about half the natural size.

Var. LACUNOSA, Chaud.

Thallus elongate, tubular, but not erect, attached to stones, in not rapid mountain streamlet, light green, thallus numerously perforated, with large elliptical lacunae. Thallus 2–10 inches long.

Plate CLXV, fig. 10, thallus half natural size; fig. 11, cells magnified.

TETRASPORA GELATINOSA, (Vauch.) Desv.

Thalli large, irregularly expanded and divided, very gelatinous, at first attached, then swimming free, colorless or edged with green; cells spherical, scattered or by twos; variable in size.

Diameter of cells, 3–12 μ.

Mountain springs, Broadtop Mountain, Pennsylvania. All the masses with scattered filaments of *Oscillaria cruenta*.

TETRASPORA EXPLANATA, (Kg.) Kirch.

Thallus attached, or floating; irregularly expanded, rather soft and slippery, green; cells somewhat elliptic, angular, or globose, usually small and by twos.

Diameter of cells, 5–7 μ.

The form recognized as of this variety most frequent on wet timbers about sluices at mills.

Syn. *Palmella terminalis*, Ag.; *Coccochloris terminalis*, Breb.

Plate CLXV, fig. 12, most frequent form, less than natural size.

Genus 55, SCHIZOCHLAMYS, A. Br.

Cells globose, either single or 2–4 associated in families, the same as *Tetraspora*, and separated from that genus by the dividing of the cell membrane into two or four parts. This splitting and peeling of the membrane of the cells either coincides with a division of the internal cell mass or it occurs without any such division.

Having seen this form repeatedly, usually associated with *Tetraspora*, and of the same general structure, same color or shade of green, same size of cells, dividing in the same way, in the same water and side by side, it has become evident, it is nothing more nor less than a form of it.

Plate CLXII, fig. 7, cells of different sizes and in different stages of peeling, and dividing; fig. 9, another form, green, corresponding with *Chroococcus dicorticans*, A.Br., among the *Cyanophyceae*, but doubtless also a *Tetraspora*.

Genus 56, PALMELLA, Lyngb.

Cells globose, oval or oblong, chlorophyl-green, but sometimes changes to orange or reddish color, surrounded with a more or less thick integument, generally very soon confluent into firm or soft shapeless jelly masses. Division of the cells alternately in all directions.

The forms under this genus, like those of the preceding genera, *Tetraspora*, *Protococcus* and others, belong to the uncertain conditions of the *Protophyta*, arrested polymorphous forms, all multiplying rapidly by the process of cell multiplication without developing, for a protracted period, the true plant. What the particular plants may be to which these *Palmella* forms individually belong has not been determined. We hold farther opinion in abeyance, in hopes of more light, and meanwhile record such forms as occur.

PALMELLA MUCOSA, Kg.

Thallus expanded, irregular in form, rather soft gelatinous, dull or olive green, cells spherical or broadly oval. Spherical cells variable in size, 7–14 μ in diameter; oval cells 12–15 μ wide, about one-third longer; cell contents more or less granular.

The former most frequent on dripping rocks, the latter on wet ground.

Plate CLXII, figs. 12, 14, the two forms.

PALMELLA HYALINA, Breb.

Thallus irregularly expanded, gelatinous, green, cells minute, crowded; tegument almost homogeneous with the gelatinous thallus, very soon diffluent.

Diameter of cells, 0.75–1.00 μ.

Syn. *Coccochloris hyalina*, Menegh.

Pools of stagnant water.

Plate CLXII, fig. 6, a well-filled part of thallus.

PALMELLA MOOREANA, Harv.

Thallus at first somewhat globose, tuberculate, dark green, gelatinous, firm; cells nearly equal, elliptical, lighter or darker green.

Diameter of cells, 5 μ by 8 μ long.

The thallus at first firm and floating; diffluent with age; the cells often found on wet ground, marshes; probably the same as *Aphanothece prasina*, A. Br., and *Palmella dura*, Wood.

Syn. *Coccochloris Mooreana*, Hass.

Plate CLXII, fig. 11, small section of thallus.

PALMELLA UVAEFORMIS, Kg.

Thallus thick, gelatinous, soft, surface irregular, rather bright green; cells small oblong, elliptic or globular, often variable in size; membranes firm; cell contents chlorophyl green.

Diameter of cells, 3–7 μ.

Wet timbers about mills.

Syn. *Cagniardia uvaeformis*, Trevis.

Plate CLXII, fig. 13, section of a large thallus.

PALMELLA MINIATA, Leibl.

Thallus indefinite, gelatinous, surface irregularly tuberculate, often changes to yellow or reddish color; cells spherical with membrane firm; contents orange, or green. Two forms, the one with cells very irregular in size, from 4–40 μ; the other with cells equal, about 14 μ in diameter.

Syn. *Merettia miniata*, Trevis; *P. aequalis*, Naeg.

Moist and wet earth.

Plate CLXII, fig. 10, the form *Aequalis*, Naeg.

PALMELLA BOTRYOIDES, Kg., including *P. heterospora*, Rab.

Thallus gelatinous, spreading, soft or firm, somewhat tubercular, green or yellowish. Cells mostly spherical and often very unequal in size; membrane of cells thin, contents chlorophylous green.

Diameter of cells, 2–4 μ.

On old wet wood; frequent after a rainy season.

Plate CLXII, fig. 8, section of a thallus.

Genus 57, PORPHYRIDIUM, Naeg.

The diagnosis which hitherto obtained for this genus, reads: Thallus between gelatinous and membranaceous, somewhat incrusting, long and broadly expanded, composed of globose or many-sided cells.

PORPHYRIDIUM CRUENTUM, Naeg.

Thallus spreading, gelatinous, composed of a single layer of cells, sometimes two or more; lighter or darker red, cells normally globose, but when crowded, angular.

This is another vague genus; has only one species and that, relying upon personal observations upon many specimens, is identical with *Protococcus miniatus*. The cells are the same in size; color of the one as of the other is changeable, first green then orange or red; habitats are also the same; the one more frequent on the flower pots, or walls of conservatories, and the other on the ground floors, but neither are confined to these localities; they occur on wet or shaded grounds, pavements, etc.; on a sultry summer's day side-walks are sometimes blotched with red as with blood stains; on examination these are found to be composed of an almost infinite number of small spherical cellules, rarely with the sides compressed, or angular.

Syn. *Palmella cruenta*, Ag.; *Tremella cruenta*, Eng. Bot. Compare *Protococcus miniatus*, page 181.

Plate CLXVI, fig. 1, a very small portion of thallus, which often extends for feet over moist earth; younger portion green and older parts lighter or darker red. Seen under low magnifying power.

Genus 58, BOTRYDINA, Breb.

Cells spherical or oblong, involved in a very thick, gelatinous, partially diffluent integument, in large families, which are often numerous, enclosed in a mother cell which constitutes a subglobose thallus.

Botrydina vulgaris, Breb.

Thallus minute, rarely larger than the head of a pin, globose, green. Cells, 2–4 μ.

At the base of trees, moist ground, moss, etc.

Plate CXXIV, figs. 5–7, younger and older thalli.

Genus 59, BOTRYCOCCUS, Kg.

Thallus botryoid clustered cells, irregularly lobed, mucous. Cells oval, spherical, or elliptic, united in families, which are densely packed within a thin diffluent tegument.

Botrycoccus Braunii, Kg.

Small, free-swimming clusters, green, or at length becoming pallid or brown.

All the forms found approaching the characters of this genus, were vague, not normal conditions, hence place little value on the merits of it. The most distinct form discovered is illustrated, Plate CXXIV, figs. 1–4, a peculiar condition with clusters connected by thin hyaline filaments. It occured in large masses of decayed *Spirogyra;* pond, New Jersey. Fig. 1, clusters connected; figs. 2–4, clusters single.

Genus 60, GLOEOCYSTIS, Naeg.

Cells globose or oblong, either single, or 2–4–8 associated in globose families. Common and special integuments gelatinous, lamellose. Divisions in alternate directions.

The forms under this genus, like the unicellular forms of foregoing genera, are merely conditions of polymorphous spore multiplication.

The distinctive feature constituting cells of this genus, is the same as of *Gloeocapsa*, except in color; wide, lamellate, colorless teguments of the cells, one or more within the maternal tegument. In *Gloeocapsa* the life-history can be more easily traced because material is often very abundant. The spore may be followed from its escape from the filament through its various transitions and transformations, until its development into a young plant. In *Gloeocystis* this is not so easy, because, in my experience, the cells are not so frequent and usually very much scattered. The analogy of the two will lead to the inference, that if the one is an intermediate development, the other must be the same.

GLOEOCYSTIS AMPLA, Kg.

Thallus gelatinous, rounded, lobed, dirty or bright green. Cells globose or rounded oblong, 2–4–6, or more, associated in families; tegument colorless, gelatinous, distinctly concentrically lamellose, contents green granular.

Diameter of cells, 9–15 μ.
Diameter of families, 45–90 μ.

Syn. *Gloeocapsa ampla*, Kg.; *Pleurococcus superbus*, Cienk.

Attached to submerged plants, or free swimming.

Plate CLXVI, figs. 2–8, varieties in size of cells, size of cysts and number of cells in cyst, and maternal cell.

GLOEOCYSTIS VESICULOSA, Naeg.

Probably merely a variety of *G. ampla;* in all respects the same except size.

Diameter of cells, 4–7 μ.
Diameter of families, 35 μ, more or less.

More frequently on old wood and stones in ponds.

Plate CLXVI, figs. 9–15.

GLOEOCYSTIS RUFESCENS, A. Br.

Another form of *G. ampla*, differing from the last merely by a change of color, which is sometimes brownish yellow or reddish.

Plate CLXVI, figs. 16–18.

On water plants, pools and ponds.

GLOEOCYSTIS RUPESTRIS, Rab.

Cells smaller, as of *G. vesiculosa*, tegument not so wide and not so lamellate. Thallus dull green or olivaceous, gelatinous, rather firm.

Diameter of cells, 3–5 μ.

Moist rocks and walls.

Plate CLXVI, figs. 19–21.

Genus 61, NEPHROCYTIUM, Naeg.

Cells oblong, kidney-shaped, with a dorsal chlorophylose vesicle, 2–4–8–16 associated in free swimming families surrounded by an ample oval or kidney-shaped tegument. Very variable in size.

Nephrocytium Agardhianum, Naeg.

Cells 2–4 times as long as wide, arranged in families of 4–16, enclosed in a thin tegument; families 2–3 times as long as broad.

Diameter of cells, variable, 3–7 μ.

Not infrequent in ponds with Desmids, etc.

Plate CLXIII, figs. 12, 13, mature cells; figs. 14, 15, 17, younger forms.

Nephrocytium Naegelii, A. Br.

Cells oblong, two or three times longer than broad; two, four or eight enclosed in a rather wide subspherical tegument. Cells bright green, at length set free by the diffluence of the membrane. Length of cells 33–38 μ, before division.

Syn. *Oocystis Naegelii*, A. Br.

Between the two genera *Nephrocytium*, Naeg., and *Oocystis*, Naeg., there appears too slight and uncertain a distinction for separation. Neither is likely to stand eventually. They have the appearance of intermediate life conditions, which are not yet fully understood.

Genus 62, RHAPHIDIUM, Kg.

Cells fusiform, or cylindrical, generally very gradually cuspidate or acuminate at the ends; rarely obtuse, straight or variously curved, single, geminate, or fasciculately aggregate, decussate in the center, or radiately conjoined, rarely two laterally united at the end; other cells free. Tegument thin, smooth. Contents green, very finely granular, furnished with a central, or rarely lateral, transparent vacuole. Division of the cells only in one direction.

Rhaphidium polymorphum, Fres.

Cells single or from 2–16 or more associated in fascicles, acutely cuspidate at each end, straight or variously curved; usually of yellowish green color. Cells 12–25 times longer than broad.

Diameter, 1.5–4 μ.

The following forms may be selected, as distinct varieties:

a.—Var. aciculare, A.Br.

Straight or slightly curved, attenuated at each end, 15–20 times longer than the diameter.

Sometimes in large numbers in stagnant waters.

Syn. *Closterium Griffithii*, Berk.

Plate CLX, figs. 22, 23.

b.—Var. SIGMOIDEUM, Rab.

Cells fusiform, somewhat sigmoid, single or two to four connected.

Syn. *R. duplex*, Kg.; *R. triplex*, Rab.; *Scenedesmus duplex*, Ralfs.

Plate CLX, figs. 24, 25.

c.—FALCATUM, (Corda.) Rab.

Cells slender, curved, or semi-lunar, single or four to sixteen congregated in fascicles.

Syn. *Closterium falcatum*, Menegh.; *Staurastrum falcatum*, Ehrb.; *Micrasterias falcata*, Corda.; *Ankistrodesmus falcatus*, Ralfs, etc.

Plate CLX, figs. 6–10.

d.—Var. CONTORTUM, (Thur.) Wolle.

Slender, variously curved, but mostly somewhat falcate, 20–30 or more times longer than the diameter. Length 38–50 μ.

Collected in clusters from a few to many; sometimes very abundant, thousands of clusters in a small space in stagnant waters; among them, occur not infrequently, two, three, four or more long slender cells, contorted or twisted together forming a body averaging 6 μ by 12–15 μ, which apparently constitute a process of fruiting. These bodies soon break up into green spherical or subspherical cells, microspores? Beyond this stage have failed to trace the process.

Syn. *Ankistrodesmus contortus*, Thur.

Plate CLX, figs. 13, 14, 15, larger clusters from pool, Florida; figs. 11, 12, smaller clusters preceding the twist; figs. 16–21, ten forms of the contorted, or twisted, fruiting specimens from Pennsylvania and Florida.

RHAPHIDIUM BRAUNII, Naeg.

Cells thicker than the preceding and proportionately much shorter; only four to six, or rarely seven times longer than the diameter, straight or moderately curved, with ends attenuated; light green.

Diameter of cells, 5–7 μ.

Plate CLX, figs. 26, 27.

RHAPHIDIUM CONVOLUTUM, (Corda.) Rab.

The type form somewhat larger than the last (*R. Braunii*); cells more curved; ends more acutely acuminate, green, homogeneous, single or two, three or four connected, usually back to back; other specimens, probably only other stages of development, are smaller; again other families are composed of larger and smaller forms intermixed; some have the ends more incurved than others. They occur in families of two or four, and again in more or less spherical masses, containing hundreds. The distinctions between the different forms are not sufficiently constant to admit of separation. Some of the larger forms agree well with *Selenastrum Bibraianum*, Reinsch, ends rather more acute; the smaller forms are *R. convolutum*, var. *lunare*, Kirch., but evidently these with numerous intermediate stages belong to the same species. Length of larger cells, three to four diameters, smaller ones about two diameters.

Plate CLX, figs. 1, 2, 3, a larger form corresponding with *Selenastrum*, Reinsch; figs. 4, 5, smaller form, often clustered in large numbers; figs. 28, 29, from a mass of hundreds of the small cells and a comparatively few larger ones among them. The larger, three times the length and breadth of the smaller ones of the group.

Genus 63, DIMORPHOCOCCUS, A. Br.

Cells united more or less in fours on short branches, the two intermediate contiguous cells oblique, obtuse ovate; the two lateral, opposite and separate from each other, lunate; families free swimming, in botryoid clusters.—*A. Br.*

DIMORPHOCOCCUS CORDATUS, Wolle.

Cells cordate, extrorsal reniform, obtusely ovate or oblong curved with ends rounded, and sometimes with a deep notch on one side; singly, or united in rather irregular clusters of 2–4–8 cells conjoined; sometimes forming coenobia, by smaller families of cells connecting by slender, colorless, radiating, gelatinous threads; thread attached to the back or rounded side of the cells. Diameter of cells, 4–8 μ, usually twice as long as broad. Free swimming.

Ponds, Pennsylvania, New Jersey, Florida.

Plate CLX, figs. 30–35, coenobia in various stages of growth; figs. 36–38, simple group, as they often occur in large numbers.

Found the coenobia forms most abundant in small pools in Florida.

The only plant-form hitherto described under this genus has been recognized in various parts of Europe. Our form is evidently distinct.

The generic description was prepared with the European plant in view, but judging by the figures which accompany, it is very vague and barely applies to our form. It is given unchanged.

There appears to exist a relationship between the *Coenobium* form and *Dictyosphaerium*, but single clusters, which are by far the most frequent, particularly north of Florida, are entirely distinct.

Genus 64, MISCHOCOCCUS, Naeg.

Thallus dichotomously branched, bearing the terminal cells. Cells globose, terminal, geminate or quaternate. Division of cells in one direction.

Propagation by zoogonidia.

MISCHOCOCCUS CONFERVICOLA, Naeg.

Cells globose, even, geminate, ternate or quaternate, on the tips of the branches; bright green, delicately granular, destitute of a chlorophylose vesicle; stem hyaline, spuriously articulated, often swollen at the angles.

Diameter of cells, 4.5–9 μ.

Plate CLV, figs. 36–41.

Transcribed substantially from Rabenhorst's *Flora Algarum*. No specimens having been found in the United States, this is given in anticipation. It appears to be common in many parts of Europe.

Genus 65, EREMOSPHAERA, D.By.

Cells large, globose, free swimming; cell walls firm, with a hyaline border. Cell contents green, granulose, sometimes containing green laminæ, disposed in a radiate manner. Multiplication by division into two or four (or more) sister cells, which escape by the rupture of the cell-wall.

EREMOSPHAERA VIRIDIS, D.By.

Cells globose, large, of a bright green color.

Diameter of cells, 100–150 μ.

Occurs in small pools, sometimes in considerable numbers. The extraordinary size and usually somewhat isolated appearance makes it possibly related to some other algæ form, but hitherto all efforts failed to detect any such connection. The cells divide and redivide, produce resting spores, etc. Different conditions are illustrated.

Plate CLXVII, fig. 1, a cell in normal condition shedding the outer membrane; fig. 2, a cell dividing into two; figs. 3, 4, a cell divided into eight sister cells, five only visible; still enclosed in the tegument; figs. 5–11, different conditions of propagation, forming macrogonidia, resting spores, changing color to brownish or red, young forms, etc.

Genus 66, UROCOCCUS, Hass.

Cells large, globose or oblong, reddish or blood-red; tegument thick, gelatinous, concentrically lamellose *Gloeocapsa*-like; stem thick, gelatinous, often ringed or annulate.—*Rabenhorst.*

Rabenhorst properly makes the parenthetical note "*Gloeocapsa*-like," because it is to this genus that these so-called *Urococcus* cells belong. They appear to be merely an occasional condition, arrested development of *Gloeocapsa* cells; but *Gloeocapsa* is an intermediate, or arrested, polymorphous spore condition of *Sirosiphon*; therefore, *Urococcus* is a spore condition of *Sirosiphon.*

Two of the forms recognized have been named by Hassall as

UROCOCCUS HOOKERIANUS and UROCOCCUS INSIGNIS.

The former is described: "Cells globose, or elliptic, variable in size, blood-red, granular, stem more or less elongated, often divided, densely ringed. Cells, 13–60 μ." The latter: *U. insignis*, "cells larger, globose, blood-red; stem abbreviated, remotely annulated."

Frequent with *Sirosiphon* and *Gloeocapsa*, on dripping rocks, mountain ravines, Pennsylvania.

Plate CXXIII, figs. 11, 12, lateral and polar views of *U. insignis;* fig. 13, cluster of cells of *U. Hookerianus.*

Genus 67, APIOCYSTIS, Naeg.

Thallus small, vesicular, fixed by a stem-like base. Cells globose, scattered or sometimes eight disposed in a circle; contents homogeneous, or delicately granulose, with a distinct colorless vacuole; tegument thick, dissolving into a homogeneous gelatine, cells dividing alternately in all directions.

Propagation by mobile gonidia, which are globose and furnished with a pair of vibratile cilia.

APIOCYSTIS BRAUNIANA, Naeg.

Thallus pear-shaped, pallid green; the cavity filled up by gelatinous matter, in which are imbedded the gonidia, at first few, increasing in number with age up to 1,600. Diameter of thallus, 20–100 μ or more. Height nearly twice as much. Internal gonidia average 7–8 μ.

Smaller pools or ponds, attached to water plants; have had some good specimens, but never in large numbers; the finest were from Florida.

Plate CXXIII, fig. 8, two young fronds; fig. 6, a mature frond; fig. 7, another with cells undergoing segmentation; fig. 9, a larger frond with matured gonidia; fig. 10, free, ciliated gonidia or zoospores.

Family XV.—CHYTRIDIEÆ.

Plants for the most part aquatic, parasitic, epiphytal or endophytal, very rarely terrestrial, one or two celled. Cells vesiculose, single or gregarious, either innate in the fostering plant, or penetrating its membrane; now and then numerous and densely aggregated; cytioplasm mucilaginous, most frequently colorless, sometimes colored. Antheridia not yet observed.

Propagation by oospores or zoogonidia.

Among a number of forms of plants of doubtful generic position, perhaps more properly placed with the Lichens or the Fungi. I retain two of the eleven genera recorded by Rabenhorst in his *Flora Algarum.* The two are the genera *Chytridium* and *Olpidium*, forms which may be retained, and classified with PROTOCOCCOIDEÆ.

Genus 68, CHYTRIDIUM, A. Br.

Cells globose or somewhat pear-shaped, operculate above; the root-like base usually innate in various algæ, penetrating the membrane of the cells.

Zoogonidia very numerous, globose, with a nucleus, bearing a single very long cilium, escaping through the orifice of the cell caused by the falling away of the operculum.

CHYTRIDIUM ACUMINATUM, A. Br.

Cells small ovate-pyriform, or balloon-shaped, which penetrate into the algæ upon which they grow by a sort of root-like base. The inflated portion of the cell is filled with colorless mucilage from which are formed very numerous small globular germ-cells with a darker nucleus and a single long cilium.

Length of cells, 56–64 μ.

On the oogonia of various *Oedogonia*.

Plate CV, figs. 20–22, *Chytridia* seated on oogonia.

Chytridium minus, Lacost et Suring.

Cells subglobose or somewhat oblong, pale yellow with a low operculum, base wide above, penetrating the membrane of filamentous algæ, and terminating in a point. Length 6–14 μ, without operculum and basal root-like process.

Frequent on algæ of various kinds.

Plate CV, figs. 17, 18, different forms of *C. minus*.

Chytridium globosum, A. Br.

Cells usually perfectly spherical, single or numerously aggregated; devoid of operculum, of radicals, of elongated neck, but possess two or more orifices; apparently of two varieties, a larger and smaller form.

Parasitic on algæ of various kinds.

Syn. *Rhizophydium globosum*, A. Br.

Plate CV, fig. 14, the most frequent variety; figs. 11, 12, 13, a larger form from New Jersey.

Genus 69, OLPIDIUM, A.Br.

Cells globose or subglobose, parasitic, epiphytal or endophytal, not rooting; mouth vertical, elongated into a cylindrical tube.

Olpidium ampullaceum, A.Br.

Epiphytal, gregarious, globose, small, sessile, rarely pedicellate, tubular, mouth erect, cylindrical, nearly as long as the cell, terminating in a conical apiculus.

Diameter of cells, 6–8 μ.

Frequent on filamentous algæ.

Plate CV, fig. 7, cells on a filament of *Oedogonium*.

Olpidium intestinum, A.Br.

Entophytal, usually gregarious in the interior of larger plants, depressedly globose, extending at the apex into a tubular neck which is globosely dilated in the middle;

perforating the membrane of its host; extending somewhat beyond, and often widened at its mouth.

Diameter of cells, about 25 μ.

The only specimens found by myself were in *Closterium lunula.* They have been found also in other algæ.

Plate CV, fig. 16, five *Olpidia* in a semi-cell of *Closterium.*

OLPIDIUM ENTOPHYTUM, A.Br.

Parasitic in the interior of plants, perfectly spherical, somewhat smaller than the preceding (*intestinum*), the tubes perforating the membrane, straight, not inflated, often extending beyond the membrane of the cell they occupy.

Diameter of cells, 15–20 μ.

Plate CV, fig. 15, cells of a filament of *Oedogonium* each containing two plants.

Diameter of larger cells, 12–15 μ; smaller ones, 6–10 μ.

Order V.—ZYGOSPOREÆ.

An Order composed of green or brownish algæ, sometimes single cells, but more frequently series of cells closely united, possessing a peculiar mode of propagation by copulation and conjugation. The contents of two cells, whether individuals or whether in series, flow together and produce a new cell termed a *zygospore.* As a rule only one, but rarely two *zygospores* are produced by the copulation of two cells. Sometimes spores are produced without copulation; such are termed, *azygospores.*

Family XVI.—CONJUGATÆ.

Simple filaments composed of a single series of cells, or independent single cells with chlorophyl-green contents. Chlorophyl arranged in parietal bands, in axillary laminæ, or twin, stellate nuclei.

SECTION I.—ZYGNEMEÆ.

Cells cylindrical, united into filaments, green, often with a mucous covering, *conferva*-like. Zygospores are clothed with a triple membrane, the exterior one decidious. When fully developed, after a period of rest, these germinate, putting forth a single germ, in the same way as the seeds of phoenogamous plants. This germ elongates by transverse division of the cells.

This section may be subdivided into two parts, the *Zygneminae*, and the *Mesocarpinae.*

SUBSECTION I.—ZYGNEMINÆ.

Chlorophyl arranged in three ways; in bands on the inside of the cell walls, in twin stellate nuclei, and in axillary laminæ.

The process of copulation is the union of two filaments; they come into close proximity, then the cells put out short tubercle-like projections by which the cells of one unite with the cells of the other filament; the ends open and thus a tubular passage is formed between each of two cells of a longer or shorter series of cells. Such copulation is termed *scalariform.* In some forms the cells become geniculate and unite at the angle; this mode is termed *geniculate* copulation. A third mode is termed *lateral* copulation, signifying that the contents of two adjoining cells unite, producing the zygospore. In the other two modes the chlorophylous cell-contents pass out through the connecting tube from one cell to unite with that of the other, or through an opening at the point of junction to mingle with that of its mate, thus producing the zygospore; sexual distinction between the two filaments conjugated, has not been observed.

Genus 70, SPIROGYRA, Link.

Cells with one to several parietal chlorophyl bands spirally winding to the right. Copulation scalariform (*Spirogyra*, Kg.) or lateral (*Rhynchonema*, Kg.). Zygospores always within the wall of one of the united cells. Copulating cells usually shorter than the sterile ones, and often more or less swollen.

More recent observations have proved that the two modes of copulation are not constant, that both ways may be found in the same filament, according to circumstances, hence *Rhynchonema* is omitted as a generic character. The most essential and reliable characters are derived from the zygospore. The length and breadth of the cells, the character, and number of spirals, are features not to be overlooked, but in themselves not sufficient to determine species.

One of the most recent and complete monographs of *Spirogyra*, embracing almost all of our species is by Mons. Paul Petit, *Spirogyra des Environs de Paris*, 1880.

In accord with his arrangement of the species of this genus, the following division is made of our United States species:

SPIROGYRA.

SECTION I.—MEMBRANE OF CELLS REPLICATE, OR FOLDED IN AT THE ENDS.

A.—*Chlorophyl band single, rarely double.*

a.—Membrane of zygospore smooth.

1. S. tenuissima, *Hass.*
2. S. inflata, *Vauch.*
3. S. Spreeiana, *Rab.*
4. S. quadrata, *Hass.*
5. S. Weberi, *Kg.*
6. S. Grevilleana, *Hass.*

b.—Membrane of zygospore punctate.

7. S. calospora, *Cleve.*

B.—Chlorophyl bands two or more. Ends of cells replicate.

8. S. Hassallii, *Jenner.*
9. S. insignis, *Hass.*
10. S. Hanzschii, *Kg.*

SECTION II.—MEMBRANE OF CELLS NOT REPLICATE AT THE ENDS.

A.—Chlorophyl band single.

a.—Membrane of zygospore smooth.

11. S. mirabilis, *Hass.*
12. S. flavescens, *Cleve.*
13. S. gracilis, *Hass.*
14. S. varians, *Hass.*
15. S. quinina, *Ag.*
16. S. communis, *Hass.*
17. S. Jurgensii, *Kg.*
18. S. longata, *Vauch.*
19. S. Lutetiana, *Petit.*
20. S. fusco-atra, *Rab.*
21. S. condensata, *Vauch.*

b.—Zygospore with membrane punctate.

22. S. punctata, *Cleve.*

B.—Chlorophyl bands, two or more.

ZYGOSPORES OVOIDAL.

23. S. decimina, *Mull.*
24. S. neglecta, *Hass.*

25. S. fluviatilis, *Hilse.*
26. S. nitida, *Link.*
27. S. subæqua, *Kg.*
28. S. jugalis, *Dill.*
29. S. setiformis, *Roth.*
30. S. dubia, *Kg.*
31. S. adnata, *Kg.*
32. S. rivularis, *Rab.*
33. S. majuscula, *Kg.*
34. S. elongata, *Berk.*
35. S. parvispora, *Wood.*

ZYGOSPORES LENTICULAR, ORBICULAR DEPRESSED.

36. S. orthospira, *Naeg.*
37. S. bellis, *Hass.*
38. S. maxima, *Hass.*
39. S. crassa, *Kg.*

SECTION I.—MEMBRANE OF CELL REPLICATE AT BOTH ENDS.

A.—One spiral, or rarely two in a cell.

a.—Membrane of spore smooth.

SPIROGYRA TENUISSIMA, (Hass.) Kg.

Diameter of vegetative cells 9–12 μ; 4–15 times longer than broad; ends inlaid; single spiral, making 3–6 turns. Spore, 24–30 μ by 50–58 μ. Sporiferous cells much swollen, about twice as long as the spore. Zygospore oblong-elliptic, yellow or brown at maturity.

Syn. *Zygnema tenuissima*, Hass.; *Rhynchonema minimum*, Kg.; *Spirogyra Naegelii*, Kg.

Ditches and pools. The smallest of our *Spirogyra;* varies considerably in size, even more than indicated by the measures given.

Plate CXXXII, figs. 1–3, fruiting and sterile filaments, a *Rhynchonema* form.

SPIROGYRA INFLATA, (Vauch.) Rab.

Diameter of vegetative filaments, 14–18 μ; cells 3–8 times longer than broad; cells with spore very much inflated; spiral single, makes 3–8 turns. Fruiting cells much inflated, zygospore fusiform-elliptic, diameter 30–36 μ; twice as long as wide.

Syn. *Conjugata inflata*, Vauch.; *Zygnema inflatum*, Hass.; *Spirogyra gastroides*, Kg.; *S. ventricosa*, Kg.; *Rhynchonema vesicatum*, Kg.

Rather common in smaller ponds.

Plate CXXXII, figs. 6, 7, two filaments in fruit—scalariform and lateral copulation.

SPIROGYRA SPREEIANA, Rab.

Diameter of filaments, 18–21 μ. Cells 10–25 times longer than wide, ends inlaid; spiral slender, loose, making 1½–4 turns; fructiferous cells inflated, 36–42 μ diameter; zygospores 36 μ diameter, 2–3 times longer than broad.

Mountain pools, Pennsylvania.

Plate CXXXII, figs. 4, 5, two parts of fruiting filaments.

SPIROGYRA QUADRATA, (Hass.) Petit.

Diameter of vegetative filaments, 24–30 μ; cells 3-9 times as long as broad; ends inlaid; spiral single, good size, making 1½–5 turns; fertile cells much swollen, often somewhat quadrate, flattened in the middle, cylindrical; one or rarely two spirals. Zygospores elliptical or fusiform, diameter 27–32 μ; 2–4 times longer than broad; copulation most frequently lateral.

Syn. *Zygnema quadratum*, Hass.; *Rhynchonema quadratum*, Kg.; *Spirogyra pulchella*, Wood.

Frequent in stagnant waters.

Plate CXXXII, figs. 8, 9, 10, a sterile filament; lateral and scalariform copulation.

Plate CXLII, figs. 7, 8, parts of two filaments having a sort of rootlets, sometimes observed on plants in a strong current of water, or when partly out of the water on shores of ponds; they are developed, apparently, as a means to sustain life in precarious situations. This feature is not peculiar to plants of this genus only. Compare Plate CIX, fig. 3, a *Cladophora*, and Plate CXVIII, figs. 29–33, a *Ulothrix*.

SPIROGYRA WEBERI, Kg.

Diameter of vegetative filaments, 18–28 μ; cells 6–15 times longer than broad; ends inlaid; spiral always single, slender and lax, describing three and a half to six turns; fructiferous cells not inflated or but slightly dilated; zygospore oval, one and a half to two times longer than broad.

Diameter, 26–30 μ.

Kirchner makes the following varieties of this species:

a.—*genuina*, Kirch. Cells four to eight times as long as broad; one spiral making 3–5 turns. Diameter of cells, 16–22 μ.

b.—*elongata*, Rab. Cells 4–14 times as long as broad; one spiral, 2–5½ turns. Diameter as the last. Plate LXX, figs. 1, 2.

c.—*Hilseana*, Rab. Two spirals, otherwise like "a."

d.—*intermedia*, Kg. Cells twice as long as broad, copulation usually lateral.

e.—*tenuis*, Rab. Filaments thinner than any of the other forms. *Rhynchonema Jenneri*, Kg.

Syn. *Spirogyra Hornschuchii*, Kerst.; *Zygnema longatum*; *Zygnema intermedia*, Hass.; *Spirogyra elongata*, Wood.

Appears widely and liberally distributed in quiet waters.

Plate CXXXII, fig. 11.

SPIROGYRA GREVILLEANA, (Hass.) Kg.

Diameter of vegetative filaments, 28–33 μ; cells 3–10 times longer than broad; ends inlaid; spiral usually single, more rarely double, describing 4–5, or occasionally 6–9 turns; when two spirals the turns are more numerous; fructiferous cells considerably swollen. Zygospores oval, brownish yellow when mature, 2–2½ times longer than the diameter, varying from 30–36 μ.

Var. DIDUCTA, Kg.; *Zygnema diductum*, Hass., and *Z. vesicatum*, Hass.

Cells 3–4 times longer than wide; fructiferous cells much inflated.

This species is separated from *S. Weberi* by the larger size of filaments, usually shorter cells and especially by the inflated spore-bearing cells.

Syn. *Zygnema Grevilleana*, Hass.; *S. inaequalis*, Kg.; *Rhynchonema diductum*, Kg.

Occurs frequently in sluggish and stagnant waters.

Plate CXXXII, figs. 12, 13, sterile and fruiting filaments.

b.—Membrane of spore punctate.

SPIROGYRA CALOSPORA, Cleve.

Diameter of vegetative filaments, 36–40 μ; 6–12 times longer than broad; spiral single, slender, describing 4–5 turns; fruiting cells shorter, slightly or not at all swollen. Zygospores elliptic or cylindric-elliptic, ends rounded, yellow or orange when mature; two or three times longer than the diameter, 40–42 μ. Spore-membrane somewhat punctate or scrobiculate.

Syn. *Spirogyra protecta*, Wood.

Not rare in ponds, East, West and South.

B.—Chlorophyl bands two or more; cells replicate at the ends.

Spirogyra Hassallii, (Jenn.) Petit.

Diameter of filaments, 30–33 μ; cells 4–8 times longer than wide; two spirals, rather large, lax, describing 1½–3 turns. Fructiferous cells considerably inflated, 48–50 μ diameter; zygospores elliptic, 1½–3 times longer than the diameter, measuring 42–48 μ, and changing to yellow at maturity.

Syn. *Zygnema Hassallii*, Jenn.; *Rhynchonema Hassallii*, Kg.

Only specimens identified, from Iowa.

Plate CXXXIII, figs. 5–7, sterile filament, and lateral copulation.

Spirogyra insignis, (Hass.) Kg.

Diameter of vegetative filaments, 36–42 μ; cells 4–12 times longer than wide; three spirals, rarely two, describing one to three turns. Cells bearing zygospores much swollen, shorter than sterile cells. Spores elliptic, usually twice as long as wide. Smaller axis about 28 μ.

Beside the typical form, Kirchner has two varieties:

Var. Braunii, Rab.

Cells 8–14 times as long as wide and two spirals; and

Var. elongata, Sur.

Cells 5–12 times longer than broad, with 2–4 spirals.

Syn. *Zygnema insigne*, Hass.; *Rhynchonema Gallicum*, Rivet.; *Sirogonium retroversum*, Wood.

Inhabits small ponds, not frequent. Pennsylvania, New Jersey to Florida, probably also westward.

Plate CXXXIII, figs. 8, 9, sterile, and fruit-bearing filaments.

Plate CXLII, figs. 8, 9, parts of two filaments of *S. insigne*, with sterile cells, and others having the chlorophyl bands destroyed, or transmuted into brown stellate forms.

The physiological function of the stellate forms remains undetermined.

SPIROGYRA HANTZSCHII, Rab.

Diameter of vegetative filaments, 40–45 μ; cells 3–5 times longer than broad; spirals two, making two or three turns in shorter cells. Spore-bearing cells not at all swollen; spores twice as long as wide.

This plant is near the preceding in size, length of cell and form of spore; but separated by having only two spirals and by fruit-bearing cells not being inflated.

Stagnant waters, Pennsylvania.

Plate CXXXIII, figs. 10, 11, filaments conjugated, with spores, and sterile filaments.

SECTION II.—MEMBRANE OF CELLS NOT REPLICATE AT THE ENDS.

A.—*One spiral in each cell.*

a.—Zygospores having membrane smooth.

SPIROGYRA MIRABILE, Hass.

Diameter of vegetative filaments, 24–27 μ; cells 4–10 times longer than broad; spiral single describing 4–7 turns in cell. Fruiting cells considerably inflated. Conjugation lateral more frequently than scalariform. Zygospore 1½–2 times longer than the diameter. Shorter axis varies from 24–26 μ.

Syn. *Zygnema mirabile*, Hass.; *Spirogyra mirabilis*, Kg.

The only specimens had for examination were from Wisconsin.

Plate CXXXIV, figs. 1, 2, sterile and fruiting filaments.

SPIROGYRA FLAVESCENS, (Hass.) Cleve.

Diameter of vegetative filaments, 13–20 μ; cells 3–5 times longer than broad; spiral single, yellow green, describing 2–3 turns. Fructiferous cell much swollen, spore 25 by 40 μ.

Syn. *Zygnema flavescens*, Hass.; *Zygnema affine*, Hass.; *Rhynchonema affine*, Kg.

Picked up satisfactory specimens of this species, frequently in stagnant waters in Florida. It averages somewhat larger than the French form, but conforms well with English specimens.

Plate CXXXIV, figs. 3, 4, sterile and fruiting filaments.

SPIROGYRA GRACILIS, (Hass.) Kg.

Diameter of vegetative filaments, 18–22 μ; cells 3–5 times longer than broad; spiral bright green, making ½–3 turns;

fruiting cells swollen only on the side of conjugation, the opposite side straight. Zygospores oval, turning yellow at maturity, about twice as long as wide.

Syn. *Zygnema gracile*, Hass.

This form has been erroneously connected with *S. flavescens.* It is distinct in size, and in spore-bearing cells, which are inflated on one side only, not on two sides.

The figures are from specimens collected in Michigan.

Plate CXXXIV, figs. 5–7, conjugation scalariform, and lateral; fruits also without conjugation; also sterile filament.

SPIROGYRA VARIANS, (Hass.) Kg.

Diameter of vegetative filaments, 25–33 μ; cells $1\frac{1}{2}$–$2\frac{1}{2}$ times as long as wide; spiral single, with margins more or less dentate, describing $1\frac{1}{2}$–3 turns; cells bearing spores much swollen on the conjugating side, straight on the outer side. Zygospores oval or elliptic, $1\frac{1}{2}$–2 times longer than wide, often appearing polymorphous, changing with the position they have in the cell.

Syn. *Zygnema varians*, Hass.; *Rhynchonema Woodsii*, Kg.; *Zygnema abbreviatum*, Hass.; *S. arcta*, Kg.; *S. nodosa*, Kg.; *S. ventricosa*, Kg.

Of all the species of this genus this appears most polymorphous, and in consequence has given rise to various terms descriptive of conditions in which it was found by different collectors, and by the same under different circumstances; frequently inflated cells are observed in longer or shorter series; these no doubt gave rise to such names as *nodosa* and *ventricosa.* Often the cells are very short, hence *abbreviatum.*

The peculiar one-sided swelling does not appear to have been noticed by Vaucher, and probably did not exist in the plant he saw and described as *S. condensata;* hence there appears no good reason for calling *S. varians* a synonym for *S. condensata.*

Most abundant in stagnant pools adjoining mountain streamlets.

Plate CXXXIV, figs. 8–13, sterile filament; fruiting filaments, cells inflated without conjugation; and early stage of conjugation.

SPIROGYRA SUBSALSA, Kg.

Diameter of vegetative filament, 22–25 μ; cells 1–$1\frac{1}{2}$ times longer than wide; single spiral, describing $1\frac{1}{2}$–2–3 turns in cell. Zygospore ovoid, slightly longer than the diameter. Sporiferous cell slightly, or not at all swollen. Color of mass deep green, slippery to the touch.

Not infrequent in wet places, Florida.

Plate CXLI, figs. 3, 4, sterile, and fruiting filaments.

SPIROGYRA QUININA, (Ag.) Kg.

Deep green, slippery, diameter of filaments, 33–40 μ. Sterile articles 1–2 or rarely 6 times longer than broad; fertile cells 1–1½ diameters, scarcely or not at all swollen; spiral single, the turns in various stages of density or of laxity; commonly 1½ or 3 turns. The zygospores vary much in form, apparently, some of them being globose, others elliptic, and still others cylindrical with obtusely rounded ends.

Syn. *Zygnema quininum*, Ag.; *Conjugata condensata*, Vauch.

One of our most common forms in sterile condition; fruits in proper season very profusely; occurs sometimes in masses, all fruit. Many spore-bearing cells without evidence of conjugation.

Plate CXXXIV, figs. 14–17, sterile and fruiting filaments.

SPIROGYRA COMMUNIS, (Hass.) Kg.

Diameter of vegetative filaments, 20–22 μ; cells 3–5 times longer than broad; spiral slender, lax, describing 1½–4 turns. Fructiferous cells not dilated; zygospores elliptic, changing from green to yellow at maturity, 2–3 times longer than broad; diameter 19–23 μ.

Syn. *Zygnema commune*, Hass.; *Zygnema reversum*, Hass.; *Rhynchonema reversum*, Kg.

Ponds and ditches.

Plate CXLII, figs. 1, 2, sterile and fruiting filaments.

SPIROGYRA JURGENSII, Kg.

Diameter of vegetative filaments, 24–26 μ; cells 2½–5 times longer than broad; spiral slender, light green. Spore-bearing cells gently swollen around the elliptic zygospore, which is twice as long as wide; diameter about 30 μ, changes color to golden yellow at maturity.

Stagnant and sluggish waters.

The distinction between this and *S. communis* is slight, resting almost altogether on the swollen fructiferous cells.

Plate CXLII, figs. 3, 4.

SPIROGYRA LONGATA, (Vauch.) Kg.

Diameter of filaments, 25–30 μ; cells 2–12 times longer than broad; fructiferous cells not swollen or rarely moderately inflated; spiral rather large, bright green, describing 2–5 turns. Zygospore oval, ends rounded, twice as long as wide, filling the breadth of the cell, changes color from green to light yellow and chestnut.

Syn. *Conferva longata*, Vauch.; *Zygnema longatum*, Ag.; *Zygnema aestivum*, Hass.

The three preceding forms *S. commune*, *Jurgensii*, and *longata*, seem closely related; *S. quinina* is also near, but separated by features which have been deemed sufficient to mark distinct species.

If the occurring varieties are taken as typical forms then a separation would prove impossible. *Spirogyra* filaments of the same species often vary very much in diameter, in length of cells, number of turns and width of spirals, and shade of color. The length of cells is constantly changing by division; the number of spirals is not absolutely constant; there are sports, so called; conjugation of filaments of different species have been observed, but such occasional deviation from rule must not be taken as a guide in classification. The features as they appear in mass have been our guide.

Occurs frequently in masses in ponds, mill-dams, etc.

Plate CXXXV, figs. 9, 10, sterile, and conjugated filaments.

SPIROGYRA LUTETIANA, Petit.

Diameter of vegetative filaments, 30–36 μ (mine 40–43 μ). Cells 3–7 times longer than the diameter; spiral single, large, dentate, deep green, describing 3–7 turns; sporiferous cells irregular, always more or less inflated, sometimes cylindrical. Zygospores polymorphous, globose, elliptic, oblong, cylindric, pyriform or reniform, of yellow tint when mature, 2–4 times longer than wide; diameter, 30–42 μ.

A plant gathered in considerable quantity, mostly sterile, in lake at Kissimmee, central part of Florida, is not identical with the one described above by Mons. Petit, but in size and proportions of cells and general appearance so much like it, and so unlike any other described form, have adopted this name for it. *S. fusco-atra*, Rab., is closely related, but varies in length of cells, number of turns of spiral in cells, and less inflated fruit-bearing cells.

Plate CXXXV, figs. 7, 8, a sterile, and fertile filaments.

SPIROGYRA FUSCO-ATRA, Rab.

Diameter of filaments, 40–55 μ; cells 2–4 times longer than broad, one spiral, making 2–3 turns in cell. Zygospore polymorphous, globose, elliptic or oval, one to two times longer than the diameter; color changes to lighter or darker chestnut.

Found this form most abundant in good fruiting condition in sluggish and stagnant waters of Paxton Creek, near Harrisburg, Pa.

Occasionally a filament with two spirals was intermingled.

Plate CXL, figs. 4 and 7, two sterile filaments, one of them with two spirals; figs. 5, 6, two fertile filaments.

SPIROGYRA CONDENSATA, (Vauch.) Kg.

Diameter of vegetative filaments, 48–54 μ (var. 62–75 μ); cells 1–1½ times longer than the diameter, spiral slender, making one to four (ante-division) turns in cell. Fructiferous cells not, or but slightly swollen, not shorter than the vegetative cells. Zygospores broadly elliptic, about one-half longer than the diameter.

Var. RUSBYI, Wolle.

Not essentially different from the type-form or from the variety *Flechsigii* described by Rabenhorst, except in size, being as much larger than Rabenhorst's variety, as the same is larger than the type, measuring 62–75 μ in diameter.

Collected by H. H. Rusby in New Mexico, January, 1881. A sterile form, probably this species, occurs in New Jersey; frequent in vicinity of Hammonton, but found no fruit.

Syn. *Conjugata condensata*, Vauch.; *Zygnema condensata*, Ag.

Plate CXXXIX, figs. 7, 8, 9, two sterile filaments, and two in conjugation of var. RUSBYI.

b.—Membrane of the spores punctate.

SPIROGYRA PUNCTATA, Cleve.

Diameter of vegetative filaments, 24–27 μ; cells 6–12 times longer than the diameter; spiral single, rather slender, containing some starch grains; describing 3½–7 turns in a cell; fructiferous cells much inflated and much shorter than the vegetative cells. Zygospore elliptic, yellow at maturity, about one-half longer than the diameter; the membrane punctate.

The mode of conjugation of this species is somewhat peculiar; the connecting tube arises from one cell only and attaches itself to the surface of the opposite cell; the chlorophyl passing over, the spore is formed and the cell becomes much inflated.

The only locality hitherto discovered for this species is Pleasant Mills, New Jersey.

Plate CXLI, figs. 5, 6, 7, four fertile and one sterile filament.

B.—Two or more spirals.

SPIROGYRA DECIMINA, (Mull.) Kg.

Diameter of vegetative filaments, 32–40 μ; cells 2–4 times longer than the diameter; two spirals (rarely three) rather large, describing 1–2 turns; fructiferous cells not inflated; zygospore broadly oval or nearly globose; same diameter as filament.

As a rule this species has two spirals, but occasionally three; being found intermingled, and having a specific appearance, the latter are not easily confounded with other species of the same number (three) of spirals. Often found in large masses, mucilaginous to the touch.

Syn. *Conferva decimina*, Mull.; *Zygnema deciminum*, Hass.

Plate CXXXV, figs. 5, 6, sterile and fruiting filaments.

SPIROGYRA NEGLECTA, (Hass.) Kg.

Diameter of vegetative filaments, 60–65 μ; cells 2–5 times longer than broad; three spirals describing 1–2½ turns; sporiferous cells 1½–3 times longer than the diameter, slightly swollen; zygospores oval, ends broadly rounded, yellow at maturity, about one-half longer than the diameter.

Kützing notes a peculiar feature in the spirals of this species—he says they are cylindrical and possess a sort of central nerve. Rabenhorst and others consider this feature of uncertain and doubtful value. My specimens were collected in South Carolina and reaching me in a partially dried condition could form no opinion. Was governed in my identification chiefly by the proportions of cells and spirals.

Syn. *Zygnema neglectum*, Hass.

Plate CXXXVI, figs. 8, 9, fruiting and sterile filaments.

SPIROGYRA FLUVIATILIS, Hilse.

Diameter of vegetative filaments, 33–38 μ; cells 3–6 times as long as broad; four spirals; wide and usually dense, bright, rather dark green, describing 1–2 turns. Fructiferous cells much inflated; zygospore oval, about one-half longer than the diameter, which averages 55 μ; length, 80 μ.

This is probably the first record of the fruiting of this species. Found it in large masses in meadow pools in this vicinity.

Plate CXXXVI, fig. 1, a frequent appearance of sterile filaments; spiral bands not universally so wide; figs. 2, 3, fertile filaments.

Spirogyra nitida, (Dill.) Link.

Diameter of vegetative filaments, 72–78 μ; cells one to three diameters in length; also longer and shorter before and after division. Chlorophyl bands about 4, making 1–4 turns of the spirals; zygospores elliptic-ovoid, often almost almond shape, 1½ times as long as broad. Germinating plant clavate.

Syn. *Conferva nitida*, Dill.; *Conjugata princeps*, Vauch.; *Zygnema nitidum*, Ag.; *Zygnema rostratum*, Hass.; *Spirogyra diluta*, Wood.

Ponds, borders of streams, forms dark green masses, slippery to the touch.

Plate CXXXVII, figs. 7, 8, sterile and fruiting filaments.

Spirogyra subæqua, Kg.

Diameter of vegetative filaments, 55-60 μ; cells 1–2 times as long as wide; slightly swollen; spirals two, or more rarely three, making each 1–2 turns. Zygospores spherical or broadly ovate.

Spring waters, Pennsylvania.

Plate CXLI, figs. 1, 2, sterile and fertile filaments.

Spirogyra bellis, (Hass.) Cleve.

Diameter of vegetative filaments, 65–78 μ; cells 1½ times (rarely 3 times) as long as broad; spirals 5–6, making ½–1 turn each. Fructiferous cells not swollen. (Hass. and Cleve say swollen—Petit says, often not swollen on the side opposite the conjugated cell.) Zygospore orbicular, depressed (lenticular) with the membrane punctate or porose; chestnut color.

Syn. *Zygnema belle*, Hass.

The species has something in common with the preceding, *S. subaequa*, but is separated by filaments slightly larger, spirals more numerous and spores lenticular, not globose.

Submerged grassy shores, Budd's Lake, New Jersey; brackish water, Egg Harbor City, N. J.; and shores of ponds, Pennsylvania.

Plate CXXXVII, figs. 5, 6, sterile and fruiting filaments, Budd's Lake.

Plate CXXXIX, figs. 1, 2, Pennsylvania specimen; sterile filament with root-like processes; occurring frequently when plants are only partially submerged.

SPIROGYRA ORTHOSPIRA, (Naeg.) Kg.

Diameter of vegetative filaments, 58–65 μ; cells 2–3 times longer than the diameter; spirals 3–4–5 (rarely 7), often nearly straight or describing $\frac{1}{4}$ to $\frac{1}{2}$ turn in cell. Fructiferous cells moderately swollen. Zygospores brown as they mature; lenticular, (orbicular flattened). Forms presented to the eye change as the position of the spore changes in the cell.

Marsh pools, Pennsylvania.

Plate CXXXVI, figs. 10, 11, sterile and fruiting filaments.

SPIROGYRA MAXIMA, (Hass.) Wittr.

Diameter of vegetative filaments, 118–125 μ; cells a little longer than broad; chlorophyl bands, 6–7, margins finely notched describing each $\frac{1}{2}$–$\frac{3}{4}$ turn; fructiferous cells not inflated; zygospores lenticular, appearing according to position in cell, spherical or elliptical; diameter same as that of filaments.

Syn. *Zygnema maximum*, Hass.; *Zygnema orbicularis*, Hass.; *Spirogyra orbicularis*, (Kg.) Petit.

In large masses in streams, Bethlehem, Pa. Fruits very abundantly latter part of Summer.

Plate CXXXIX, figs. 3, 4, sterile, and fruiting filaments; figs. 5, 6, two spores germinating, from zygospores kept in glass jars from September to the following January and February.

According to Petit this species often attains a diameter of 132–138 μ.

Var. INÆQUALIS, Wolle.

A singular variety of *Spirogyra maxima;* the one filament having a much larger diameter than the other conjugating with it. The larger measuring 125 μ, the smaller 80 μ. The zygospore is most frequently in the smaller filament, and in consequence considerably smaller than the zygospore of the typical form. The smaller filaments if seen independent of the others would pass for *S. nitida*, or *S. bellis*.

Occurring in small coves, shores of river, Bethlehem, Pennsylvania.

Syn. *Spirogyra setiforme*, var. *inæqualis*, Wolle. Bull. Tor. Bot. Club, 1883.

Specimens were furnished to Witt. and Nord.'s *Algæ Exsiccatæ; vide* No. 541.

SPIROGYRA CRASSA, Kg.

Diameter of vegetative filaments, 150–156 μ; cells 1–1½–2 times longer than the diameter; spirals numerous, four or more, dentate or tuberculate, often close, subtransverse, making ½ to 1 to more turns in cell; fertile cells like the others, not inflated. Zygospores broadly oval, elliptic, ovoid or subglobose.

The type-form has the cells ½–2 times as long as broad; var. *Heeriana*, Naeg., has cells 1½–2 times as long as broad.

This, the largest of the genus, is common in ponds and sluggish river waters; it forms in early Summer long lubricous masses, of a bright green color, easily distinguishable by the unaided eye; later in the season it assumes a dirty green color; in this condition it may be found very abundant in fruit.

Syn. *Zygnema serratum*, Hass.; *Spirogyra Heeriana*, (Naeg.) Kg.

Plate CXL, figs. 1–3, two sterile and one fruiting filament.

SPIROGYRA JUGALIS, (Dill.) Kg.

Diameter of filaments, 90–100 μ; cells 1–1½ times longer than the diameter, somewhat constricted at joints; chlorophyl bands 3–4, each making 1–2 turns. Fructiferous cells somewhat inflated; zygospore elliptical or oval; membrane even, brown at maturity, one-half more in length than the diameter.

Syn. *Conferva jugalis*, Dill.; *Spirogyra setiformis*, Petit; *Spirogyra decimina*, Kg.

Pond waters.

Plate CXXXVIII, figs. 7, 8, sterile and fruiting filaments.

SPIROGYRA SETIFORMIS, (Roth) Kg.

Diameter of vegetative filaments, 102–110 μ; cells equal to 1½–2 times as long as wide; chlorophyl bands four or more, up to eight, margins irregularly notched, describing ½–1 turn each in a cell; sporiferous cells not inflated; zygospores elliptical, sometimes appearing ovate or globose as they change position in the cell; diameter slightly less than the cell.

S. jugalis and *S. setiformis* appear closely related, probably ought to be united; following the example of Mons. Petit their separate positions are retained. The one having somewhat inflated fruit-bearing cells, the other not, they differ also in some degree in the form of the zygospores.

Common in ponds and quiet river waters.

Syn. *Conferva setiformis*, Roth; *Zygnema interruptum*, Hass.

Plate CXXXVIII, fig. 1, sterile filament; fig. 2, fruiting filament approaching maturity, showing the spirals of the coming germs in the zygospores; figs. 3, 4, two spores germinating.

SPIROGYRA DUBIA, Kg.

Diameter of vegetative filaments, 43–50 μ; cells $1\frac{1}{2}$–$2\frac{1}{2}$ times as long as broad; chlorophyl bands two, or more rarely three, narrow, nodose, lax, making each 1–2 turns in a cell; sporiferous cells slightly swollen. Zygospores oval-elliptic, or subcylindrical, as broad as long, or one-half longer.

Ditches; fruiting abundantly in May; forming dirty, light yellowish-green masses.

Var. LONGI-ARTICULATA, Kg.

Cells five times as long as broad, spirals 2 or 3; turns in cell, 7–8.

Plate CXXXV, figs. 11, 12, typical form, sterile and fertile filaments.

SPIROGYRA ADNATA, Kg.

Diameter of vegetative cells, 40–45 μ; cells 1–3 times as long as broad; 2, sometimes 3, spirals, making 3–4 turns each; spore-bearing cells moderately swollen; zygospores oval-elliptical.

Stagnant waters, New York, Iowa.

Syn. *Zygnema adnatum*, Ag.; *Conjugata adnata*, Vauch.

Plate CXXV, figs. 3, 4, sterile and fertile filaments.

Appears nearly related to *S. decimina*, but vegetative cells are shorter and spore-bearing cells are more or less inflated.

SPIROGYRA RIVULARIS, Rab.

Diameter of vegetative filaments, 32–36 μ; cells of sterile plants 7–11 times as long as wide. Fertile cells usually about four times longer than wide; cylindrical or slightly tumid. Three spirals (rarely 2 or 4), lax, making $2\frac{1}{2}$–$3\frac{1}{2}$ turns in a cell. Zygospores oval-elliptical.

Distributed in flowing waters from New York to Florida, forming lubricous, darker or yellowish green masses.

Syn. *Zygnema rivulare*, Hass.

Plate CXXXVI, figs. 4, 7, sterile and fertile filaments.

SPIROGYRA MAJUSCULA, Kg.

Diameter of vegetative filaments, 54–62 μ; cells $2\frac{1}{2}$–10 times as long as broad; chlorophyl bands light green, 3–5, sometimes more, as many as 8–10; usually lax; fruiting cells not inflated, 2–4 times longer than wide. Zygospore oval or subglobose.

Forming often large, lubricous masses in ponds or pools, pale yellow green, or light greenish yellow. Not rare.

Syn. *Spirogyra orthospira*, Naeg.

Plate CXXXVII, figs. 1–4, two sterile and two fertile filaments.

Plate CXLII, figs. 5, 6, a singular and extraordinary freak. Two filaments of distinct species, the one *S. majuscula*, and the other *S. calospora* (*S. protecta*, Wood,) in conjugation. Prof. C. E. Bessey, in the *American Naturalist* for January, 1884, describes an instance of this kind observed by himself. Apparently a hybridism between two distinct forms; the one with one spiral and infolded ends of cells, the other with numerous spirals and obtuse ends.

SPIROGYRA ELONGATA, (Berk.) Kg.

Diameter of filaments, 22–30 μ; cells 4–14 times longer than broad; spirals two, or more rarely three, lax, describing 3–4 turns in a cell. Fructiferous cells much inflated; diameter of elliptic or oval zygospore somewhat greater than that of the vegetative cell.

Pools and ditches, Pennsylvania.

Plate CXXXV, figs. 1, 2, sterile and fertile filaments.

SPIROGYRA PARVISPORA, Wood.

Diameter of vegetative filaments, 75 μ; cells 2–4 times longer than broad; spirals four narrow bands, making each about $1\frac{1}{2}$ turns; zygospores very small, elliptical, $1\frac{1}{4}$–2 times longer than broad, diameter 50 μ.

Dr. Wood reports this form from the Pine Barrens, near Hibernia, Florida. It is remarkable for the comparatively small size of the spores.

Plate CXL, figs. 8, 9, sterile and fertile filaments.

Genus 71, SIROGONIUM, Kg.

Filamentous, composed of a series of cells with parietal longitudinal or somewhat spiral chlorophyl bands. Fructifying cells diverse, arising by unequal division of the cells of the filaments, bending knee-like towards each other and growing together; united at the point of adnation; zygospore elliptic.

The sterile cells, with the chlorophyl bands, resemble those of *Spirogyra*, but differ in the genuflexuous conjugation.

SIROGONIUM STICTICUM, Kg.

Diameter of vegetative filaments, 45–50 μ; cells 2–4 times longer than broad; 3–4 chlorophyl bands; zygospores broadly elliptical; spore-bearing cells more or less swollen.

Syn. *Sirogonium breviarticulatum*, Kg.; *Sirogonium Braunii*, Kg.; *Conferva stictica*, Eng. Bot.; *Zygnema curvatum*, Ag.; *Choaspes serpentina*, Gray.

Ponds, Florida. Have seen no specimens found north of the Gulf States.

Plate CXLI, figs. 8–10, copulating filaments, with two spores matured and one forming.

Genus 72, ZYGNEMA, Kg.

Cells with two axile many-rayed chlorophyl bodies standing near the central cell nucleus, each containing a starch-granule. Copulation scalariform or lateral; zygospore in one of the united cells, the same as in *Spirogyra*. Intermedial membrane of the sporoderm scrobiculate, even, or punctate. Cells having densely granular contents, including the two starch granules and often surrounded by a cytioderm of several layers, are supposed to be resting cells.

A.—The intermedial membrane of spores smooth.

ZYGNEMA LEIOSPERMUM, D. By.

Diameter of vegetative filaments, 20–22 μ; sterile cells twice as long as wide; fructiferous cells usually shorter; equal to the diameter, somewhat swollen. Zygospores orbicular or broadly oval.

Small pools.

Plate CXLIII, figs. 1, 2, 3, parts of two sterile filaments and one fertile.

ZYGNEMA INSIGNE, Kg.

Diameter of vegetative filaments, 26–30 μ; cells equal to twice as long as broad. Copulation usually scalariform, or sometimes lateral, sporiferous cells usually slightly swollen. Zygospore brown, globose; diameter about 30 μ, or somewhat broadly oval, 26 by 32 μ.

Syn. *Tyndaridea insignis*, Hass.; *Zygnema tenue*, Rab.

Plate CXLIII, figs. 4–6, sterile and fruiting filaments, the latter with matured spores in part, others forming.

B.—Sporoderm punctate or granulate.

ZYGNEMA STELLIUM, Ag.

Forming loose interwoven masses, primarily light green, but later, in time of fruiting, dirty yellow, or brownish. Cells 1–6 times as long as wide. Fructiferous cells more or less swollen. Copulation scalariform. Zygospores oblong or globose. Very variable in size.

Kirchner suggests the following separation of the different forms, all of them occurring frequently here in smaller ponds, pits, rivers, lakes, etc.:

1.—GENUINUM, Kirch.

Diameter of vegetative filaments, 25–36 μ; cells 1–3 times longer than broad.

Plate CXLIII, figs. 7, 8, sterile and fertile filaments.

2.—VAUCHERIA, Ag.

Diameter of vegetative filaments, 22–26 μ; cells $2\frac{1}{2}$–6 times longer than broad. Same as *Z. Brebissonii*, Kg.

Plate CXLIII, figs. 9–11, two sterile and two fertile filaments.

3.—TENUE, Rab.

Diameter of filaments, 12–22 μ; cells 1–3 times as long as wide.

Plate CXLIII, figs. 12–13, sterile and fertile filaments.

4.—SUBTILE, Rab.

Diameter of filaments, 15–19 μ; cells 2–4 times as long as wide. Same as *Z. ovale*, Kg.

Plate CXLIII, figs. 14, 15, sterile and fertile filaments.

5.—STAGNALE, Kg.

Diameter of filaments about 10 μ; cells 3–4 times as long as broad.

Plate CXLIII, figs. 16, 17, sterile and fertile filaments.

ZYGNEMA PURPUREUM, Wolle.

Diameter of vegetative filaments, 20–25 μ; cells one, or more rarely two diameters in length. Primarily yellowish green, but soon changes to a dark purple; fruiting filaments more or less geniculated; zygospores spherical; spore-bearing cells slightly, or not at all swollen.

Common in ponds of New Jersey, floating in large, loosely interwoven masses, but very rarely in perfect fruit. Found it very abundant also, in Florida; ditches in the Tocoi marshes, near St. Augustine, literally covered with it, as a smooth, glistening dark purple mantle; frequent in perfect fruit. The chlorophyl is usually more or less centrally contracted in each cell. There is no evidence of twin nuclei, a fact which, with the color and the geniculate feature of the filaments, make distinct specific characters.

Plate CXLIV, figs. 3–7, sterile and fertile filaments.

ZYGNEMA CRUCIATUM, Ag.

Diameter of vegetative filaments, 35–50 μ; cells one-half to twice as long as wide. Fructiferous cells not swollen; copulation scalariform; zygospores spherical, dark brown; sporoderm finely punctate.

Mostly in stagnant waters.

Mainly separated from larger form of *Z. stellium* by the spherical spores.

Syn. *Conjugata cruciata*, Vauch.; *Tyndaridea cruciata*, Hass.; *Conferva bipunctata*, Dillw.; *Zygnema Dillwyni*, Kg.

Plate CXLIV, fig. 1, an early stage of spore-formation by the union of the two stellate nuclei in a cell; fig. 2, fertile and sterile cells on the same filaments.

ZYGNEMA ANOMALUM, (Hass.) Kg.

Diameter of vegetative filaments, about 25 μ; surrounded by a colorless gelatinous sheath, often twice the diameter of the vegetative cells; sometimes even, sometimes much inflated, constricted at the joints. Cells equal or nearly twice as long as wide. Zygospores globose, olivaceous; sporoderm distinctly punctate.

Syn. *Tyndaridea lutescens*, Hass.; *Tyndaridea anomala*, Hass.

Var. CRASSUM, Wolle.

Diameter of vegetative filaments, 40–44 μ, without sheath; with it 63 μ more or less; cells primarily 3–4 times longer than broad; after division 1–1½ times longer. Cells, and sheath of shorter cells, somewhat swollen.

Received this plant repeatedly from the northern part of Vermont, collected by Dr. F. Hosford; all the specimens were in sterile condition, hence leaving the generic position somewhat in doubt.

Ralfs and Hassall, of England, report this species having the zygospores in the cells of the filaments; Kützing, of Germany, on the contrary, reports it as having the spore between the filaments in the canal of conjugation. While there can be no doubt about its belonging to the *Zygnemincæ*, it appears not decided whether it is constant as a *Zygnema* or may be a *Zygogonium*.

A remark by Ralfs on a character of the species under consideration may be well to note: "In its usual state the sheath is very conspicuous, and the dense endochrome so fills the cells, that the plant looks like a *Conferva*, the continuity being interrupted merely at the dissepiments. When about to conjugate the sheath has nearly, or altogether disappeared, and the endochrome is collected into the stellæ, having the rest of the cell colorless."

Plate CXLIV, fig. 9, part of vegetative filament as occurring most frequently with wide sheath; cells densely filled with chlorophyl previous to its gathering into twin stellate nuclei; fig. 13, part of a fruiting filament more enlarged than fig. 9, may also represent an ideal fruiting filament of var. *crassum*; figs. 10, 11, 12, three parts, vegetative filaments of var. *crassum*, in different stages of growth.

Genus 73, ZYGOGONIUM, Kg.

Filaments and arrangement of chlorophylous cell contents the same as in *Zygnema*; zygospore not in one or the other of the conjugating cells, but in the bladder-like middle space between the united pairing cells. Copulation scalariform, or lateral between cells of the same filament.

Some modern authors have proposed classifying all of the following forms of this genus with *Zygnema*, using the argument that the two modes of fruiting are not constant. Personal observations do not lead to the same conclusion; deviations from rule are rare, and then only with imperfectly developed fruit, hence prefer the old division.

Zygogonium pectinatum, Kg.

Diameter of vegetative cells, 30–38 μ; cells 1–2–2½ times longer than broad, slightly constricted at the joints. Zygospores globose, or broadly elliptic; diameter about 50 μ;

when fully matured, dull-olivaceous; sporoderm punctate or scrobiculate.

In stagnant waters.

Syn. *Conjugata pectinata*, Vauch.; *Conferva decussata*, Dillw.; *Tyndaridea conspicua*, Hass.

Plate CXLV, figs. 1, 2, sterile and fruiting filaments, with three perfected spores and two forming.

ZYGOGONIUM AEQUALE, (Kg.) Wolle.

Diameter of vegetative filaments, 30–33 μ; cells 1–2–3 times as long as wide; zygospores not as long as wide, measuring 25 by 30 μ, transversely oval.

Marsh pools, Pennsylvania.

Syn. *Zygogonium saxonicum*, Rab.

Rabenhorst quotes this species in his *Flora Algarum*, but fails to give the size or form of the zygospore—the distinguishing feature; we assume the name, however, at a hazard, as it agrees so well in proportionate length and breadth of cells.

Plate CXLV, fig. 3.

ZYGOGONIUM DECUSSATUM, (Vauch.) Kg.

Diameter of vegetative filaments, 18–20 μ; cells 3–5 times longer than broad; cell membrane thin; connecting tube inflated, bearing a spherical zygospore; somewhat larger than the diameter of the filament.

Ponds, sluggish or stagnant waters.

Syn. *Tyndaridea decussata*, Hass.; *Conjugata decussata*, Vauch.

Plate CXLV, figs. 4, 5, conjugating filaments with cells partly sterile, partly with zygospores.

ZYGOGONIUM AGARDHII, Rab.

Diameter of filaments, 15–18 μ; cells 1½–2 times longer than broad, more rarely equal; bright yellow green, cells not swollen; sometimes moderately constricted at joints; zygospore globose, rarely slightly oval, membrane firm, colorless, smooth; diameter, 20–25 μ.

Wet ground, Florida, frequent.

Plate CXLV, figs. 6, 7, fruiting filaments.

In size the plants ascribed to this species are thinner than those of *Z. conspicuum*, Kg., nearer *Z. decussatum*, Kg.; the articulations are longer than the average of the former, and shorter than those of the latter.

ZYGOGONIUM PARVULUM, Kg.

Diameter of filaments, 22–24 μ; cells 4–6 times longer than broad, not swollen; zygospore globose produced in the conjugative canal; diameter very little more than that of the cells.

Pools and ponds.

Syn. *Zygnema ordinarium*, Berk.

The distinction between this form and *Z. decussatum*, is slight, hardly sufficient for a good species. We quote it without confidence in its value, probably a form of *Z. decussatum.*

Plate CXLV, fig. 9.

ZYGOGONIUM RALFSII, Kg.

Diameter of vegetative filaments, 16–20 μ; cells 2½–3 (rarely 4) times as long as broad; zygospore compressed ellipsoid twice as long as broad, produced in the inflated conjugative canal; sporoderm smooth.

Syn. *Tyndaridea Ralfsii*, Hass.

Pools, Pennsylvania; rather rare.

Plate CXLV, fig. 8, part of conjugated filaments.

The above description is from European works and describes our form correctly except the zygospores; the difference between the length and breadth of the spore is not near as great.

Genus 74, MOUGEOTIA, D. By.

Cells cylindrical with axile chlorophyl-plates. Copulation scalariform. Zygospores drawn together in the widely swollen, bladdery, persisting middle space.

MOUGEOTIA SPHAEROCARPA, Wolle.

Diameter of vegetative filaments, 20–25 μ; cells 3–6 times longer than broad; zygospores large spherical, diameter about 40 μ.

Ponds, New Jersey, Pennsylvania, Florida, etc. The nearest allied species of Europe is *M. laevis*, Arch. Filaments about the same diameter, but cells shorter (2 diameters, or before division 4 diameters). Zygospores elliptic or oval. Archer says, "conjugation takes place by short wide processes, which, along with the shortness of the cells, give the pair of conjugating filaments somewhat of the appearance of a perforated ribbon-like structure." He adds, "The elliptic zygospore, within the inflated transverse tube, has the longer diameter of the spore placed vertically to the length of the filament."

Judging also by an illustration in Cooke's *British Algæ*, *M. laevis*, Arch., is entirely distinct from our plant. The conjugating connecting tube is comparatively narrow, the spore small, not wider than the diameter of the filaments and decidedly elliptic.

Plate CXLVI, figs. 1, 2, two pairs of filaments conjugated; zygospores forming, and matured.

MOUGEOTIA MINNESOTENSIS, Wolle.

Diameter of filaments, 15-18 μ; cells 4–5 times as long as broad. Zygospores very large, spherical, diameter 60 μ. General appearance near the preceding, but proportions of cells and spores, and size of filament, all distinct. From the comparatively few specimens seen, judge it a different species from the preceding *M. Sphaerocarpus.*

Pond, near Minneapolis, Minnesota.

Plate CXLVI, fig. 3, two filaments in conjugation; spores mature.

MOUGEOTIA DIVARECATA, Wolle.

Diameter of vegetative filaments, about 20 μ; cells 4–10 times longer than broad; zygospores average 45 μ; cells more or less diverging between the spores.

Ponds, Pennsylvania.

Somewhat like the two preceding species in the spherical spores, but differing in size, also in length of cells, and in the recurving of the same.

Plate CXLVI, fig. 4, two conjugating filaments with matured spores.

MOUGEOTIA DELICATULA, Wolle.

Diameter of vegetative filaments, 12–14 μ; cells 4–6 times longer than broad; zygospores spherical, diameter 25–30 μ.

Shores of St. Lawrence River, Canada.

Plate CXLVI, fig. 5, conjugated filaments with spores matured.

These four species are introduced with some degree of hesitancy as new species of *Mougeotia*. They evidently belong to this genus, but whether absolutely distinct species may not be so certain. They were found in distinct, and widely separated localities, never in large quantity, and not all so frequently as to remove all doubt of constancy in the specific characteristic features given. They are unlike any European species known. Cooke's figures represent very different forms; possibly incorrectly, because not strictly in harmony with Archer's description, when he remarks of *M. laevis*, "the conjugation takes place by short, *wide*, processes."

MOUGEOTIA GLYPTOSPERMA, D.By.

Diameter of filaments, 10–13 μ; cells 6–12 times as long as broad. Zygospore large, oval, with a thick, firm, yellow-brown epispore, more or less radiately corrugated when fully matured; sporiferous cells elongated.

The position of the zygospore gives the appearance of a *Mesocarpus*, but the distinction between the two genera must determine its proper place. In *Mougeotia* the zygospore is the result of the complete fusion of the cell contents of the two conjugating cells, whereas in *Mesocarpus* the spore is the result not of the complete coalescence of the green contents of the two cells, but only of a part thereof; the spore is not a true zygospore, but rather a daughter cell of it. This plant has a true zygospore, hence is properly placed with *Mougeotia*.

The only good specimens, from marsh pools, Florida.

Plate CXLVI, figs. 6, 7, conjugating filaments with spores in different stages of advancement toward maturity; figs. 8, 9, two sterile filaments.

MOUGEOTIA VERRUCOSUS, Wolle.

Diameter of filaments, 13–14 μ; cells 6–10 times longer than broad, somewhat recurved. Spores transversely oval, shorter diameter 20–25 μ; and longer axis, 40 μ. Membrane coarsely granular, dark brown.

Pools, near Mobile, Alabama. A very distinct form. Found only a limited number of specimens; short fruiting filaments; no sterile cells; farther observations may modify the above description somewhat.

Plate CXLVIII, fig. 5, conjugated filaments with matured spores.

SUBSECTION.—MESOCARPINÆ.

Green filamentous plants, with chlorophyl more or less axillary. Copulation similar to that of the *Zygneminæ*, scalariform, geniculate or lateral; the spore formed, however, is not the result of the flowing together of the entire chlorophyl masses of the two cells united; the chlorophyl does pass out from the two cells and conjoins, but it unites only in part, being separated by two or four partition walls. The spore thus formed is not properly a zygospore, but a hypnospore, or a resting spore.

Genus 75, MESOCARPUS, Hass.

Spores spherical or oval, between two cylindrical, straight or slightly inbent cells. Copulation scalariform.

Spore membrane smooth.

MESOCARPUS SCALARIS, (Hass.) D. By.

Diameter of vegetative filaments, 25–30 μ; cells 2–6 times longer than broad; spores spherical or broadly oval, membrane brown, smooth, nearly the same in diameter as the filaments.

Syn. *Mesocarpus intricatus*, Hass.; *Sphaerocarpus intricatus*, Hass.

Frequent in marsh and meadow pools.

Plate CXLVII, fig. 2, conjugated filaments with spores; fig. 3, a specimen from Plainville, Conn., 1879, noted at the time as variety *M. scalaris.* Have seen no specimens since, and question, may it be a *Mougeotia?*

MESOCARPUS PARVULUS, (Hass.) D. By.

Diameter of filaments, 8–10 μ; cells 6–12–16 times as long as broad; spores globose, brown at maturity; membrane smooth. Filaments of fruiting cells usually straight, but sometimes arched between the spores.

Syn. *Sphaerocarpus parvulus*, Hass.; *Mougeotia splendens*, Kg.; *Mesocarpus angustatus*, Hass.

Ponds and pools, North, West and South.

Plate CXLVIII, figs. 3, 4, ordinary form of fruiting filaments.

MESOCARPUS MACROSPORA, Wolle.

Diameter of vegetative filaments averages about 30 μ; cells 6–10 times longer than broad; spores nearly or quite twice the diameter of the filaments; filaments arched between the spores. Membrane of spores smooth.

Shallow waters, Susquehanna River, Harrisburg, Pa.

Plate CXLVII, fig. 4, specimen of spores and filaments.

MESOCARPUS CRASSA, Wolle.

Diameter of vegetative filaments, about 50 μ; cells 4–5, or before division sometimes ten times longer than broad. Spores spherical, membrane smooth, diameter averages 65 μ, about one-third more than that of the filaments.

In large light yellowish green masses, floating on stagnant waters in ditches in Tocoi marshes, near St. Augustine, Florida.

Plate CXLVII, fig. 1, spores and cells of filaments.

Mesocarpus recurvus, Hass.

Diameter of filaments, 10–18 μ; cells 5–10 times longer than broad, more or less recurved. Zygospores globose, membrane smooth, diameter, 20–24 μ.

Syn. *Sphaerocarpus recurvus*, Hass.

Ponds and ditches.

Plate CXLVII, fig. 6, conjugating filaments and spores.

Mesocarpus radicans, Kg.

Diameter of filaments, 22–29 μ; cells 3–8 times as long as wide. A sterile form scarcely to be counted a distinct species, possibly a variety, or condition of *M. scalaris*, possessing the singular feature of short branchlets usually emitted nearly at right angles, about the middle of a cell.

Plate CXLVIII, figs. 7–10, sterile, branched filaments.

The arrangement of the endochrome and of the starch grains in the cells, are a good illustration of sterile filaments of nearly all species.

Spore membrane punctate.

Mesocarpus nummuloides, Hass.

Diameter of vegetative filaments, 9–15 μ; cells 7–14 times longer than broad. Spores spherical, 17–23 μ in diameter, membrane punctate.

Syn. *Sphaerocarpus nummuloides*, Hass.

Meadow, or wayside pools.

Plate CXLVIII, figs. 1, 2, sterile and fruiting filaments.

Mesocarpus robustus, D. By.

Diameter of filaments, 25–32 μ; cells 3–8 times longer than broad, nearly straight; spores nearly spherical, 40–50 μ diameter, membrane reddish brown, finely punctate.

Small ponds and ditches.

Plate CXLVII, fig. 5, copulated cells, with spores too nearly spherical for the typical form.

Genus 76, PLEUROCARPUS, A. Br.

Filamentous, cells the same as the cells of *Mesocarpus;* copulation not scalariform, but lateral, by the flowing together of the chlorophyl of two adjoining cells. Sterile filaments often bent nearly at right angles, and united at the angles, but producing no fruit.

This genus has by some authors been incorporated into the genus *Mesocarpus*, but the method of fruiting is so absolutely distinct, prefer to keep it separated.

PLEUROCARPUS MIRABILIS, A. Br.

Diameter of vegetative filaments, 25–30 μ; cells 2–5 times longer than the diameter. Spores somewhat depressed globose, about the same diameter as that of the cells, having a lateral position, mostly on one side of the filament at the joint of the two copulating cells.

Common everywhere; forms large, loosely interwoven light green floating masses, usually only one to two feet in diameter, but sometimes 20–30 feet across. The filaments are very fragile, breaking into short lengths; almost always geniculately united, but never in fruit. Was familiar with this form for eight years, saw it constantly, but always sterile, and was coming to the conclusion that the story of A. Braun about the mode of fruiting must be a myth, when suddenly, in 1883, it was found in three distinct localities; first by E. S. Cheeseman, Knowlesville, N. Y.; second by Miss E. Butler, in a swampy meadow near Malden, Mass.; and third, by myself in a small pool on the border of a pond familiarly known as Buckaberry Pond, in Northern New Jersey. Have not seen it since.

Syn. *Mougeotia genuflexa*, Ag.; *Conferva genuflexa*, Dillw.; *Zygogonium pleurospermum*, Kg.

Plate CXLIX, figs. 8, 9, two pairs geniculate filaments grown together. The form known by earlier authors as *Mougeotia genuflexa*. Fig. 10, the beginning of the formation of a lateral spore; figs. 11–13, three matured spores, the result of lateral conjugation; figs. 14, 15, sterile filaments.

PLEUROCARPUS COMPRESSUS, Lyngb.

This specific term, *compressus*, was applied by Lyngb., Gray and Rab., and others to the form figured, Plate CXLIX, figs. 10–13, and *Mougeotia genuflexa* to figs. 8, 9.

PLEUROCARPUS COLUMBIANUS, Wolle.

Diameter of filaments, 37–40 μ; cells 4–8 times longer than broad, geniculately joined. In the year 1879, we announced this plant as a new species. Bull. Torrey Bot. Club, January, 1879. It is nearly one-half thicker and the cells are longer than those of *P. mirabilis*; would more properly be named a variety of that species.

Plate CXLIX, figs. 6, 7, sterile filaments.

Genus 77, PLAGIOSPERMUM, Cleve.

Cells cylindrical, united into filaments; cell contents similar to other *Mesocarpinæ*. Spores spherical or broadly oval in one of the conjugated cells. The spore-bearing cell somewhat inflated and shortened by distinct and thickened, suture-like, partition walls.

PLAGIOSPERMUM TENUE, Cleve; var. MINOR, Wolle.

Diameter of vegetative filaments, 17–18 μ; cells 4–8 times longer than broad. Spores spherical, ½–2 times more in diameter than the filaments. Spores dark green to brown or red.

The filaments of the typical form found in Sweden and described by Cleve, measure 25–30 μ, and cells 8–16 times longer than broad.

Shallow pools, Bethlehem, Pennsylvania, and Florida.

Plate CXLVIII, figs. 11–15, fruiting filaments; the same are also found in series of fruiting cells on the same filaments.

Genus 78, GONATONEMA, Wittr.

Cells elongated, cylindrical, united into filaments with axile plates of chlorophyl. Agamospores produced without conjugation, formed by biseptation of the mother cells, which latter are often bent angularly, and alternately, at the point of fructification.

GONATONEMA VENTRICOSUM, Wittr.

Diameter of vegetative filaments, 5–6 μ; cells 8–12 times longer than broad, somewhat geniculately bent; spore-bearing cells inflated; spores spherical or broadly oval.

Prof. Wittrock, of the Academy of Science, Stockholm, made a thorough investigation of the spore-formation of the *Mesocarpeæ* and especially on the new genus *Gonatonema*. The paper is too long for transfer to these pages; a few words may be quoted: "It appears that the spores are always formed without a preceding act of conjugation. The spore formation, therefore, may be regarded as neutral, or we may assume that, as in exceptional cases, spores may be formed by the instrumentality of a single cell; in this case the exception has become the rule, and the spores would then be regarded as parthenospores, and not as agamospores."

"Because this plant differs in such an essential respect in the spore from the other *Mesocarpeæ*, I have thought fit to form a new genus for it, to which I have given the name of *Gonatonema*, meaning geniculate filament."

Collected this plant in small pool on margin of river, Bethlehem, Pennsylvania. It may not be absolutely the same plant as described by Wittrock, but it is too near to be separated as a new species.

Plate CXLIX, figs. 1–5, sterile cells, cells forming spores, and bearing matured spores.

Genus 79, STAUROSPERMUM, Kg.

Filaments geniculate, zygospores short cylindrical, in front view quadrangular; in lateral view narrow elliptical, between the truncated corners of, usually, four sessile lateral cells. Cells often twenty times longer than broad.

STAUROSPERMUM CAPUCINUM, Kg.

Diameter of vegetative filaments, 14–20 μ; cells 6–14 times longer than broad; zygospores quadrate, angles obtuse, truncate or incurved, sides often deeply sinuate. Sporoderm smooth. Filaments acquire a bluish tinge and with age a purple hue.

Ponds, widely distributed, the most frequent of our species.

Syn. *Staurocarpus glutinosus*, Hass.; *Staurocarpus capucinus*, Kg.; *Leda capucino*, Bory.

Plate CL, figs. 1–5, sterile filament; immature spore and three forms of matured spores.

STAUROSPERMUM QUADRATUM, Kg.

Diameter of vegetative filaments, 8–12 μ; cells 8–18 times longer than broad, forming floating masses of considerable size. Zygospores quadrangular, sides straight, angles truncate, membrane punctate or porose. Spores, 28–40 μ.

Ponds, New Jersey, frequent.

Syn. *Staurocarpus quadratus*, Hass.

Plate CL, figs. 6–8, three zygospores of different sizes.

STAUROSPERMUM VIRIDE, Kg.

Diameter of filaments, 6–8 μ; cells 6–10 or more times longer than broad; zygospores mostly quadrangular, with sides more or less deeply incurved; membrane smooth.

Syn. *Staurocarpus gracilis; S. virescens; S. affinis*, all by Hass.; *Staurospermum franconicum*, Reinsch.

Small pools and ponds, Florida.

Plate CL, figs. 9, 10, a quadrangular, and a triangular zygospore.

Genus 80, CRATEROSPERMUM, A. Br.

Filamentous, elongated, membrane thin. Chlorophyl-green cell contents primarily diffused, later more contracted into an axillary band. Copulation geniculate. Zygospore spherical, involved in a cylindrico-subquadrangular membrane, at the point of conjugation.

CRATEROSPERMUM LAETEVIRENS, A. Br.

Diameter of vegetative filaments, 38 μ; cells 3–8 times longer than broad; zygospores green, changing to olivaceous, or brown. Floating in rather light green interwoven masses.

Syn. *Mougeotia craterosperma*, Itz.

The only specimens recognized as possibly of this genus, were collected, July, 1880, in Green Pond, New Jersey. The conjugation was complete, but the spores were imperfectly developed, hence my hesitancy in calling it a pronounced species of this genus.

Plate CL, figs. 11, 12, the conjugated cells as observed.

Class III.—CYANOPHYCEÆ.

(PHYCOCHROMOPHYCEÆ.)

Plants one or many-celled, living in water, or enclosed in a maternal jelly when out of it, mostly in families formed from successive generations of cells. Cell membrane (*cytioderm*) not siliceous, combustible. Cell contents (*cytioplasm*) variously colored by means of *phycochrome*, aeruginous, red, violet, orange yellow, brown, or olivaceous, but never chlorophyl-green; destitute of nucleus and usually without starch granules.

Order VI.—SCHIZOSPOREÆ.

(CYSTIPHORÆ.)

Cells single or united in single or branched series; they divide in one direction only. Cytioderm soft, smooth, immersed in a more or less liquid or firm mucilage, variable in color, for the most part irregularly disposed.

The two families NOSTOCACEÆ and CHROOCOCCACEÆ are separated by the former having the cells united after division into filamentous series, and the latter having the cells separated and scattered.

Family XVIII.—NOSTOCACEÆ.

Filamentous, simple or rarely with spurious branches, furnished with heterocysts; involved in a copious gelatin, more or less firm or diffluent. The plants of some of the genera develop spores, and are provided with heterocysts; the former, usually dark green, granular; the heterocysts yellow or lighter or darker yellowish brown, or nearly colorless, almost devoid of cytioplasm; sometimes they are terminal, sometimes interstitial, between vegetative cells. The spores divide after a period of rest, before or after the rupture of the cytioderm, and then germinate and reproduce. The function of the heterocysts is not determined.

The Family NOSTOCACEÆ may be divided into the following five sections:

I. RIVULARIEÆ.
II. SCYTONEMEÆ.
III. SIROSIPHONEÆ.
IV. NOSTOCEÆ.
V. OSCILLARIEÆ.

SECTION I.—RIVULARIEÆ.

Genus 81, CALOTHRIX, (Ag.) Thur.

Filaments rather rigid, nearly straight, branched; branches spurious, being younger trichomes, agglutinated at the base and part of their length to the parent stem, terminating at the apex in a delicate hair-like extremity. Heterocysts normally present, usually at base of branches; often fasciculately branched; growing in small tufts, or forming a light turf of indefinite extent.

CALOTHRIX ORSINIANA, Thur.

Forming a pulvinate stratum, about 40 μ in thickness, dark brown, or reddish brown, lubricous, opaque; trichomes elongated, branches of nearly equal thickness, cuspidate at the apex or obtuse, distinctly articulate; sheaths thick, smooth or lamellate, light golden brown. Trichomes with sheath, 20-25 μ; without sheath, 10-13 μ.

Syn. *Scytonema cirrhosum*, Berk.; *Coenocoleus cirrhosus*, Berk.; *Schizosiphon cateractæ*, Naeg.

On submerged stones, Florida.

The measures quoted by Kirchner and by Cooke are less than given above, but otherwise the description seems to indicate a similar plant.

Plate CLXVIII, figs. 1, 2.

Calothrix Dillwynii, Hass.

Flaccid, aeruginous (blue-green) or more rarely brownish; sheaths inconspicuous, except sometimes towards the base; articulations, 1–1½ times as long as the diameter; heterocysts at the base of the spurious branches, ovate or sometimes cordate. Diameter of trichomes, 12–15 μ; smaller forms, 10–13 μ. The latter sometimes with twin heterocysts.

The larger from specimen from Garrett County, Maryland. The other from swamps, etc., New Jersey.

Plate CLXVIII, figs. 3, 4.

Calothrix gypsophila, Kg.

Brown, or almost black, smooth, shining, in small tufts, or extended strata on rocks at water's edge washed by the waves. Trichomes about one-fourth of an inch long, subdichotomously branched, somewhat attenuated at ends; sheath rather close, brownish yellow. Articulations indistinctly ½–1 diameter. Heterocysts the size of trichome, usually two or three in series.

Diameter of filaments, 12–14 μ.

Syn. *Schizosiphon gypsophilus*, Kg.

Lake Hopatcong, New Jersey.

Plate CLXVIII, fig. 5, two short filaments with spurious branches.

Have adopted this name although our plant is not in every particular in accord with the diagnosis given in Rabenhorst's *Flora Algarum*.

Plate CLXVIII, figs. 6, 7.

Smaller variety from Pennsylvania, and from Minnesota.

Calothrix gracilis, Rab.

Small tufts, aeruginous, or later dull brown, usually fasciculately branched; branches closely attached; sheath firm, close, colorless or light yellow, indistinctly lamellate, ends closed, attenuate, except in older, brown plants, then often open and fibrous. Heterocysts oval, yellow, same size as the filaments, single or twin.

Diameter of basal parts of trichomes, 6–8 μ.

Syn. *Schizosiphon gracilis*, Rab.

Occurs frequently in ponds; differs from *C. Dillwynii* mainly in size.

Plate CLXXIII, figs. 2, 3.

Calothrix Meneghiniana, Kirch.

Forming strata on partially submerged rocks, usually near the water line, composed of small, deep aeruginous or brown dense tufts; trichomes short, somewhat prostrate, at first simple, later much and compactly branched. Cells equal or half as long as wide. Sheath distinctly lamellose, at the base yellow or brownish, at the ends colorless and torn into fine fibers. Heterocysts usually single, same thickness as the vegetative cells.

Diameter of vegetative cells, 6-8 μ.

Diameter of sheath, about 13 μ.

Syn. *Schizosiphon Meneghinianus*, Kg.

Plate CLXX, figs. 5–7, three plants in different stages of growth.

Calothrix radiosa, (Kg.) Kirch.

Small tufts, sometimes gregariously extended on submerged rocks, waving, made up of radiating, fasciculate trichomes, about 40 μ long, considerably branched; stems and branches somewhat curved, the two adhering about half the length of the branches, ends free; mostly of brownish red color. Vegetative cells, $\frac{1}{3}$–$\frac{1}{2}$ as long as wide. Sheath close, golden yellow or colorless. Heterocysts single, globose, size the same as filament to which it is attached.

Diameter of internal trichomes, 12 μ.

Diameter of sheaths up to 30 μ wide.

Plate CLXX, figs. 1, 2, two plants drawn on a much smaller scale than the others on the plate; figs. 3, 4, a variety, appears to stand between this species and *C. Meneghiniana;* figs. 8, 9, young forms of the last, (3, 4).

Calothrix Brebissonii, Kg.

Caespitose, bright aeruginous, or sometimes changing to light brown, spurious branches short, stout, quickly attenuate to a hair-point, beautiful aeruginous; distinctly and shortly articulate, sometimes interrupted; articles with granular contents, 3–4 to diameter. Sheath usually close, widens with age, colorless or light yellow. Heterocysts globular, single, at base of branches, colorless or light yellow.

Diameter of trichomes, with sheath, 16–20–25 μ.

Submerged stones, ponds, New Jersey.

Plate CLXIX, figs. 5, 6, 7, two characteristic forms.

CALOTHRIX HOSFORDII, Wolle.

Stratum olivaceous, trichomes aggregated, bright aeruginous, subdichotomously spuriously branched; branches flagelliform, turgid below, tapering to a fine, colorless hair-point. Articulations 4–5 to diameter. Sheath wide, distinctly lamellose, yellow toward the base; colorless and hyaline toward the ends. Heterocysts depressed semi-globose; 3–4 times broader than long; bluish tint, somewhat lighter than the vegetative cells.

Diameter of internal trichome, thicker parts, 10–12 μ.

Diameter of sheath, 25–28 μ.

Collected by F. H. Hosford, in pond near Charlotte, Vermont. Bears some resemblance to the last, *C. Brebissonii*, but is particularly distinct in the form and color of the heterocysts.

Plate CLXIX, figs. 1, 2, a long filament with numerous, young forms, spurious branchlets, attached; figs. 3, 4, three young, isolated plants.

CALOTHRIX LACUCOLA, Wolle.

Floating, dull yellow or brownish, dichotomously branched; branches somewhat patent, not concrete, moderately attenuated, apices obtuse, slightly bent. Internal trichomes thin, dull aeruginous or yellowish brown, homogeneous or indistinctly articulate, subequal or less. Heterocysts globose, yellow, single or twin, at base of branchlets.

Diameter of thicker parts, 15–20 μ.

Splitrock Pond, New Jersey, the only habitat hitherto found.

This singular plant bears a resemblance to *Tolypothrix*, but is unlike the forms of that genus in having the filaments attenuated, beside the distinct branching.

Plate CLXXII, fig. 1, one of the larger forms.

CALOTHRIX CRUSTACEUM, (Ag.) Wolle.

Plants densely caespitose, erect, somewhat regularly branched, branches free, with obtuse rounded apices, and each with a heterocyst at the base. Aeruginous endochrome annulated, increasing in diameter towards the apices of the filaments.

Diameter sheath, 17–20 μ.

Diameter of internal filaments, 8–10 μ more or less.

This plant has been variously described in its different stages of development.

The first condition is described as *Zonotrichia minutula*, Wood.

Fronds very small, blackish green, semi-globose, not distinctly zoned, rather soft, growing on mosses; not impregnated with lime: internal filaments shortly articulate, very distinctly fasciculately *pseudo*-ramose, etc.

Second condition *Zonotrichia parcezonata*, Wood.

Blackish green, irregularly semi-oval, to six lines long, hard, slippery, not fragile, impregnated (partially) with lime, internally distinctly radiate, sparsely and often obsoletely zoned; filaments moderately long, straightish, etc.

The author remarks, "I found this plant growing on rocks as glossy, blackish, very hard and slippery fronds or masses, which varied in size from that of a very small shot to nearly half an inch in length. The filaments (internal) are often very evidently and frequently *pseudo*-ramose."

Certain specimens which I obtained, growing with the others, instead of being blackish in color, are grayish, but agree in all other respects with their fellows. The gray color depends upon the deposit of lime salts, distributed in quantity with the spray of the falls. It is probably this condition which Prof. Bailey refers to as *Rivularia calcaria*. This stage would make the third condition.

A fourth condition is well calculated to deceive the novice —with age the trichome contracts, and the ends of the wide sheaths become fibrillose.

Syn. Besides the above three, may be added *Schizosiphon crusiformis*, Naeg.; *Sch. cataractæ*, Naeg.; *Petronema fructiculosum*, Thwaites; *Scytonema crustaceum*, (Ag.) Cooke.

Very abundant, particularly on the rocks subject to the spray of water falls, Niagara, Genesee River falls, Adirondack Mountains, etc.

Plate CLXXII, figs. 4, 5, the gray crustiferous form, natural size, often forms a thicker crust; fig. 3, a section of a glossy blackish frond, *Zonotrichia parcezonata*; fig. 6, section of a more advanced growth; fig. 2, a single plant separated and more highly enlarged; fig. 7, more advanced stage, ends of trichomes fibrillose.

Plate CLXXVII, fig. 15, natural size of thalli, as sometimes found in clusters; fig. 14, a section of one of them showing the *Zonotrichia* form.

Genus 82, MASTIGONEMA, (Fisher) Kirch.

Filaments short, free, without gelatinous sheath, branchless, singly or sometimes in small mats. Heterocysts at the base of the filaments ; spores unknown.

All the forms under this genus are probably merely arrested, or intermediate conditions of higher developments of plant-life, as will appear in the following list of forms, under the names of species.

Mastigonema æruginеum, (Kg.) Kirch.

Filaments straight, bent, or curved. Sheath thin and close, extended into a slender flagelliform end. In vegetative state aeruginous, distinctly or indistinctly articulate ; cell contents more or less granular. Heterocysts variable in size and form, single or geminate, globose, oval, depressed globose, pyriform, etc., usually yellow of lighter or darker shade ; sizes indefinite ; with age the sheath widens and sometimes becomes fibrillose.

Plate CLXXIV, figs. 3–9, three distinct forms ; figs. 3–4, having double heterocysts, a larger oval, connected with a smaller globose cell ; figs. 5–7, pyriform heterocysts, both forms with thin, close sheaths ; figs. 8, 9, spherical, single heterocysts, wider sheath, becoming fibrillose.

Plate CLXXI, figs. 8–10, three forms in a gelatinous coating on the sides of a pump trough, commencing to branch after the manner of a *Scytonema*.

Plate CLXXVI, figs. 2, 3, 4, another form, indicating the same manner of branching as the last.

Plate CLXXV, figs. 1–3, young stages, developed from spores, and more advanced conditions ; fig. 4, a long filament indicating a connection with *Tolypothrix ;* figs. 5, 6, another form, developing after a manner of its own. The young filaments commencing growth in small clusters, like fig. 9 ; these changing to horizontal positions, so that alternate cells lie in opposite directions, (fig. 8) ; at first short, flagelliform, then elongating and becoming linear (fig. 6), and much longer, having the appearance of *Tolypothrix muscicola ;* fig. 7, is another specimen of the same ; the branching commences at some distance from the basal heterocysts. Pennsylvania. Figs. 9, 10, same mode of developing ; Florida specimens ; figs. 12–14, a larger form, from New Jersey ; manner of arrangement the same ; figs. 15, 16, 17, more scattered filaments—showing a gradual increase in breadth and length; first flagelliform, then linear and much elongated. All indicating that these so-called *Mastigonema* forms are not fully developed plants.

Plate CLXXVI, fig. 8, young conditions gradually developing into larger forms; figs. 6, 7, in mass producing a dark olive coating on old planks subject to inundation from marine waters. These forms I named some years since, *Mastigonema velutina*, but have now reason to believe they are the young condition of *Lyngbya aestuarii.* Compare *L. aestuarii;* figs. 9–11, a variety of sizes, similar to figs. 2–4, having the peculiarity of interstitial heterocysts not heretofore noticed.

Plate CLXXIII, figs. 4, 5. A variety frequently occurring, from Florida; juvenile and maturer forms, corresponding with Plate CLXXI, fig. 7, also from Florida; figs. 5, 6, of latter plate, represent filaments from a large floating mass, heterocysts torn off; probably the same, but older condition of fig. 7. Filaments instead of being bright aeruginous many are partially changed to yellow or light brown, and others brownish red. Fig. 1–4, appear distinct in a process of fruiting; the basal articulations develop macrogonidia which pass out through a rupture at the end. These trichomes also have interstitial heterocysts. The clinging of the young to two of the older trichomes indicates a relation to *Calothrix.* The formation of the macrogonidia in the basal cell is worthy of a note. Prof. A. Borzi remarks in his *Morfologia e Biologia*, etc., p. 297, that nearly all, or quite all of the *Rivulariaceæ* multiply not only by *ormogons*, but also by the spores which originate in the basal portion of the trichomes. These are true spores capable of hibernation.

Plate CLXXVII, figs. 1, 2, somewhat distinct in heterocysts and the fibrillose sheath; from wet moss and rocks, Niagara; figs. 3, 4, more usual forms of variable sizes; fig. 11, more elongated form; fig. 12, very turgid specimens; fig. 13, heterocysts wider than the filaments.

Plate CLXXVI, fig. 1, a parasitic form on *Lyngbya Wollei*, and probably a young development of it.

MASTIGONEMA HALOS, Wood.

In little tufts; filaments simple, in mature state greatly elongated, and with the sheath truncate and open; in the young condition shorter and often ending in a rather short seta; internal filament shortly articulate, minutely granular, continuous or variously interrupted; sheath firm, rather thick, often distinctly lamellated, colorless; heterocysts subglobose.

Diameter with sheath, about 12 μ.

An inhabitant of salt or at least brackish water. Have found its like in fresh water also.

Plate CLXXIV, fig. 2, the growth, under low magnification; fig. 1, the plant enlarged 250 diameters.

Mastigonema sejunctum, Wood.

Thallus somewhat caespitose, soft, parasitic; filaments simple, mostly inarticulate, but sometimes shortly, sometimes long articulate, attenuate at the apex, yellowish olive or greenish, sparsely granulate; sheaths mostly ample and distinct hyaline, often strongly undulate, the apex mostly much amplified and dissolved into fibrillae; heterocysts about equal to diameter of the filaments.

Diameter of trichome, 4 μ.
Diameter of sheath, 12 μ.

Growing on the edges of minute leaves, so as to form little prominences or thickenings of the margin. Carp River bog.

Plate CLXXIII, fig. 9, a small tuft; fig. 6, an isolated trichome.

Mastigonema elongatum, Wood.

Thallus at first subglobose, afterwards frequently fusiform, blackish green, slippery, firm; filaments aeruginous, very elongate, sometimes not articulate, but more generally shortly articulate, sometimes strongly contracted at the joints; apices sometimes truncate, but generally produced into long, flexuous, translucent hair-points; sheath transparent, close, frequently truncate at the apex; heterocysts globose or subglobose.

Diameter of filaments, 6–7 μ.

Was found growing in an aquarium on some brook moss. It forms little nodules of the size of a pin's head upon the wire-like stems, or sometimes longer fusiform masses which are apparently produced by the coalescence of the little globules. The color of these fronds, which are very firm, is blackish green. The filaments radiate from the base in all directions, etc.— *Wood.*

Evidently not a *Mastigonema*, but a *Rivularia.*

Plate CLXXIV, fig. 9, a single filament, after Wood.

MASTIGONEMA FIBROSA, Wood.

Light bluish-green, or olivaceous-green, apex of the mature filament prolonged into a long, distinctly articulated hyaline seta; sheath transparent; in the immature filament distally, broad, and distinct although hyaline; below, rather thick and close; in the mature filament below close, indistinct, above dissolved in fibrillæ and wanting at the apex; heterocysts globose, sometimes geminate.

Diameter of filaments, 10–11 μ.

Found growing with other low algæ in a thick jelly, which clothed some wet, dripping rocks. Appears to be only one of the many varieties of this genus, not worthy of a distinct name.

Syn. *Mastigothrix fibrosa*, Wood.

Plate CLXXIV, fig. 8, four trichomes after Wood.

MASTIGONEMA FERTILE, Wood.

Caespitose, intermingled with other algæ; filaments simple, elongate, truncate at the apex; internal filament green, often interrupted, sometimes articulate, sometimes not; joints 2–3 times longer than the diameter; sheath moderately close, thick, firm, transparent and colorless, truncate and open at the apex; spores (?) cylindrical, scattered, each contained in a cell, frequently several in a filament; heterocysts globose, sometimes compressed.

Diameter of filaments, about 8 μ.

Found in stagnant pool in Bear Meadows, Pennsylvania, forming a filamentous, felty mass with *Oedogonia* and other algæ.

"The variously curved and interlaced, flexible filaments are always simple and of uniform, or nearly uniform diameter through their whole length. All specimens seen were abruptly truncate.—*Wood.*

Seems a singular fact; not one of these five forms discovered by Wood came under our observation.

Genus 83, ISACTIS, Thur.

Filaments agglutinated by a more or less firm mucilage, often calcariously incrusted, forming strata of flat surfaces, not arched, filaments erect parallel, attached at the base.

ISACTIS FLUVIATILIS, (Rab.) Kirch.

Stratum turf or sod-like often extended, more or less with a calcarious crust and then of an olivaceous gray color;

usually olivaceous, brown or reddish; filaments closely compacted and sometimes, apparently, one stratum on another, the result of interrupted growths. The ends of the trichomes suddenly acuminate; cells, light aeruginous, sheaths close, colorless, light yellow or brown, widened at the ends and dissolved into fibrillæ; heterocysts colorless globose or depressed.

Single trichomes, separated from a mass, have a wide sheath; cells often distinct and moniliform.

Diameter of filaments, 8–12 μ.

Syn. *Zonotrichia fluviatilis*, Rab.; *Mastigonema plana*, Rab.; *Isactis plana*, Thur.

Frequent on rocky margins of the bed of the Genesee River, about Niagara Falls, and similar localities.

Plate CLXXVII, figs. 5, 6, two small sections of the turf; figs. 7–10, isolated trichomes separated from the masses.

Isactis caespitosa, (Kg.) Wolle.

Trichomes erect, awl-shaped, forming dark brown or blackish, slippery coatings on submerged stones; cells yellowish green or brownish; sheath close colorless; primarily closed, later open and often dissolved into fine fibrillae.

Diameter of trichomes, 5–6 μ, more or less.

Syn. *Mastigonema caespitosum*, Kg.

Plate CLXXVI, fig. 5, a very small section of a thallus.

Frequent on river stones in shallow water.

Forma *tenuior viridis*, Rab.

Forms deep olive, or almost black spots, larger or smaller in size, with a smooth even surface, on pebbles and larger stones near the shore of ponds. No appreciable distinction between this and the type-form. Rarely the trichomes are linear.

Plate CLXXVIII, figs. 1, 2, 3, from specimens collected in northern Vermont and New Jersey.

Plate CCV, fig. 6, section of thallus greatly magnified; fig. 7, thallus moderately enlarged.

Genus 84, GLOEOTRICHIA, Ag.

Trichomes radiate, sometimes spuriously branched, distinctly vaginate; sheaths broad, often succate at the base, transversely plicate, involved in a rather firm, more or less spherical mucus; spores originate in the lower part of the trichome.

GLOEOTRICHIA NATANS, Thur.

Globose or angular, tuberculose, variable in size and form, green, becoming brownish; trichomes straight, torulose, flexuous and hyaline above, lower articulation more or less compressed. Sheath broad, here and there constricted, colorless or yellowish. Spores oblong, cylindrical; heterocysts subglobose.

Kirchner divides the numerous forms of this species into the following four sections:

a.—TYPICA, (*Rivularia Boryana*, Kg.).

Thallus somewhat globose, firm; trichomes with upper part much elongated. Spores cylindrical, 10–13 times as long as thick.

Diameter of sheath about 36 μ. Spores 11–17 μ; heterocysts, 9–11 μ.

b.—GIGANTEA, (*Rivularia gigantea*, Trent).

Thallus large, sometimes four or more inches in diameter. (Had a case reported to me from Maryland, as large as a man's head.) Spores cylindrical, olive, 3–6 times longer than wide.

Diameter of spores, 9–13 μ; heterocysts, 6–8 μ.

c.—ANGULOSA, (*Rivularia angulosa*, Roth).

Thalli the size of cherries. Spores ellipsoidal, aeruginous-brown, 3–10 times as long as wide.

Diameter of spores, 14 μ; heterocysts, 9–12 μ.

d.—BRAUNIANA, (*Rivularia Brauniana*, Kg.).

Thallus less than cherries in size; trichomes ligulate, sheath narrower than of the preceding. Spores 8–12 times longer than wide.

Diameter, 10–12 μ; heterocysts, about 9 μ.

Syn. *Tremella natans*, Hedwig; *Rivularia gigantea*, Trent.; *R. angulosa*, Roth; *R. Boryana*, Kg.; *R. Brauniana*, Kg., etc.

Ponds and stagnant pools.

Plate CLXXVIII, figs. 15–19, smaller and larger thalli. The larger corresponding with very small specimens of *G. gigantea;* figs. 4–7, progressive stages of the growth of a trichome; figs. 5, 6, 7, the appearance of the sheath, first simple then constricted; figs. 8–12, progressive stages of another form; figs. 13, 14, trichomes, fertile and sterile in the same thallus; fig. 20, a form from Colorado, trichomes peculiarly contorted.

Plate CLXXIX, fig. 10, two trichomes from a thallus apparently in a state of dissolution, without maturing; fig. 11, two trichomes with long spores, narrow sheath and gonidia formed above the spores and passing out of the sheath at the ruptured ends.

GLOEOTRICHIA PISUM, Thur.

Thallus rather soft, as a rule spherical, of the size of mustard seeds to that of peas, attached to water plants, various in color, brown, aeruginous or olive-green. Trichomes elongated; lower cells with a distinct sheath, cell contents aeruginous, 1–2 times as long as broad; upper cells longer with sheaths indistinct. Sheaths always close simple, not inflated or contracted. Spores cylindrical, rarely as much as 30 times longer than the diameter. Heterocysts usually wider than the vegetative cells.

Diameter of spores, 5–12 μ; of heterocysts, 7–14 μ.

Syn. *Rivularia Pisum*, Ag.; *R. durissina*, Kg.; *R. Lens*, Kg.; *R. villosa*, Rab.; *R. cartilaginea*, Wood.

Often very abundant, parasitic on water plants, but most frequently seen without having the sheath developed.

A very peculiar and perhaps novel mode of fruiting was observed in specimens collected in a stagnant pool, Quakertown, Pa., August, 1879. The spores were long, about twenty times longer than the diameter; the contents of these passed down, breaking through the wall separating between the spore and the heterocyst, not only filling but greatly expanding the heterocysts to a capacity to hold the larger portion of the spore contents. Saw none quite empty, but many more than half vacated. The subspherical, inflated heterocysts were numerous, many separated from the spore and scattered loosely; assuming a vegetative green appearance; cell contents granular, forming possibly sporangia of some kind. Facilities failed to trace these bodies to farther development.

The process of forming gonidia in the basal cells of plants of this family has already been alluded to (*vide* page 236 and Plate CLXXI). This appears to be another way, perhaps abnormal way of propagation.

Plate CLXXIX, fig. 7, part of a thallus, filaments show the spore cases partly emptied; the contents emptying into the enlarged heterocysts; figs. 8, 9, small sections from other thalli which did not show the same process, because not in proper condition for it; fig. 9, shows gonidia or cells, and ormogonia passing upward; fig. 6, natural size of thalli;

fig. 1, a young form of *Gloeotrichia;* fig. 2, half of a transverse section of a smaller thallus; spores formed, but sheath not yet evident; fig. 3, a half of a similar section of a thallus arrested in its growth and fading.

Genus 85, RIVULARIA.

Filaments radiately arranged, agglutinated by a more or less firm mucilage and unitedly forming hemispherical, or bladdery well-defined forms. Heterocysts basal.

Forms of this genus, in my earlier experience, were supposed to be frequent, but now I question whether any of them can be separated from the genus *Gloeotrichia.* The form most familiarly known as *Rivularia dura*, Kg.; with such synonyms as *Limnactis dura*, Kg.; *Rivularia radians*, var. *dura*, Kirch.; *Limnactis flagellifera*, Kg.; *Limnactis minutula*, Kg.; and others, is often very abundant in ponds, attached to water plants; it is a true *Rivularia*, in accord with the diagnosis of the genus; but gathered at a later period of the year the spores, and the sheaths, evidences of the genus *Gloeotrichia*, develop themselves. Of the thousands which may be quickly gathered many are found to have developed the characteristic spores and sheaths; while others retain their simple form, and yet others have the trichomes shrunken or partially withered, showing signs of a state of decay. It has been shown how young forms of *G. natans*, gradually develop the mature trichomes; Plate CLXXVIII, 4–7; figs. 8–12, etc. In a collection of many thalli of *Rivularia dura* all possible stages of development may be found in proper season.

Judging simply by personal observations on living plants, and by analogy, all *Rivularia* should be transferred to *Gloeotrichia.*

There is one form, however, of which we have not seen living plants; apparently the same, which was found in England, and reported in the English Botany as early as 1804, named by Smith, *Conferva echinulata*, (indexed as *Rivularia echinulata*). Since then it has been found repeatedly in England and on the Continent. Prof. Cohn reports it as *Rivularia fluitans*, covering a sluggish river for miles in extent.

Prof. J. C. Arthur, of the Iowa Agricultural College, reported a similar, or the same plant, found as a scum of large extent on Western lakes.

Bornet and Flahault, of France, made a careful examination of this form of *Rivularia*, but unfortunately had not living plants. Judging by the specimens they had, they reached the conclusion, that *Rivularia echinulata* and *Gloeotrichia Pisum* are probably identical. These plants like most of the algæ multiply very rapidly by means of spores and by hormogonia. One filament gives rise to five or more hormogons, each of which in the course of several days gives rise to as many more thalli; thus in a comparatively short time millions of thalli may be produced.

The following two diagnoses may be preserved as matters of historic interest, and for reference:

RIVULARIA ECHINULATA, Smith.

Thalli globose, minute, dark olive-green or brownish. Trichomes fastigiate, attenuated upwards to the apex, closely cohering, articulate; heterocysts basal, globose; sheaths very narrow, inconspicuous.

Diameter of trichomes, at base, about 7 μ; 250 μ, more or less, long.

Syn. *Chaetophora punctiformis*, Kg.; *Echinella articulata*, Eng. Fla.; *Conferva echinata*, Eng. Bot.; *Conferva echinulata*, Gray, etc.

Plate CLXXIX, fig. 4, a thallus from the surface of lake, Minnesota, collected by J. C. Arthur, noted above, flattened under cover glass of slide; fig. 5, natural size of thalli.

RIVULARIA DURA, Kg.

Thalli nearly globose, about the size of mustard seeds, sometimes larger, dark olive green, brownish or nearly black. Trichomes aeruginous, gradually tapering from the base to the hyaline apex, or sometimes variable in the same thallus; some apparently withered, others more swollen, some inarticulate, others torulose; all with distinct sheaths. Lower cells as long as broad or nearly so, upper ones longer, all with cytioplasm granulated; sheaths colorless or yellowish; heterocysts rounded.

Diameter of trichomes, 8–9 μ at the base.

Syn. *Limnactis dura*, Kg.; *Rivularia radians*, var. *dura*, Kirch.; *Dasyactis mollis*, Wood.

Attached to aquatic plants in ponds.

Plate CLXXIX, fig. 1, transverse section of a large thallus; fig. 2, a section showing the development of spores; fig. 3, a section with withered, or fading trichomes.

SECTION II.—SCYTONEMEÆ.

Filaments not terminating in a hair-point, enclosed in a sheath, branched; cells divide transversely only; ramifications produced by the deviation of the trichome and emerging through the sheath; usually furnished with heterocysts.

Genus 86, SCYTONEMA, Ag.

Sheath enclosing a single trichome. Ramification usually twin, produced by a fold of the trichome which ruptures outside of the sheath and gives origin, usually to two, but sometimes only one branch, at right angles. Heterocysts scattered here and there in the trichome, without any evident relation to the ramifications. The branched filaments produce interwoven mats of greater or less extent.

Propagation by microgonidia, which arise from the cells of the trichome after having passed out of the older sheaths. The microgonidia increase in size after separation from the maternal cell; the contents divide and redivide producing larger forms (*Microcystis*), which again divide producing others of like kind. Finally the small cells of a cyst arrange themselves in series, *Nostoc*-like, and these encysting in the maternal tegument (*Hormosiphon*-forms) reproduce the original type of the species.

In the process of the propagation of *Scytonema* species, perhaps not always strictly in accord with the successive steps in the plan briefly described, occur various forms of so-called unicellular plants, heretofore known by such generic names as *Microcystis*, *Polycystis*, *Gloeocapsa*, *Gloeothece*, *Hormosiphon*, *Nostoc*, and others; all the forms under these heads are doubtless merely intermediate polymorphic conditions of development in higher algæ life.

Different observations made in the study of different species, will be illustrated with the description of the species. Some of these were given to the public in the *Microscopic Journal*, in 1878 and 1879. One article, "*A Nostoc the matrix of Scytonema*," another, "*Dubious Character of some of the Genera of Fresh-water Algæ*," etc.

SCYTONEMA TOLYPOTRICHOIDES, Kg.

Thallus turf-like; filaments much interwoven, mucous, dark olive or brown. Filaments long; *pseudo*-branchlets mostly geminate. Thinner, even to one-half that of the stem, usually close at the base; cells two or three to the diameter, sometimes constricted at the joints, aeruginous when young; later, brown. Sheath primarily thin, but later, thick and brownish yellow. In older filaments the internal trichome is often contracted to less than one-third of the diameter of the sheath. Heterocysts somewhat oblong or cylindrical, bright brownish yellow.

The development of this species from *Nostoc*-forms has often become evident by such conditions as are illustrated.

Syn. *Sc. calotrichoides*, Wood.

Most frequent on dripping rocks; also on wet or moist earth on the banks of rivers, etc.

Plate CLXXXII, fig. 4, a normal vegetative condition; fig. 5, an older filament with the internal trichome greatly contracted; figs. 6, 7, part of a filament with secondary branches; fig. 8, a young filament just developed from a *Nostoc*-form such as figs. 9, 10, corresponding with conditions of *N. rupestre*, Kg., and *N. verrucosum*, Vauch.; fig. 11, a *Nostoc*-form found mingled with the others, showing the tendency to geminate branching before assuming the strictly *Scytonema* character.

Scytonema calotrichoides, Kg.

Tomentose, aeruginous; filaments more or less curved and interwoven, sometimes distinctly, sometimes indistinctly articulate; articulations subequal or half as long as wide. *Pseudo*-branchlets usually geminate, thinner than the stem; aeruginous, cytioplasm more or less granular. Sheath close and thin, rarely lamellate, colorless or light yellow; heterocysts oblong subcylindrical, hyaline.

Diameter of filaments, 12–16 μ.

Frequent on submerged sticks, ponds, New Jersey. In size and color this is the typical plant; in habitat it is nearer the Forma *natans*, Rab.

Plate CLXXXIII, figs. 5–7, three parts of filaments with geminate branchlets and heterocysts; from submerged specimens.

Scytonema natans, Breb.

Floccose, tomentose, usually brown or olive; filaments slender, smooth, shining, elongated, sometimes colorless, but more frequently yellowish brown; internal trichomes aeruginous or brownish, one-third or less than the diameter of the sheath; articulations about as long as wide, not always distinct. *Pseudo*-ramuli mostly in pairs, rather distant. Heterocysts interspersed, oblong or ovoid, pellucid.

Diameter of filaments, 12–20 μ.

Diameter of branchlets, 10–16 μ.

Syn. *Scytonema immersum*, Wood.

Frequent in ponds, floating.

Plate CLXXXIII, figs. 8–10, three fragments of filaments. Branchlets usually very long.

SCYTONEMA NAEGELII, Kg.

Dull aeruginous to cinereous; floccoso-caespitose, about three lines long; *pseudo*-branchlets most frequently geminate, much thinner at the base than the stem, but quickly enlarging; articulations short, 3–4 to diameter, often inclining in the sheath, now and then interrupted. Sheath close and thin, colorless or light brown. Heterocysts oval.

Diameter of filaments, 14–18 μ.

Occurs on moist rocks, unlike the European form which is found submerged.

Plate CLXXXIII, figs. 11–13, representations of three filaments.

SCYTONEMA CATARACTA, Wood.

Forming on rocks an extended turf-like stratum of brownish black color; filaments flexuous, flexible, long; irregularly branched, their surface smooth; branches elongate, singly or in pairs; sometimes fuscous, frequently hyaline, their apices rounded, rarely somewhat attenuate, frequently provided with enlargements; cytioplasm aeruginous, generally distinctly articulate; articles mostly shorter than broad, but sometimes longer; frequently disjoined, sometimes subglobose; sheaths thick and firm. Heterocysts interjected and mostly single.

Diameter of filaments, with sheath, 12–16 μ, rarely 25 μ.

Syn. *Scytonema Brandegei*, Wolle.

Abundant on rocks below the great Niagara Falls.

Received specimens from C. Brandegee, collected on the Rocky Mountains, evidently the same species but many of the filaments much larger, measuring 38–42 μ in diameter, but forming the same dark turf-like stratum.

Plate CLXXXIII, figs. 1, 2, from Rocky Mountain specimens; figs. 3, 4, Niagara specimens.

SCYTONEMA MYOCHROUS, Ag.

Strata thin, pannosely tomentose, obscurely fuscous or olivaceous, often with a silky gloss; filaments strong, fuscous or olivaceous, slightly curved, ascending; the internal trichome aeruginous, distinctly articulate with the terminal five or six joints sometimes reddish. Branches mostly geminate, often very long, flaccidly erect, about half as thick as the stem. Sheath of trichomes thick, distinctly lamellate of older plants, smooth, firm, yellowish fuscous. Sheath of the branches paler and thin, with the apex colorless, short and obtusely rounded. Heterocysts about equal to the diameter of the internal filaments.

Diameter of filaments average, 25–33 μ.

Moist ground in extended patches, and dripping rocks, Pennsylvania; North Carolina; *Ravenel.*

Syn. *Conferva myochrous*, Dillw.

Plate CLXXXII, figs. 1, 2, 3, different sizes, single and twin branched.

SCYTONEMA GRACILE, Kg.

Stratum thin, dark brown, often forming several interwoven layers. Filaments much entangled; *pseudo*-branchlets mostly single; cells often 2–3 times longer than broad, but most frequently indistinct, dull aeruginous, somewhat contracted at the ends, and often of a brownish red color. Sheaths yellow brown, smooth; heterocysts somewhat ovate, brown.

Diameter of filaments, with sheath, 9–15 μ.

On rocks bordering ponds, about the water line, also on moist earth.

Plate CLXXXV, figs. 1–4, after specimens collected on the rocky shores of Morrís Pond, New Jersey.

SCYTONEMA TURFOSUM, Kg.

Stratum brownish black; filaments thicker than the preceding; articulations about as long as wide, sheath thin and close at first, then wider, and later the internal trichome is much contracted, occupying only about one-fourth of the diameter of the sheath. Filaments vary greatly in thickness, from 11–22 μ; of reddish brown color.

Turfy strata on exposed earth, and moist rocks.

Plate CLXXXV, figs. 5–7, medium sized filaments.

SCYTONEMA CHRYSOCHLORUM, Kg.

Stratum crustaceous, olivaceous brown or blackish. Filaments flexuously curved and interwoven; irregularly and sparsely branched; branches mostly single, elongated. Articulations rather distinct, not constricted; ½–1½ times as long as broad; dull aeruginous. Sheath usually close and colorless, rarely yellow or brown, not lamellate.

Diameter, including sheath, 9–16 μ.

Found this species particularly abundant on Anastatia Island, St. Augustine, Florida. Parts subject to an occasional overflow by the tides were black with scab-like, black crusts, composed of *Nostoc communis* and this *Scytonema;* had a horn-like character when exposed to the sun and dried, but when soaked in water soon became soft and gelatinous. Could not trace the relationship between the *Nostoc* and the *Scytonema*, but evidently they are very closely related.

SCYTONEMA CINCINNATUM, Thur.

Usually forms dark green, or brown floating mats, with filaments much interwoven. Vegetative cells short, often contracted at the margins, three to six cells to a diameter; contents aeruginous. Heterocysts short, ellipsoidal or globose, single or two (or more) in series of golden yellow color; diameter the same as the cells. Sheaths primarily thin and colorless, later yellow or brown, and thicker.

Diameter of internal filament, 14–18 μ; sheath 14.5–25 μ.

Syn. *Lyngbya cincinnatum*, Kg.; *Chrysostigma cincinnatum*, Kirch.

Inasmuch as this plant occurs in masses without branches and without heterocysts, it justly represents Kützing's form, a *Lyngbya*; and again in simple filaments with heterocysts, it agrees with Kirchner's *Chrysostigma*, but it is found also as described and illustrated. The different forms occur at different seasons of the year, evidently the same plant.

Plate CLXXXV, figs. 8–10; this specimen from a small pond, near Bethlehem, Pa. Have the plant also from the West and South.

SCYTONEMA NOTARISII, Menegh.

Stratum thin, filaments loosely interwoven, brown tinge; trichomes subsimple; sparsely single and twin branched; internal filaments bright or duller aeruginous; articulations commonly indistinct, equal or half a diameter in length, sometimes torulose; filaments primarily attenuated, sheath multilamellate dissolving into fibrillæ. Heterocysts rarely observed.

Plate CLXXXIV, figs. 1, 2, 3, normally developed plants; figs. 4, 5, the primary growths; figs. 6–9, younger forms developed from macrogonidia; figs. 10–11, gonidia developing, producing cysts (figs. 12, 13), with gonidia multiplied; young plants (fig. 14) in early stage.

On old wood and rocks around water falls, on mosses, etc., Niagara, N. Y.

SCYTONEMA CASTELLII, Mass.

Somewhat pulvinate and pulverulent, soft and porous, widely extended on shelves, walls and flower-pots in a conservatory. Filaments sparsely ramulate; aeruginous internally; distinctly or indistinctly shortly articulate. Sheath close and firm, colorless.

Diameter of filaments, 8–12 μ.

The many polymorphous varieties of cells, usually connected with the development of *Scytonema*, were in great abundance with this species. Some are illustrated.

Plate CLXXXIV, figs. 16–19, normally developed filaments; figs. 20, 21, two older filaments; the articulations, which are thin discs, 2–4 to a diameter, separate, fall over, and slide out at the broken end; from these the microgonidia are evolved and scattered (fig. 21); these enlarge by growth and develop from one stage to another (fig. 23), until a large cyst is reached (fig. 24). This again ejects its contents (fig. 26); smaller cells, which grow by the division of the internal cellules until smaller encysted forms are developed in the maternal tegument, (figs. 27, 28, 29). (*Gloeothece*-forms). These in turn escape, forming masses; in these masses and from the *Gloeothece*-forms the young plants (figs. 30, 31, 32, 33) are developed.

The *Nostoc* process, shown in part, Plate CLXXXII, figs. 8, 9, 10, and Plate CLXXXVII, figs. 30–33, is also evident. Returning, figs. 35–38, are *Nostoc*-forms; figs. 39, 40, young plants from them. *Gloeocapsa* cells occur also (fig. 41).

Whether this is strictly the same plant collected by Massalongo in Italy, may be questioned; it is very near it.

SCYTONEMA MIRABILIS, Wolle.

Forms small, tomentose tufts on the bark of trees, olive green or brown. Internal trichome aeruginous, cells about half as long as wide, or longer, often torulose; sheath wide, light or dull yellow. *Pseudo*-branchlets usually in a manner geminate; making the usual fold in the sheath and pressing through, it does not rupture in the usual manner, but the two grow unitedly to considerable lengths, producing also secondary branchlets in the same manner. Heterocysts more or less compressed globose, yellow.

Diameter of filaments, including sheath, 12–16 μ.

From the bark of Cypress trees, Florida.

In a short paper to the *Bulletin* of the Torrey Botanical Club, New York, April, 1878, a *Nostoc* was represented as the *Matrix of Scytonema.* The present plant was taken as one of the illustrations; it is very distinct in the character of the *pseudo*-branchlets and hence well suited to trace the various stages of development.

Plate CLXXXVII, figs. 1, 2, 3, parts of three filaments with characteristic branchlets, heterocysts, and arrangement of internal filaments; fig. 4, the microgonidia developed from the cells of the filaments, the same gradually enlarging; fig. 5, forming large cysts, (sporangia), the *Microcystis* forms; these divide forming smaller cysts; fig. 6, within the maternal tegument (*Gloeocapsa*-forms), or the microgonidia arrange themselves in series, *Nostoc*-like (figs. 7, 8, 9); these moniliform series gradually become surrounded with a gelatinous envelope, at first very thin, then more consistent until a membrane is formed; fig. 10, sometimes wide, then close. The tegument is finally dissolved and the vermiform contents are set free; figs. 11–15, a few varieties of such, in part showing a tendency to double branchlets; figs. 16, 17, withered branchlets.

SCYTONEMA CORTEX, Wood.

Forming small turfy spots of an olive green or brown color on the bark of trees; filaments mostly creeping, rather sparsely, twin or singly branched. Internal trichome articulate, joints longer or shorter than broad; after division one-half diameter; sheaths close, rather thin, transparent, colorless or sometimes light brown; heterocysts subglobular, or quadrate, usually single, interstitial sometimes at the base of branchlets. Diameter of filaments variable; smaller forms, 8–10 μ; larger forms, up to 15 μ.

Syn. *Scytonema Ravenelii*, Wood.—Very near also to *Scytonema truncicola*, Rab.

Among no less than thirty different specimens collected by H. W. Ravenel in South Carolina, and by J. D. Smith in Florida, from the trunks of various kinds of trees, I found this plant in almost as many forms and phases of growth. The number afforded ample opportunity for a thorough study. Its development from macrospores was well exemplified, and also, that the two forms described by Wood, viz.: *Sc. cortex*, and *Sc. Ravenelii*, are really one and the same species.

The cells, or joints of the filaments which separate in the older plants, commonly falling over, and slipping out of the sheaths, are in fact sporangia, the spore-bearers; they give rise to microspores; these develop into macrospores and finally produce the young plants.

Plate CLXXXVII, figs. 18–21, four samples of larger forms of branching filaments; figs. 22, 23, two broken-off ends; the internal trichome separating, and single cells, laid over, sliding out of the sheath; fig. 24, two cells enlarging, maturing macrogonidia which are scattered by the breaking of the membrane; they continue to enlarge (figs. 25, 26), the cellules in the cysts at first without order, then arranged in moniliform series (fig. 27), *Nostoc*-like. Here commence two processes—the macrogonidia develop young forms, in shape not unlike small chestnut-worms, (figs. 28, 29), and the *Nostoc* process (figs. 30–33), both of which give rise to young plants such as figs. 34–37. All of these forms (figs. 18–37) with various modifications are constantly associated.

Forma *Ravenelii*, Wood, may be retained as a form. It is represented

Plate CLXXXVI, figs. 1–4, matured plants, and figs. 5, 6, young plants.

Forma *saxicola*, Green. Another form, found on moist rocks, but so much in character with *Sc. cortex*, it can not be separated except by habitat, therefore the name is retained as another *form*. The color is usually of a darker reddish brown, not so much of an olive-green or aeruginous as *Sc. cortex.*

Diameter of filaments, 17–18 μ.

Plate CLXXXVI, figs. 7, 8, 9, three parts of filaments, showing the manner of branching, the position and form of heterocysts.

Forma *corrugata*, Wolle, (1879), another distinct form, bright aeruginous color, coated with a colorless gelatin, which in drying contracts irregularly, thereby causing the filaments to appear crenated or corrugated.

Diameter of filaments, 17–26 μ.

The filaments are short; they occur in clusters on the bark of trees in South Carolina and Florida.

Plate CLXXXVIII, figs. 5–9, a few representative short filaments. Probably the same form as seen by Wood and named by him *Sirosiphon scytonematoides.*

Forma *brunea,* Wolle, (1879). This form is dark brown and is covered with what appear to be subspherical resinous cells. Probably an older condition of the last (*corrugata*), age making the change of color, and causing the gelatin to assume a resinous appearance. Size and habitat the same as the last.

SCYTONEMA INTERTEXTUM, (Kg.) Rab.

Forms an interwoven tomentose stratum, dark brown, or olivaceous. Ends of trichomes and *pseudo*-branches more or less erect. Internal filaments light or dull aeruginous, distinctly articulate, before division equal or longer or shorter than the diameter; sheath varies with the age of the plants; at first thin and close. Heterocysts most frequently at the base of the branchlets, single or twin, oblong or subglobose, light brownish yellow.

Diameter of filaments averages about 20 μ, including sheath; without sheath, 12–16 μ.

Syn. *Symphyosiphon intertextum,* Kg.

On old wood, Florida.

This form appears closely related to the preceding *Sc. cortex.* The only points of separation are, that the filaments are somewhat thicker, the sheath firmer, and the cells frequently inclined, producing dark interruptions in the internal trichome.

Plate CLXXXVI, figs. 10–14, peculiarity of the species in five parts of filaments; figs. 15, 17, microgonidia developed from the joints of the filaments, enlarged, producing first macrogonidia and then cysts of much greater dimensions, and finally *Nostoc*-forms; figs. 17, 18, the youngest condition of filamentous forms. Compare Plate CLXXXVII, figs. 24–37.

SCYTONEMA CINEREUM, Menegh.

At first pulvinate, cinereous, green, then confluent, forming a more or less tomentose pulverulent stratum, becoming pale blue when dry, now and then violet or purplish; trichomes very fragile, elongated, flexuose and curved, loosely interwoven. Sparingly branching, indistinctly articulate, internally dingy, aeruginous green, joints shorter than broad; sheaths thick, brownish or almost colorless, often incrusted with a granular deposit of lime.

Diameter of vegetative cells, 3–10 μ; sheaths 9–20 μ.

Syn. *Scytonema Julianum*, Wittr. and Nord.; *Drilosiphon muscicola*, Kg.; *Oscillaria cyanea*, Hass.; *Humida cyanea*, Gray.; *Scytonema pulverulentum*, Ag., etc.

On moist rocks, shaded walls and the like.

Plate CLXXXVIII, figs. 1–4, from rocks, New Jersey and Pennsylvania; figs. 10, 11, 12, from New York State; figs. 13, 14, from Florida.

SCYTONEMA THERMALE, Kg.

Stratum thin, blackish; filaments flexuously curved, intricate, sparingly branched; internal filament pale greenish, often almost colorless, here and there interrupted, mostly inarticulate, but often indistinctly and sometimes distinctly articulate, granular; joints shorter or about as long as broad; branches geminate, mostly short, equal or unequal to the filaments in diameter, coalescent at the bases, rarely so even to their middle; sometimes divergent from the base; sheath thick, indistinctly lamellate, yellowish fuscous and scarcely semi-transparent, but here and there nearly colorless and pellucid; generally so at the apices of the branches; heterocysts subquadrate or cylindrical, singly interspersed. Internal filament less than one-half as thick.

Diameter of filaments, with sheath, 10–14 μ.

Dr. Wood recognized this species from sandy soil, near Aiken, South Carolina.

SCYTONEMA SIMPLICE, Wood.

Forms moderately thick, somewhat tomentose, blackish green strata; trichomes very elongate, flexuously curved, very sparsely branched or frequently without branches; branches geminate or single, mostly elongate; internal filament partly distinctly articulate, partly inarticulate, granular, pale greenish, in its apex sometimes very shortly articulate, sparsely granular, often nodose or disjoined at the joints; articles mostly equal to seven times longer than the diameter; sheaths thick, transparent, often colorless, sometimes pale yellowish brown, mostly open and truncate at apex; heterocysts cylindrical, interspersed, 2–5 times longer than their diameter.

Diameter of trichomes, with sheath, 10–15 μ; without sheath, 3–6 μ.

Adhering to the wet sides of a wooded gutter, leading water from a spring, Aiken, South Carolina. Transcribed from Wood's *Contribution* to Fresh-water Algæ. The correctness of "*articles seven times longer than the diameter*," may be questioned.

SCYTONEMA DUBIUM, Wood.

Evidently a *Hapalosiphon*.

SCYTONEMA AUSTINII, Wood.

See *Symphyosiphon*.

SCYTONEMA NAEGELII.

Described by Wood, and doubtfully referred to this species, is most likely a *Plectonema*, Thur.

SCYTONEMA HEPPII, (Naeg.) Wolle.

Stratum gelatinous, blackish-brown; filaments somewhat flexuously curved, densely intricate; internal trichome pale or dull aeruginous, with age brownish, moniliform, irregular in thickness, measuring 8–13 μ; here and there interrupted; articulations equal, to one-half as long as wide. Sheath wide, distinctly lamellose, golden yellow or colorless, smooth; heterocysts depressed globose at base of branchlets or more rarely interstitial, brownish yellow, usually single.

Propagation by macrogonidia, which slide out of older or ruptured filaments, increasing in size, dividing and redividing until finally they reproduce the young forms.

Diameter of sheath, 20–25 μ.

Syn. *Diplocolon Heppii*, Naeg.

The reasons for forming a new genus to receive this species appear insufficient; it is really a *Scytonema*.

Unlike the European form found on rocks and stones, the present form was collected from old wood, Florida, March, 1878.

Plate CXCV, figs. 1–4, plants in vegetative condition; fig. 5, a broken filament, the macrospores escaping out of it, gradually developing and multiplying; figs. 6, 7, reproducing plants; figs. 8, 9, young conditions.

Genus 87, SYMPHYOSIPHON.

Trichomes as in *Scytonema*, but agglutinated in erect wick-like bundles, or forming more or less extended strata with even or pulvinate surfaces.

SYMPHYOSIPHON AUSTINII, Wood.

Growing on rocks, stratum tomentose, and somewhat turfy, brownish-black; trichomes ascending, mostly simple, curved; internal filament dull aeruginous, or more frequently fuscous, articulate or inarticulate, sometimes thickened at the ends (indicating a vegetative condition); articles much shorter to slightly longer than the diameter. Sheaths reddish or yellowish fuscous, at the apex often colorless and transparent, firm; surface smooth or rough; heterocysts shortly cylindrical, subquadrate or subglobose, sometimes much compressed.

Diameter of filaments, 15–20 μ.

Occurs in blackish strata, a line, more or less in thickness, forming a sort of miniature turfy cushions upon rocks. Pennsylvania and New Jersey.

Plate CLXXXIX, fig. 5, a few filaments separated from a cluster.

SYMPHYOSIPHON BORNETIANUM, Wolle.

Forms a thin, dark, reddish brown stratum on clay soil, old bricks and the like, surface smooth; filaments and branches a close upright growth; filaments short, thick; articulations one-half as long as the diameter, or somewhat longer or shorter. Internal trichomes brown, or slightly aeruginous; sheath close; heterocysts yellowish, interjected.

Diameter of filaments, 12–15 μ.

Possibly a young form, or arrested growth, but have not been able to trace it beyond the present condition.

Plate CLXXXIX, fig. 4, from specimens on old bricks, Port Royal, South Carolina; fig. 6, from clay cliffs, South Carolina.

SYMPHYOSIPHON HIRTULUS, Kg.

Stratum somewhat extended, pulvinate, olivaceous-black, consisting of small, erect wick-like bundles of filaments agglutinated below, free at the ends. Sheaths distinct; trichomes aeruginous; articulations about as long as wide. Sheaths colorless or yellowish, smooth when young, becoming granularly rough with age. Heterocysts single or twin. Somewhat oblong, light brown or colorless.

Diameter of filaments, with sheaths, 8–10 μ, and about 10–15 μ with sheaths.

Moist rocks, damp earth, etc.

Plate CLXXXIX, fig. 7, the normal growth, moderately magnified; fig. 8, single filaments separated from a bundle, much enlarged.

SYMPHYOSIPHON CASTELLI, (Hass.) Rab.

Forms a dark, black coating, pulvinate, on wet rocks, surface pubescent, or hirsute by the projecting ends of the filaments. Trichomes sparsely branched, somewhat curved; internal trichomes aeruginous, shortly articulate, not torulose, 2–4 articles to a diameter, often interrupted by the inclining of the short cells. Sheath close, firm, colorless. Heterocysts rather square with angles rounded.

Diameter of filaments, 9–15 μ.

Plate CLXXXIX, fig. 1, filaments occur more or less in cluster of 30-50. This imperfectly represents one such cluster.

SYMPHYOSIPHON HOFMANNI, (Ag.) Kg.

Terrestrial, resembling a *Symploca* in habit. Tufts small, ascending, dark brown; trichomes simple, erect, loosely collected in pointed fascicles, internally pale aeruginous green, sometimes interrupted, joints delicately granulose; inferior cylindrical, thin; superior thicker and sometimes more or less swollen. Sheath wider at the base, close above, indistinct, colorless or yellowish. Heterocysts intercalated, globose, hyaline.

Diameter of filaments, 8–12 μ.

Occurs not only on the ground; have found good specimens on old wood.

Plate CLXXXIX, fig. 3, a simple cluster, ends not always so spreading.

SYMPHYOSIPHON AMBIGUUM, Naeg.

Stratum somewhat crustaceous, extended, dark fuscous. Trichomes fasciculately clustered. Internal filament dilute aeruginous, distinctly or indistinctly articulate, finely granulate, articles short, one-half diameter or less; sheaths close, colorless, sometimes with a yellow tinge.

Diameter of filaments, 5–7 μ.

Frequently intermingled with larger algæ on moist rocks, wet earth, etc.

Plate CLXXXIX, fig. 2.

SYMPHYOSIPHON CRUSTACEUS, Kg.

Forming a crustaceous, black coating on moist rocks; filaments in clusters irregularly united. Articulations somewhat constricted at joints; cytioplasm dull aeruginous. Sheath somewhat indistinct; tapering from the base to the apex, yellowish brown, smooth, uneven; heterocysts single or rarely twin, elliptic, pale orange.

Diameter of filaments, 2–3 μ; sheath at base, 6–7 μ; at apex, 3–4 μ.

Not infrequent, wet cliffs, Pennsylvania.

Genus 88, TOLYPOTHRIX, Kg.

Trichomes furnished with a sheath, branched. Ramifications solitary (very rarely geminate), originating where the continuity of the trichome is interrupted by a heterocyst; the trichome below it breaking through the sheath and continuing its growth; in consequence there is normally, one, or more than one heterocyst directly above the branchlet.

TOLYPOTHRIX DISTORTA, Kg.

Caespitose floccose, bright aeruginous, now and then becoming pale; trichomes and *pseudo*-branches very loosely interwoven, internally aeruginous, sometimes apparently continuous, sometimes distinctly articulate; joints equal, to a little shorter than the diameter; sheaths close, colorless; heterocysts subglobose or oblong, solitary or two or three together, usually colorless.

Diameter of trichomes, 12–17 μ.

Forma *magma*, Wolle, has a diameter of 33 μ. Differing from the type-form in size only.

Syn. *Calothrix distorta*, Ag.; *Oscillaria distorta*, Ag.; *Conferva distorta*, Mueller.

Pond waters. Forma *magma*, East Charlotte, Vermont. The typical form is widely distributed.

Plate CLXXX, figs. 1, 2, 3, the usual form; fig. 4, Forma *magma*.

TOLYPOTHRIX AEGAGROPILA, (Kg.) Kirch.

Thallus spherical, about the size of peas (diagnosis of Kg. and Kirch. has diameter an inch or more) floating in masses, greenish olive (primarily aeruginous) trichomes and *pseudo*-branches loosely interwoven, internally pallid blue-green, continuous or distinctly articulate, joints equal to a little longer than broad; sheaths narrow, colorless; heterocysts two or three (rarely more) in a series; oblong hyaline.

Diameter of filaments, including sheath, 8–9 μ.

A stormy day at Budd's Lake, New Jersey, August, 1881, brought large quantities of this plant into the sheltered coves of the lake; the water was literally covered with what appeared to be rather large, somewhat faded green peas, all perfectly spherical. The agitation of the water probably tore the plants from their attachments and washed them to the shore; except for this habit of forming spherical clusters, it can not be separated from the following *T. muscicola.*

Plate CLXXXI, figs. 1–4, individual filaments.

TOLYPOTHRIX MUSCICOLA, Kg.

Caespitose floccose, aeruginous or fuscous, branches freely, elongate, loosely intricate; internal filaments light aeruginous, distinctly articulate, often apparently interrupted by the turning or inclining of the disc-like cells. Sheath thin and close, colorless; heterocysts subglobose or oblong, two or three in series.

Diameter, 9–11 μ.

Usually found in ponds, or sluggish river waters attached to water mosses and other plants.

Where this plant prevails there are in proper season, an abundance of forms as illustrated Plate CLXXV, figs. 1–8, evidently the young stage of development of *Tolypothrix;* the filaments at first flagelliform, then linear, and often elongated before they commence branching. Compare also page 241 (*Mastigonema*).

Plate CLXXXI, figs. 1–4, filaments of *T. aegagropila*, or *T. muscicola.*

TOLYPOTHRIX PULCHRA, Kg.

Appears most nearly related to *T. distorta*, but slighter; bright, somewhat dilute, aeruginous, grows in tufts; articulations rather shorter than longer than the diameter; sheath thin and close, colorless or light yellow. Heterocysts usually geminate.

Diameter of filaments, 12–14 μ.

Attached to sticks and the like in ponds.

Syn. *T. aegagropila*, var. *pulchra*, Kg.

Plate CLXXX, figs. 5–7.

TOLYPOTHRIX RAVENELII, Wolle.

Forms a thin stratum on exposed sand-stone and rocks; reddish brown, sheath thin and close; articulations half as long as wide, or more rarely as long as wide. Internal trichome now and then interrupted by inclining cells causing dark transverse bands. Heterocysts single, usually longer than wide, oval.

Diameter of filaments averages 20 μ (15–25 μ).

Bears a resemblance to *T. distorta* in size, but strikingly distinct in color, if normal, and in habitat. Had fine specimens, but only once, from Gainesville, Florida, December, 1877. Collected by H. W. Ravenel.

Plate CLXXX, figs. 8, 9, 10.

TOLYPOTHRIX RUPESTRIS, Wolle.

Strata expanded on dripping, gelatinous, exposed rocks, variously tinged with red, purple and black; trichomes much branched, loosely interwoven; internal filaments dull aeruginous, granular; articulations as long or twice as long as the diameter. Sheaths wide, yellowish, or colorless; heterocysts oblong or less frequently globose, two or three in series.

Diameter of filaments, 12–15 μ.

Wet rocks, Pennsylvania.

Plate CLXXX, figs. 11, 12, 13, specimen from the Delaware Water Gap, Pa.

TOLYPOTHRIX FLACCIDA, Kg.

Caespitose, aeruginous, trichomes and *pseudo*-branchlets spreading, elongated, flaccid, arising from a prostrate base internally pale aeruginous, distinctly articulate, joints a little shorter than broad, sheaths colorless, rather broad; heterocysts subglobose or oblong, two or three in series, colorless, or light yellow.

Diameter of filaments, 10–13 μ.

Ponds, Pennsylvania.

Plate CLXXX, figs. 14–16, parts of three filaments.

TOLYPOTHRIX TENUIS, Kg. Forma BRYOPHILA, Rab.

Small caespitose tufts, on water mosses; gelatinous, olive-brown; filaments sparsely branched; articulations about as long as broad, often indistinct; light aeruginous or yellowish; sheath very thin, colorless or yellowish; heterocysts usually single, spherical or somewhat longer than broad.

Diameter of filaments, 3-4 μ.

Ponds, Pennsylvania and New Jersey, often very abundant.

Plate CLXXXI, figs. 5-7, three parts of filaments.

TOLYPOTHRIX TRUNCICOLA, (Rab.) Wolle.

In small caespitose clusters, usually confluent, surface velvet-like, fuscous black; trichomes ascending, fasciculate, concreted below, internally dull aeruginous or olive yellow; articulations granular, short, about one-third as long as broad; sheath close, colorless or light yellow, indistinctly lamellate; heterocysts, subspherical, singly at the base of the branchlets.

Diameter of filaments, 11-14 μ.

Frequent on trunks of trees, South Carolina.

Syn. *Scytonema truncicola*, Rab.

In adopting this name it may be proper to state that Rabenhorst in his diagnosis does not allude to heterocysts, hence may be a different plant; beside the omission of this feature the agreement is sufficiently close.

Plate CLXXXI, figs. 8-11, from trunks of trees.

Genus 89, PLECTONEMA, Thur.

Filaments branched, singly or geminate, rather irregular; every filament enclosed in a distinct sheath; devoid of heterocysts; cell contents deep aeruginous.

PLECTONEMA MIRABILE, Thur.

Filaments usually deep aeruginous; older plants change to a shade of brown; forms dense dark green tuft, $\frac{1}{4}$-$\frac{1}{2}$ inch in length on aquatic plants in limestone springs. Articulations shorter than their diameter; granular, sheath narrow, colorless or yellowish, smooth.

Diameter of filaments, 15-20 μ.

Syn. *Conferva mirabilis*, Dillw.; *Calothrix Brebissonii*, Kg.; *Calothrix atrovirens*, Harv.; *Calothrix mirabilis*, Ag.; *Scytonema Naegelii*, (Kg.) Wood.

Limestone springs, attached to submerged plants, wood and stones.

Plate CLXXXI, figs. 12-15, four type-forms of branching, inclining discs, short cells, etc.

Genus 90, PETALONEMA, Berk.

Trichomes enclosed in a very broad, striate membranous sheath, which forms a transparent layer, resembling a hyaline wing. Internal thread as in *Scytonema.*

PETALONEMA ALATUM, Berk.

Forming a thin brown stratum. Trichomes small, a few lines only in length, winged, obtuse, with numerous striae; when taken in conjunction with the wings or membranous expansions, they are linear and plane. Each wing is about thrice the breadth of the proper filament, bright yellow near the trichome, gradually fading to the colorless margins; under favorable light numerous series of transverse lines or folds are observable.

Diameter of trichomes, about 10 μ; with sheath, 50–120 μ.

Syn. *Arthrosiphon alatus*, Rab.; *Arth. Grevillei*, Kg.; *Oscillatoria alata*, Grev.

The only locality hitherto discovered for this plant, is on the high cliff, near the Cave of the Winds, Niagara Falls. 'Twas found there twenty-five years since and it may be gathered there to-day.

Plate CLXXXVIII, figs. 15, 16, from specimens of recent date.

SECTION III.—SIROSIPHONEÆ.

Filaments destitute of a hair-point; trichomes enclosed in a sheath, profusely branched. Division of cells takes place in a line parallel with the sides as well as transversely; filaments often contain three, four, or more series of cells.

Genus 91, SIROSIPHON, Kg.

Cells of the filaments one, two to many seriate, in consequence of their lateral division or multiplication. Younger forms have one or two series, older ones often have six to ten series. Sheaths large. Cells surrounded with a distinct membrane, very prominent in the older filaments.

"Hormogons originating in lateral branchlets formed of a single row of cells."—*Cooke.*

Propagation by means of microgonidia, originating in the single cells of the lateral branchlets after their sliding out of the sheath. The microgonidia develop into macrogonidia and these produce various forms of cells heretofore known as *Microcystis*, *Gloeocapsa*, *Gloeothece*, etc. After passing through, often numerous cycles of evolution, the original form is reproduced.

The propriety of Cooke's remark, in his *British Fresh-water Algæ*, p. 270, "It can scarcely be doubted that all the members of the genus *Stigonema* (or *Sirosiphon*) and *Hapalosiphon* must be transfered to the Lichens," is beyond our comprehension.

The generic terms *Stigonema*, Ag., and *Sirosiphon*, Kg., are sometimes interchanged, as though both represented the same kind of plants; this does not appear to be the case. The true *Stigonema*-forms, according to Agardh himself, who originally suggested the name, partake of the nature of Lichens. He says in his *Sys. Algarum*, page xxii, "*Habitus magis Lichenosus.*" Rabenhorst also says of *Stigonema*, "*Genus ad Lichenes certe referendum, in aliis apothecia detecta sunt*," etc. But *Stigonema*-forms are not related to *Sirosiphon*-forms, hence Kuetzing deemed it wise to separate the two, and made the newer genus *Sirosiphon*. If the two represented similar plants, then the term *Stigonema*, 1824, would have the priority claim. Kuetzing's term dates only to 1843, but his diagnosis describes the forms here to be presented; Agardh's description falls short.

Hapalosiphon also rests on a good basis among the Algæ. A study of the life-history of *Sirosiphon*, briefly illustrated in this work, will confirm the correctness of the position asserted.

SIROSIPHON PULVINATUS, Breb.

Forming expanded strata on dripping rocks; deep olive-black, cushion-like, or sometimes velvet-like when dry; masses about two lines thick (4 *mm*). Filaments often very thick, much branched, brownish, irregularly curved; branches polymorphous, varying in thickness and length according to age, obtusely rounded at the apex; cells of the filaments very variable, younger forms with a single series, and older forms from two to three to many series. Sheaths thick, yellow-fuscous to deep fuscous, pellucid or opaque, sometimes rugose-tuberculate.

Diameter of filaments range from 10–12 μ, for younger plants; up to 100 μ, for older ones.

This is our most common form, often spreading over dripping rocks in partially shaded mountain ravines, many square yards in extent. The plants are not attached except by a mucus in which all are more or less imbedded. Young and older filaments, with one, two, or more series of cells, and macrogonidia (*Gloeocapsa* cells) are intermingled; filaments so polymorphous in size and form, fear this plant is innocently responsible for the record of many species which have absolutely no value. For illustration, looking at Plate CXC, which represents *S. pulvinatus*, some of the diversities of form become evident. No diagnosis of this form, nor of *turfaceum* (a synonym), by different authors, acknowledges filaments of a single row of cells; nevertheless it is certain that all young forms are uniseriate, and that they often grow to considerable length without dividing laterally. Such condition represents *S. torulosus*, Rab., and *S. saxicola*, Kg.; it is not unlike other young forms (figs. 5–8). *S. minutum*, Hass., is a still more slender form which occurs also, not infrequently mingled with the larger forms.

S. crustaceus, (Ag.) Rab.; *S. rugulosus*, Kg.; *S. secundatus*, Kg., *S. Heufleri*, Menegh.; *S. rhizoides*, Breb.; *S. hormioides*, Kg.; and others, appear to be mere conditions, or stages of development of the same species.

Plate CXC, figs. 1–3, macrogonidia (*Gloeocapsa* cells); figs. 4–8, earliest development of filaments from macrogonidia; figs. 9, 10, two elongated young plants with a solitary series of cells; figs. 11, 12, older forms, with 2–6–8 series of cells.

SIROSIPHON PULVINATUS, Breb. Forma ALPINUS, (Kg.) Wolle.

Bearing some resemblance to *S. Alpinus*, Kg., and with habitat similar to the last; it exhibits now and then a distinct, yellow heterocyst, and possesses here and there a spine-like outgrowth, or attenuated apex, which is a young growth with very short cells.

Associated with this plant there are, usually intermingled during the later Summer months, many solitary cells (*Gloeocapsa*, etc.), which are spores or macrogonidia. They may be found in many progressive stages of development. They imply two processes of propagation, which may be illustrated as follows:

Plate CXCI, figs. 1, 2, are two ends of filaments with young growths, spine-like processes; fig. 3, a broken-off part of a filament, the sporangia, or cells bearing the microgonidia, are enlarging and passing out of the sheath; figs. 4, 5, the same increasing in size internally and externally and producing such encysted cells as figs. 6, 7; the teguments of these dissolve gradually and then set the daughter cells free; these (figs. 8, 9, 10) pass through another similar cycle of evolution, and again another and so on often for a number of generations; finally the young forms commence to develop as represented by figs. 11–14.

Another process differing somewhat in the details may be illustrated. By the diffluence of the walls of the filaments and of the membranes of the internal cells, the microgonidia are scattered; from these large masses of small, almost colorless, thin membraned, circular cells are evolved (figs. 15, 16); gradually a nucleus is formed in them (fig. 17); they enlarge, the nucleus divides, producing larger and more firmly constructed cells (fig. 18), which become encysted by lamellate membranes, dividing and redividing and enlarging (figs. 19, 20), resulting in cells of the true *Gloeocapsa*-type. These cells often occur in such quantities on wet cliffs, that they may be stripped with the palm of the hand. Among them there are always some in an early state of development, others more advanced and some fully grown. Most of the cells are sterile.

Plate CXCV, fig. 16, fragments of specimen of the same species, from wet rocks, Black Water Creek, West Virginia. Reddish brown with three bright aeruginous spots, indicating preliminaries for fresh growth. Associated with forms of this kind are young aeruginous filaments, 9–12 μ diameter, others yellowish 25–30 μ and the larger forms 38–62 μ; fig. 15, a tuberculose specimen, however merely a form of *S. pulvinatus*, which occurs occasionally in older masses. Kirchner denominates this form *S. mamillosum*, and credits the species to Agardh; but Agardh's plant was, probably, no true *Sirosiphon*, but a *Stigonema*, a Lichen; nevertheless we retain the name and call it

Forma *mamillosum*. It is not identical with Agardh's form.

SIROSIPHON CORALLOIDES, Kg.

Strata more or less expanded, tomentose, greenish-black or fuliginous black, trichomes rather short, prostrate, rigid, sometimes very irregular in outline, much branched, tuberculose, yellowish brown or greenish; branches erect, polymorphic, often short, sometimes papilliform, obtuse; two to eight or more series of internal cells; cells round or subquadrangular, aeruginous green, granular; sheath often yellowish brown or golden yellow.

Diameter of filaments from 25–150 μ.

The finest specimens are from stones along the rocky shores of Green Pond, New Jersey, constantly washed by the waves. Unlike the last *S. pulvinatus*, this is firmly attached to the stones, or rocks. Have it also from other parts of New Jersey, and from wet rocks, Mt. Mansfield, Vt. The latter specimens have the filaments very irregularly inflated, tuber-like.

Plate CXCI, fig. 21, represents a single, rather large stem from a tomentose mat on a stone, New Jersey.

Plate CXCII, figs. 9–12, from specimens from Mt. Mansfield, Vt.

SIROSIPHON COMPACTUS, Kg.

Forming a more or less expanded, compact, tomentose, dark brown stratum, trichomes and branches ascending, a little attenuated at the apices, obtuse, internally formed of a single, rarely a double series of cells, which are torulose and sometimes almost moniliform; diameter and length nearly equal, filled with a pale blue-green, granular cytioplasm; sheaths firm, golden brown; heterocysts subglobose or oblong.

Diameter of filaments, 12–15 μ.

Syn. *Stigonema compactum*, Kirch.; *Hassallia compacta*, Hass.; *Scytonema compactum*, Eng. Fla.

Sandstone rocks, South Carolina; shaded limestone rocks, Pennsylvania, etc.

Plate CXCII, figs. 1, 2, several characteristic filaments.

SIROSIPHON SCYTONEMATOIDES, (Wood) Wolle.

Filaments often closely intricate, flexuous or variously curved, not rigid, (sparsely) branched; cells uniseriate, about equal in length to their diameter; sheaths ample, not distinctly lamellate, (their surface rough and corrugate) transparent, (mostly) colorless, (sometimes light brown).

Diameter of filaments, .00066″ = 16–17 μ.

This species was collected in South Carolina by Mr. Ravenel, growing on the limbs of *Myrica cerifera*. There can be little doubt that the form seen by Dr. Wood is the same as already described (page 257) as *Scytonema cortex*, var. *corrugata*. Doubting the validity of the normal condition of our present plant, and not able to duplicate it for corroboration, we retain the name selected by Dr. Wood for a plant, or a condition of a plant, entirely distinct, but to which the diagnosis applies well, omitting the few words we enclose in parentheses.

The plant was found on damp soil, not on trees, collected by Dr. Hosford, of Charlotte, Vermont. The sheath is colorless, the trichomes light blue, about one-third as wide as the sheath. The macrogonidia were seen escaping at the broken ends of the rather short filaments.

Plate CXCII, figs. 3–5, filaments; fig. 6, macrogonidia.

SIROSIPHON OCELLATUS, Kg.

Stratum more or less expanded, woolly-tomentose, dark olive brown; filaments elongate, irregularly branched; branches, primary and secondary; cells of the stems mostly biseriate, and of the branches commonly uniseriate, subglobose or oblong compressed, equal or one-half, or one-third as long as broad, normally aeruginous; sheaths thick, often lamellose, golden brown, external layers now and then paler; sheaths of the branches colorless, or yellowish, quite smooth.

Diameter of filaments, 12–38 μ.

Syn. *Stigonema ocellatum*, Thur.; *Hassallia ocellata*, Hass.; *Conferva ocellata*, Dillw.; *Scytonema ocellatum*, Harv.; *Sirosiphon pellucidulus*, Wood.

Most frequent in small pools, swamps; also in larger ponds. The finest specimens occurred in Bamber Lake, New Jersey, attached to submerged sticks in dark brown waving tufts about one-half inch in length. Samples of this are preserved in Wittrock and Nordstedt's *Algæ Exsiccatae*, No. 668, A.D. 1883.

Plate CXCIV, figs. 1–3, three fragments of branching filaments; fig. 4, part of a broken filament; fig. 5, the microgonidia bearing cells; fig. 6, the same, sliding out of the sheath and developing; figs. 7–10, young plants.

SIROSIPHON CRAMERI, Bruegg.

Forming a blackish, widely expanded, tomentose, turfy covering to rocks; filaments with scattered branches; branches mostly single, often elongate and clavate; cells uniseriate about equal or shorter than long, sometimes subglobose; in advanced age often strongly compressed and transversely oblong from mutual pressure, yellowish, or sometimes when young, greenish; the apical cells coalescent into an irregularly cylindrical mass, (merely a condition of young growth,) sheaths yellowish brown; at maturity more or less opaque and distinctly lamellate; in youth more or less transparent, and sometimes colorless.

Diameter of filaments, about 50 μ; branches 38 μ, more or less, with sheath; without sheath, 20–25 μ.

On slopes of Mount Tahawas, in the Adirondack Mountains, N. Y., at an altitude of about 5000 feet, over which water is continually dripping, this plant flourishes, forming a turfy coating, yards in extent. The specimens agree well with the description of the European, Alpine plant, found at practically the same altitude. (Wood's *Contribution Fresh-Water Algæ*, p. 71.)

Plate CXCIV, figs. 11–16, taken from specimens found in New Jersey, answering the description, but given not without a suspicion that they are closely related to *S. ocellatus.*

SIROSIPHON LIGNICOLA, Wood.

Occuring in small black spots, often aggregated, forming extended tomentose strata. Filaments much branched, green, golden, or brown; branches straight or variously curved; sometimes very much contorted and interwoven; their apices obtusely rounded or subacuminate; cells 1–2 or more seriate, light or deep aeruginous, irregular; terminal parts of trichomes sometimes cylindrical; shortly articulate, granulate; sheaths somewhat ample, not transparent, fuscous or ferruginous.

Diameter of filaments variable, from 12–30 μ. Most commonly, 15–20 μ.

Frequent on old wood and on the trunks of trees in South Carolina. During the past eight or ten years I have received scores of specimens collected by the indefatigable W. H. Ravenel, of Aiken, South Carolina. The collections were made in various seasons of the year, and from the trunks of many kinds of trees, in dry, and in continuous wet weather. *Sirosiphon* is at best a very polymorphic algæ. A few specimens illustrate this fact, but when many of the same genus are brought together from the same habitat, it becomes utterly impossible to separate them into different species. We therefore unite the species *S. guttula*, Wood; and *S. acervatum*, Wood, with *S. lignicola*, Wood.

Plate CXCIII, figs. 1, 2, two well developed forms; figs. 3, 4, an occasional appearance of a distorted growth; figs. 5–11, conditions of young developing plants.

SIROSIPHON ARGILLACEUS, Wood.

Stratum thin, expanded, blackish, sub-membranaceous; filaments short, densely intricate and frequently somewhat concreted, giving origin to numerous irregular branches;

branches short, variously curved, somewhat rigid, mostly ascending; cells in simple or double or triple series; sheath thick, firm; in the mature filament deep reddish brown, in the branches yellow-brown, at the apices of the branches nearly colorless and transparent.

Moist clay banks, moist rocks, and the like. Habitat distinct from the last, *S. lignicola*, but otherwise, could not be separated; it is like it very polymorphic.

Plate CXCIII, figs. 12, 13, two of the simplest forms from a cluster; figs. 1, 2, are as characteristic of the plant.

SIROSIPHON BRANDEGEEI, Wolle.

A form of which no full description can be given, as the only specimen received was very limited. It was collected by T. S. Brandegee, on the shores of a soda spring, Colorado. Filaments short with apices subacute, reddish brown; cells one, two, or three seriate. Microgonidia-bearing cells enlarge to form sporangia; these eject macrogonidia which develop into *Gloeocapsa* or *Chroococcus*-forms, mostly simple, having but one nucleus which gives rise to a young plant.

Diameter of filaments, about 20 μ; younger forms, 12–15 μ.

Soda Springs, Cannon City, Col.

Plate CXCIV, figs. 17–20, older and younger forms; figs. 21–23, intermediate forms of development, of the character of *Microcystis* and *Chroococcus* cells; figs. 24–27, various conditions of young, developing forms.

SIROSIPHON CRUSTACEUS, (Ag.) Rab.

Stratum thin, sub-tomentose, fuscous-black; trichomes decumbent, densely intricate, branches longer or shorter, sometimes inclining to corymbose near the ends, erect flexuous, subtorulose, apices rounded or subacute; cells in simple series, rarely two series, globose, loosely disposed, light aeruginous; sheath rather ample, colorless, hyaline, more rarely light yellow.

Diameter of filaments, 15–18 μ.

Syn. *Scytonema crustaceum*, Ag.; *Scy. velutinum*, Wallr.; *Sirosiphon velutinus*, Kg.; *Sirosiphon rhizodes*, Breb.

Moist rocks, Charlotte, Vt.

Had this plant from only one locality. It is very near to *S. rhizodes*, but larger; *S. crustaceus* is so nearly the same, they are probably varieties of the same species.

Genus 92, HAPALOSIPHON, Naeg.

Forming tufts, attached or floating, olive green, aeruginous, or with age light or darker brown, branched; branches ordinarily simple, springing at right angles, or nearly so, from the prostrate stem; sometimes with secondary branchlets. Cells in a single series, distinct, or sometimes continuous, granulate. Heterocysts occur not infrequently. Inhabits submarine, as well as fresh waters.

Dr. Itzigsohn, of Prussia, made an elaborate study of the life-history of plants of this genus, particularly of *H. Braunii*, devoting two years to it. He gathered fresh material from a pond near his home at least once a week. In the winter months he obtained his specimens from under the ice. He was abundantly rewarded for his labors, making many very important and valuable observations heretofore unknown, and so new to science that the value of his work was not credited at the time. Even now, after a lapse of more than thirty years, it is only here and there that the correctness of his observations is accepted. Old theories, numerous genera and a multitude of species are admitted, which have no value as species. In the life-history of this one plant, in its numerous polymorphic transition-forms of development, occur conditions of plant-life corresponding with such genera as *Chroococcus*, Naeg., *Aphanotheca*, Naeg., *Aphanocapsa*, Naeg., *Microcystis*, Kg., *Nostoc*, Vauch., *Hormosiphon*, Kg., *Rivularia*, Ag., *Gloeocapsa*, Kg., *Synechococcus*, Naeg., and others, each distinctly characteristic, and yet all of them only links in the chain of evolutions necessary to their propagation; some of them may be abnormal conditions or freaks. Dr. Itzigsohn satisfied himself that all of the many forms described are connected with the present plant, but he failed to find the precise relation of each to each.

For full particulars consult "*Skizzen zu einer Lebensgeschichte des Hapalosiphon Braunii*," 49 pp. 5 Plates, by H. Itzigsohn.

HAPALOSIPHON BRAUNII, Kg.

Floccose caespitose, often parasitic, attached, or floating; aeruginous, lighter or darker olive brown; filaments loosely interwoven; interior trichomes usually light aeruginous; articulations of stems distinct, about as long as wide or shorter, granular; sheath thin and close, colorless, rarely yellowish.

Diameter of filaments, 10–12 μ.

Primarily parasitic on submerged plants, later floating, sometimes in large masses.

Plate CXCVI, figs. 2, 3, 4, three filaments; branches often very much longer than illustrated, and thinner than the the stem; cells of stem usually more moniliform than those of the branchlets; heterocysts somewhat oval, scattered; fig. 5, short section of a filament, cells dividing, enlarging, developing large encysted cells, fig. 6; from these come *Chroococcus*, figs. 7, 8; *Palmagloea* cells, figs. 9, 10; *Nostochopsis*, Wood, figs. 11–15; *Nostocs*, figs. 16, 17; *Hormosiphon*, fig. 18. Fig. 19, a specimen developing secondary branchlets.

HAPALOSIPHON BYSSOIDEUS (Hass.) Kirch.

Stratum turfy, dull black, somewhat olive green: filaments or branchlets ascending; *pseudo*-branchlets rather short, rigid. Cells primarily as long as wide, later one-third or one-fourth as long, aeruginous or with age brown; sheath thick, often distinctly lamellate, smooth, ends slightly attenuate, apices rounded, colorless or golden yellow. Heterocysts compressed oval usually between the cells of the stem only; light yellow.

Diameter of filaments, 20–25 μ; branches somewhat thinner.

Syn. *Hassallia byssoidea*, Hass.; *Sirosiphon truncicola*, Rab.

On the trunks of trees, South Carolina and other Southern States.

Plate CXCV, figs. 10, 11, 12, two younger and two more advanced, branching filaments.

From trunks of trees near Aiken, South Carolina.

HAPALOSIPHON TORULOSUS, (Rab.) Kirch.

Filaments apt to be solitary, rarely longer than 4 *mm;* sparsely branched; cells ordinarily half as long as wide, torulose, pale aeruginous; sheaths close and thin, indistinctly lamellate, smooth, brown yellow.

Diameter of filaments, 22–27 μ; branchlets somewhat less.

On moist rocks intermingled with *Gloeocapsa* cells, Kirch. From moist rocks, Prince Edward Island, Virginia. The specimen received did not indicate the presence of *Gloeocapsa* noted by Kirchner. Their presence would imply a relation to *Sirosiphon* as originally placed by Rabenhorst; the arrangement of the branchlets, however, is *Hapalosiphon*-like.

Plate CXCV, figs. 13, 14, a short section of a filament.

HAPALOSIPHON BREBISSONII, Kg.

Caespitose, 3–4 lines long, dull aeruginous, much branched, distinctly articulate, articles equal or somewhat longer than broad, aeruginous; sheath of stem rather ample, often yellowish brown; of branchlets, thin, close, colorless, hyaline.

Diameter of filaments, 15 μ, more or less.

Very near *H. byssoideus*, but more slender, cells longer, and aquatic, parasitic on water plants; appears to stand between *H. byssoideus* and *H. Braunii*.

Plate CXCVI, fig. 1, after a specimen from Dennisville, New Jersey.

HAPALOSIPHON FUSCESCENS, Kg.

Floccose caespitose, dull aeruginous, changing to lighter or darker olive brown, parasitic; much branched; usually internal trichome light aeruginous or light olive yellow, more or less distinctly articulate, granular; articles equal, to two or more times longer than broad; ends of branchlets often somewhat swollen.

Diameter of filaments, 8–11 μ; branchlets, 5–7 μ.

Pond waters.

Syn. *Tolypothrix pumila*, Kg.; *T. fuscescens*, Breb.

Differs from *H. Braunii* in its more slender filaments, and longer cells.

Plate CXCVI, figs. 22, 23, specimens from ponds, New Jersey.

HAPALOSIPHON TENUISSIMUS, Grun.

Parasitic, floccose, irregularly, squarrosely branched. Branches internally, pale aeruginous, often interrupted, indistinctly articulate, variously curved; sheath thin and close, colorless.

Diameter of stems, about 7–8 μ; branchlets about half as thick.

Ponds and wet ground.

Plate CXCVI, figs. 20, 21, specimens from pond, New Jersey; not infrequent also in Pennsylvania, Minnesota, Florida; no doubt widely distributed.

SECTION IV.—NOSTOCEÆ.

Simple, branchless filaments, with or without a sheath, never terminating with a hair-point, always provided with heterocysts. Spores usually present in mature filaments.

Multiplication takes place in a two-fold manner. First, by means of the spores which give rise to young plants; and secondly, by means of hormogons, or parts of internal trichomes which separate from the filaments and develop new plants.

Genus 93, NOSTOC, Vauch.

Filaments moniliform, enclosed in a thin gelatinous envelope more or less distinct, often invisible, flexuously curved, irregularly interwoven; cells globose or elliptic, more or less closely connected. Heterocysts intercalated or more rarely terminal. Cells about the size of the heterocysts or a little larger, which occur in the older forms, have been considered spores. Clusters of such filaments form distinct bodies, thalli, which are usually surrounded by a firm membrane, variously colored, most frequently olivaceous, but sometimes dark bluish green, dark brown, or light yellow; sometimes colorless. In form either globose or subglobose, irregularly divided or often indefinitely expanded.

The value of *Nostocs* as algæ has frequently been questioned; they have been associated with the lichens; however true, that in the life-history of some lichens a *Nostoc*-form may occur, there can be no doubt that the usual forms of *Nostocs* belong to the algæ, but there may be a question, whether they are true, normally developed, plants. Many observations and studies lead us to believe that they are merely intermediate life conditions, arrested growths of algæ life. It has already been shown (Plate CLXXXVII, figs. 1–15), that a *Nostoc* is the matrix of *Scytonema;* also, how *Nostocs* are developed into *Scytonema;* compare Plate CLXXXII, figs. 9–13, also fig. 8; Plate CLXXXVII, figs. 27–33, and Plate CLXXXIV, figs. 34–40.

Dr. Itzigsohn in his studies of the life-history of *Hapalosiphon* found that *Nostocs* constitute a stage of development, Plate CXCVI, figs. 16, 17. Where *Scytonema* prevails to any extent, there *Nostocs* are sure to occur also. Sometimes one may greatly predominate over the other, but they are usually consociated.

Nostocs form an intermediate life-stage, an abortive existence in which they grow and multiply, producing their like for a number of generations, as do many of the unicellular forms of algæ, without developing the true plant. There appears to be a struggle for existence in which various forms are produced; there may be thousands of them and only here and there one which is destined through its fertility, to propagate the species; the others are abortive and soon fade away. Many of the varieties of *Nostoc*-forms have given rise to a host of specific names which have no value as fully developed plants.

Nostocs constitute a condition of plant-life which occurs frequently; they are objects which attract the attention of amateurs and older collectors, and must needs have a name to be able to distinguish them when they become the subject of pen or tongue; we therefore treat them briefly and retain such names as are most familiar. The collector should bear in mind that *Nostocs* are liable to great variations both in size and color; some may be microscopical in size to-day; at a later season they will be as large as peas or cherries; some may have thin colorless membranes, while others have firm teguments of yellow or brown color; the trichomes of some may be very slender and almost colorless, others are thicker, light yellow, brown, or lighter or darker aeruginous, apparently so distinct and unlike one another they have been accounted different species, but in reality the changes merely indicate a variety of stages of development or decay.

In a comparatively recent work (Italian) a number of *Nostocs* are described and illustrated as *N. macrosporum*, Menegh.; *N. rupestre*, Kg.; *N. coriaceum*, Vauch.; *N. verrucosum*, Vauch.; *N. tenuissimum*, Rab.; all of which forms occur together, here, in mass on dripping rocks, and evidently constitute but one species; then there are some noted as having the filaments sheathed, others as unsheathed; neither are such properly separated, because in the younger stage of growth the sheath is not developed; in older forms (and yet not always) the sheath becomes evident.

Various stages of growth of another *Nostoc*-form, found at different seasons of the year, and by different individuals, have given rise to a number of names for the same plant. In early Spring it is found as a soft, floating, gelatinous stratum, and is called *N. comminutum*, Kg.; or *N. piscinale*, Kg.; when the filaments are not surrounded by a soft gelatin, then they form *N. tenuissimum*, Kg. These moniliform threads soon separate and sink. Next they are found as very small thalli attached to submerged grasses or mosses producing the form of *N. minutissimum*, Kg., or *N. depressum*, Wood. These thalli grow, and when about the size of peas, pass for *N. coeruleum*, Lyngb. Later in the season, about September, all of those which were so numerously attached to the plants a month or two earlier, will have disappeared, but instead there will be found on the bottom of the pond, larger thalli, from the size of cherries to that of plums; this is *N. pruniforme*, (Roth) Ag., and is one of our most attractive *Nostocs* with its firm, smooth, glossy periderm and its dark aeruginous green color. Having attained this mature condition, they soon fade; the cytioplasm becomes watery, the periderm breaks and dissolves and the contents are scattered.

Specimens of this species have been reported to me from waters beyond the Rocky Mountains, as large as a man's fist.

Have endeavored to cultivate this *Nostoc* to get it to develop the higher plant of which it is probably an intermediate stage or condition, but failed. They did separate, multiply, and re-multiply, merely reproducing, however, of their own kind in the various stages of growth indicated above. The idea suggested itself that water, possibly, is not a normal habitat; they need an occasional exposure to make them develop, as on dripping rocks, moist wood or earth, trunks of trees in wet seasons, and the like. On the banks of ponds where *N. pruniforme* occurs, there *Scytonema* is also found, but did not succeed in tracing the immediate connection between the two.

The form known as *N. commune*, Vauch., is widely distributed and appears in conditions as variable as the localities in which it is found. It has been described under numerous names; sometimes appearing on damp or wet ground in small thalli, but these soon enlarge, and then flow together forming a soft expanded stratum; sometimes bullate, membrane thickens and hardens; have seen the surface of the earth, after a rainy season, acres in extent, dotted over with olive black, thin, dried membranes, somewhat coriaceous fronds, an inch more or less in diameter, a condition of this *Nostoc;* these membranes, after a good soaking, show their true character. A striking instance of personal observation occurred on the island of Anastatia, Florida. Capt. J. D. Smith, a faithful collector in Florida, sent me fresh specimens developed under favorable circumstances; they were parts of thalli which were inflated even to the size of a man's head. Among the numerous specimens examined the majority gave more or less evidence of a disposition to develop a filamentous plant—a *Scytonema.* Have transferred a few of these to paper, Plate CXCVII, fig. 8, a not infrequent form of a thallus; fig. 9, normal form of filaments; figs. 10, 11, cells of filaments separated and forming young plants; figs. 12–15, forms of newly developed plants; figs. 16, 17, filaments, one part moniliform, unchanged, and the other part changing or already developed to twice the diameter.

Two French algologists, Messrs. Bornet and Thuret, published a few years since a synopsis of the *Nostocs.* They were guided by the old notion that they are really fully developed plants. They made eight groups, which we transcribe somewhat modified and adapted to our forms as still useful in our present imperfect knowledge of the full life-history of these spurious forms.

I.—INTRICATA. Aquatic species. Fronds soft, gelatinous without determinate form, often floating.

A.—Trichomes forming irregular masses deprived of the general mucilage. Circumvolutions of trichomes distinct. . . . . 1. TENUISSIMUM.

B.—Trichomes involved in mucilage more or less abundant, loosely interwoven, joints of equal diameter, rather distant; spores subglobose. . 2. COMMINUTUM.

II.—GELATINOSA. Fronds soft and gelatinous, adherent, joints of trichomes cylindrically elongated in the young filaments. Spores oblong large.

A.—Growing in watery or inundated places; fronds thick, deformed. . . . . 3. SPONGIÆFORME.

B.—Plant terrestiial. Frond plane, applied to the ground by the inferior surface. . . . . 4. ELLIPSOSPORUM.

III.—HUMIFUSA. Terrestrial species. Fronds at first globose, then confluent, and forming gelatinous cushions adhering to the substratum by their lower face; spores smooth, oval; sheaths confluent. . . 5. MUSCORUM.

Spores measuring $4 \times 6\,\mu$ or more; mucilage tolerably firm; trichomes olive; spores oval. . . . 6. HUMIFUSUM.

Mucilage soft, easily diffluent; trichomes aeruginous green. . . . . 7. CALCICOLA.

IV.—COMMUNIA. Terrestrial species, (sometimes inundated). Fronds at first globose, then becoming tongue-shaped, plane, or irregular. Adult frond suborbicular, folded, undulate, entire or lobed, often perforated, and often expanded. . . . . . . 8. COMMUNE.

V.—SPHAERICA. Fronds globose or subglobose (often becoming irregular when they grow large); limited by a firm and resisting peridermic coating.

A.—Terrestrial species.

a.—Fronds often large, firm, trichomes compact, joints compressed spherical, rarely cask-shaped; close together, uniform. . . 9. SPHAERICUM.

b.—Fronds soft, trichomes much spread out, of unequal size, joints nearly spherical, sheaths often colored, contrasting with the generally uncolored mucilage. . . . . 10. RUPESTRE.

c.—Fronds very small, punctiform, not attaining 1 *mm* diameter. Trichomes large, joints cylindrical, a little constricted at the point of junction; spores globose smooth. . . . 11. MACROSPORUM.

d.—Trichomes fusiformly swollen between the heterocysts. . . . . 12. SPHÆROIDES.

B.—Aquatic species (color approaching to blue).

a.—Trichomes dissimilar, unequal; joints of two forms, the one (young) elongated, the other large spherical often filled with opaque granules. . . . . 13. CŒRULEUM.

b.—Trichomes homogeneous, regular.
1.—Frond very small; trichomes very compact. . . . . 14. MINUTISSIMUM.
2.—Frond attaining 2-10 *mm.* . . . . 15. GREGARIUM.
3.—Fronds attaining the size of a large cherry. . . . . 16. PRUNIFORME.

VI.—VERRUCOSA. Aquatic species; fronds rounded or discoid, at first full, then hollow; periderm firm and tough; trichomes thin, regular.
a.—Fronds subglobose or warty; mucilage tolerably soft; trichomes medium, compact; sheaths not frequent. . . . . . 17. VERRUCOSUM.
b.—Fronds at first discoid, or tongue-shaped, a little ovoid, hard. . . . . . . 18. ALPINUM.

VII.—ZETTERSTEDTIANA. Aquatic species. Fronds spherical, hard, tuberculose, divided into radiating separable lobes. . . . . 19. ZETTERSTEDTII.

VIII.—FLAGELLIFORMIA. Terrestrial species; fronds forming thongs, linear, straight and long; subdichotomous; trichomes longitudinally parallel. . . 20. FLAGELLIFORME.

Following the order of the synopsis a few notes and references will be in place.

NOSTOC TENUISSIMUM, Kg.

Scarcely separable from the next except that the thallus is not so gelatinous—a young condition of *N. pruniforme.*

NOSTOC COMMINUTUM, Kg.

Syn. *N. piscinale*, Kg.; *N. lacustre*, Kg.; *N. agglutinum*, Kg.

Floating in ditches and smaller ponds.

NOSTOC SPONGIÆFORME, Ag.

NOSTOC ELLIPSOSPORUM (Desm.) Rab.

Two forms not recognized.

NOSTOC MUSCORUM, Ag.

Usually found on wet calcareous rock, and on the mosses which cover them.

Plate CXCVII, fig. 35, a gelatinous thallus formed by the confluence of a number of smaller subspherical thalli.

NOSTOC HUMIFUSUM, Carm.

A form described as globose, or subglobose, from the size of a pepper corn; often aggregated and confluent; have not identified it, but have suspected that the form alluded to above as *N. commune* on Anastatia Island (p. 280) may be this form. The same ground on which it occurs abounds also in a small form of *Scytonema*, near *S. chrysochlorum*, Kg.

NOSTOC CALCICOLA, Ag.

Not separable from *N. commune*, Ag.; a condition of it.

Moist rocks, South Carolina.

NOSTOC COMMUNE, Vauch.

In connection with this form, read note above under generic characters.

Syn. *Tremula nostoc*, Linn.; *Nostoc ciniflonum*, Born. and Thur.; *N. foliaceum*, Ag.; *N. arctum*, Kg.; *N. littorale*, Kg.; *N. prismaticum*, Ces.; *N. rugosum*, Kg.; *N. salsum*, Kg.

Frequent on wet ground, rocks, etc.

Diameter of filaments, 5–6 μ.

Plate CXCVII, fig. 8, a not unusual form of a thallus; fig. 9, filaments separated from the thallus and greatly enlarged; figs. 10, 11, cells of filaments separated, and young filaments developing; figs. 12–14, filaments somewhat advanced, commencing to branch; fig. 15, young filaments uncoiling after the manner of some *Oscillaria*; figs. 16, 17, two filaments with one part unchanged, moniliform, the other end widened and changed, in character with the others.

NOSTOC SPHAERICUM, Vauch.

Fronds very variable in size from that of poppy and mustard seed to that of peas; gregarious, usually olive or yellowish brown, more rarely somewhat aeruginous; periderm firm, brownish.

Diameter of filaments, 4–5–6 μ.

Frequent on damp rocks, in large numbers.

Plate CXCVII, figs. 18–20, sizes as they vary with age.

NOSTOC RUPESTRE, Kg.

Fronds same as the last; the forms that receive this appellation appear to be merely another growth, or another generation of fronds; primarily the moniliform filaments are sheathless as figs. 21–23, then they become sheathed as figs. 24, 25. Next the teguments dissolve, and the young are scattered, producing such forms as figs. 26–30, which constitute the *N. rupestre*, Kg., a form which embraces also *N. macrosporum*, Menegh.; *N. coriaceum*, Vauch.; *N. verrucosum*, Vauch.; *N. tenuissimum*, Rab.; *N. microscopicum*, Carm.; *N. gregarium*, Hantzsch.; *Hormosiphon farfuraceus*, Kg.; *H. macrosiphon*, Kg.; and others, all of which are merely different stages of growth.

NOSTOC MACROSPORUM, Menegh.

Fronds very small, merely a form of the last, *rupestre*, and often intermingled with it.

Syn. *Hormosiphon macrosporus*, Kg.; *Nostoc pyreniacum*, Ripart; *Nostoc ichthyon*, Rab.

NOSTOC SPHAEROIDES, Kg.

A form not recognized in the United States.

NOSTOC CŒRULEUM, Lyngb.

Fronds small, globose or subglobose, 1–8 μ in diameter, fixed or free swimming, blue or greenish blue.

Diameter of filaments, 4–7 μ.

On mosses and submerged plants.

NOSTOC MINUTISSIMUM, Kg.

Var. N. PRUNIFORME.

NOSTOC GREGARIUM, Thur.

Var. N. PRUNIFORME.

NOSTOC PRUNIFORME, Ag.

Fronds from the size of a mustard seed to that of a pea, to that of a damson or larger; olive or dark aeruginous green, when old becoming blackish brown; periderm coriaceous. Trichomes loosely interwoven, joints subglobose, compressed, closely connected. Heterocysts globose.

Diameter of filaments, 4–5 μ.

The two preceding forms appear to be merely younger conditions of *N. pruniforme*. Compare note under the generic description, page 279.

Syn. *Ulva pruniformis*, Linn.; *N. coccymelon*, Kg.; *Tremella pruniformis*, Roth.

Plate CXCVII, figs. 3, 4, young forms (*N. minutissimum*, Kg.; *N. gregarium*, Thur.); fig. 5, well matured forms; figs. 6, 7, moniliform filaments from a frond.

NOSTOC VERRUCOSUM, Vauch.

Fronds more or less warty, subglobose or nodulose, brownish green, limited at the circumference by a firm periderm. Trichomes slender, somewhat compact, spaced out, joints subglobose, closely connected; heterocysts spherical.

Diameter of filaments, 3–4 μ.

Syn. *Nostoc irregulare*, Wartm.; *N. nivale*, Kg.; *N. Peloponnesiacum*, Kg.; *N. sphæricum*, Menegh.; *Tremella verrucosa*, Huds.

In limestone springs, streams, etc.

Plate CXCVII, fig. 1, a frond; fig. 2, filaments from a frond.

NOSTOC ALPINUM, Kg.

Growing attached by its margin to rocks in running water, also to dripping rocks. Frond suborbicular, erect, membranaceous, 3–8 lines high, and 1–3 lines thick, very tenacious; deep olive green, smooth, often rugosely plicate at the base; trichomes laxly or somewhat densely interwoven; heterocysts spherical.

Syn. *N. Sunderlandi*, Dickie; *N. cristatum*, Bailey; *N. parmelioides*, Kg.

From specimens from the rocky bottom of the Susquehanna, Harrisburg, Pa., and from the Palisades, N. Y.

Plate CXCVII, figs. 33, 34, fronds in front and in side view.

NOSTOC ZETTERSTEDTIANA, N.N.

A form not recognized here.

NOSTOC FLAGELLIFORME, Burk. and Curt.

Fronds dark olive, several inches in length, half a line in diameter, lying prostrate on the surface of the soil, much branched in an irregular dichotomous manner; branches linear compressed; periderm firm and elastic, cartilaginous, densely filled with moniliform filaments.

On naked aluminous soil, at San Pedro, Texas. Collected by C. Wright.

Plate CXCVII, fig. 32, specimen in my herbarium from Texas.

Genus 94, ANABÆNA, Bory.

Filaments similar to those of *Nostocs*, moniliform, singly or clustered in gelatinous masses, with rare exceptions with a sheath; cells globose, or subglobose, some of which change into globose or elongated spores, usually of a brownish color. Heterocysts intercalated in the filaments.

There is considerable vagueness of character in this and three or four allied genera. Different modern authors have modified the diagnosis to suit their own observations; they fail to agree. Thuret hoped to have reached a definite limit, but neither Borzi, Wittrock nor Nordstedt are in accord with him.

Wittrock and Nordstedt suggest that the genus *Anabæna* be divided into four subgenera under the following designations:

Sub-Genus 1. TRICHORMUS, spores globose or subglobose, heterocysts intercalated, distant from the spores.

Sub-Genus 2. DOLICHOSPERMUM, spores subellipsoid, or subcylindrical, heterocysts as in *Trichormus.*

Sub-Genus 3. SPHAEROZYGA, spores subellipsoid or subcylindrical, heterocysts intercalated, proximate to the spores.

Sub-Genus 4. CYLINDROSPERMUM, spores subellipsoid or cylindrical, heterocysts for the most part terminal and proximate to the spores.

Entertaining doubts whether these forms are true, fully developed plants, we continue, provisionally, the old arrangement as nearly as possible.

That *Anabæna*-forms develop *Lyngbya* and that *Cylindrospermum* and *Mastigonema* forms do likewise develop *Phycochromes*, has been clearly elucidated in our observations of the living plant-forms. A very satisfactory example was found on ponds of stagnant waters, submarine, in the vicinity of Dennisville, New Jersey. In all directions there were seen, July, 1880, large floating masses, dull, pale greenish, tea color, or olivaceous, gelatinous scums, composed apparently of two distinct filamentous plants, the one moniliform, the other with even margins. The former is an *Anabæna* although not strongly marked by heterocysts or spores, nor strictly in accord with any described forms, nevertheless appears to be a form of the genus.

Plate CXCVIII, figs. 9, 10, two filaments, the one in normal, moniliform condition, the other with the cells in the process of dividing; figs. 11, 12, 13, progressive stages of development; cells becoming square, adjoining walls resorbing and making a continuous, homogeneous filament; figs. 14–19, cytioplasm divides, and forms septa; articulations at first equal then dividing into two, four, or six to a diameter. For details of this plant see *Lyngbya vermicularis*. For reference to other developments see *Cylindrospermum.*

ANABÆNA FLOS-AQUAE, Kg.

Free swimming, submembranaceous, aeruginous; trichomes more or less curved, often circinate, joints spherical, or from mutual pressure transversely elliptic or quadrate; heterocysts intercalated, elliptical; spores globose.

Diameter of filaments, 4–6 μ; heterocysts often twice the size; spores, 8–10 μ.

Syn. *Nostoc flos-aquæ*, Lyngb.; *A. gelatinosa*, Wood.

Var. CIRCINALIS, (Rab.) Kirch.

Trichomes more circinate and joints larger; spores and heterocysts not proportionately so much larger than the typical form; sometimes very little larger than the cells.

Diameter, 7–10 μ.

Syn. *Anabæna circinalis*, Rab.; *A. spiralis*, Thompson; *Trichormus spiralis*, Ralfs.

Plate CXCVIII, figs. 20–23, filaments of type-form; figs. 24–26, var. *circinales*, from specimens from Minnesota, and from Chautauqua Lake, N. Y.

Var. AESTUARII, Wolle.

Same in size as *circinales*, but filaments not so circinate, and heterocysts and spores very slightly larger than the cells.

Plate CXCVIII, figs. 9, 10, specimens collected at Dennisville, New Jersey. See note under generic description.

ANABÆNA GIGANTEA, Wood.

Filaments occur floating singly or in great numbers, straight, but in the young state often spirally convolute; articles mostly subglobose, closely connected, granular; heterocysts subspherical, intercalated, a very little larger than the vegetative cells, thickened at each end in a punctiform manner; spore subspherical.

Diameter of vegetative cells, 9–11 μ; heterocysts, 12 μ.

Found occasionally intermingled with other algæ, or forming a part of a thick, dirty green, almost pulverulent scum.

Plate CXCVIII, figs. 27, 28, two short filaments; one in process of cell division.

ANABÆNA VARIABILIS, Kg.

Gelatinous, submembranaceous, deep blue green; trichomes slightly flexuously curved, almost parallel, verdigris green; joints globose or elliptic, compressed or depressedly subcylindrical, equal to one-half longer than broad; heterocysts intercalated, paler; spores numerous seriate, ellipsoid, golden tawny, with a rather thick membrane.

Diameter of cells, 3.5–4 μ; heterocysts and spores, 7–8 μ.

Syn. *Sphaerozyga Thwaitesii*, Harv.; *Sphaer. variabilis*, Kg.; *Trichormus rectus*, Ralfs; *Anabæna licheniformis*, Hass.; *Trichormus Thwaitesii*, Ralfs.

In ditches and smaller ponds.

Plate CXCVIII, figs. 29–32, four short filaments; spores variable in size as they approach maturity.

ANABÆNA STAGNALIS, Kg.

Forming a gelatinous stratum, dilute aeruginous, sometimes turning to yellowish; trichomes more or less flexuously curved, usually occurring in clusters; joints globose and elliptic intermixed, closely connected, finely granular; heterocysts few, elliptic, fully twice the diameter of the vegetative cells; spores spherical, as large as the heterocysts.

Diameter of vegetative cells, 3–4 μ.

Margins of pools, ponds, etc.

ANABÆNA OSCILLARIOIDES, Bory.

Forming a bluish stratum; trichomes elongated flexuous, joints subquadrate, distinct; heterocysts barrel-shaped or elliptic; spores oval, catenate, somewhat larger than the vegetative cells. Intermingled occur filaments which have the appearance of *Oscillaria*.

Diameter of cells, 4–5 μ.

Syn. *Sphaerozyga oscillarioides*, Kg.; *Trichormus oscillarioides*, Ralfs; *A. gelatinosa*, Wood.

In brackish ditches, Southern New Jersey. The latter, *A. gelatinosa*, evidently an imperfectly developed plant.

Plate CXCVIII, figs. 39, 40, filaments in different stages of growth.

ANABÆNA CUPRESSAPHILA, Wolle.

Forming a gelatinous, submembranaceous, deep aeruginous, stratum on cedar trees. Trichomes moniliform, enclosed in a delicate sheath, slightly curved, or nearly straight, more or less parallel, light aeruginous; vegetative cells about half as long as wide, granular, sometimes separated; heterocysts intercalated, brownish yellow, compressed globose, homogeneous.

Diameter of filaments, 7–8 μ.

Syn. *Trichormus incurvus*, Allman.

On the trunks of trees, low down near the water's edge in swamps, New Jersey.

Plate CXCVIII, figs. 1, 2, specimens of filaments.

Genus 95, SPHAEROZYGA, (Ag.) Ralfs.

Trichomes sheathless, singly, or agglutinated in an indefinite gelatinous stratum; rarely a number enclosed in a definite tegument; cells spherical, elliptic or oblong, or transversely compressed. Heterocysts intercalated, binary or solitary. Spores proximate to the heterocysts.

Sphaerozyga polysperma, Kg.

Filaments subsolitary or associated and interwoven, light bluish green, straightish, or variously curved and flexuous; articles, either subspherical or shortly cylindrical; heterocysts globose or very broadly elliptical; a little larger to twice the diameter of the vegetative cells; spores more or less, elongate, cylindrical; in the mature state dark bluish green, densely granulate and with rather thick membrane.

Diameter of vegetative cells, 2.5–6 μ.

Syn. *Sphaerozyga Carmichaelii*, Harv.; *Cylindrospermum elongatum*, Kg.; *Sph. Flotowiana*, Kg.; *Dolychospermum polyspermum*, Wood.

Small pools, stagnant waters.

Plate CXCVIII, figs. 37, 38, two short filaments.

Sphaerozyga Hassallii, Rab.

Trichomes equal, curved, often circinate, interwoven into a thin aeruginous stratum; joints globose or more or less compressed, delicately granular; heterocysts spherical, colorless, intercalated without order; spores oblong cylindrical, single or in pairs, sometimes in series, distinctly curved, dark aeruginous, densely granulated, 2–3 times longer than broad.

Diameter of cells, about 8 μ; heterocysts, 9–10 μ; spores, 12 μ.

Syn. *Anabæna flos-aquae*, Hass.; *Ana. Hassallii*, Nord. and Wittr.; *Dolychospermum Thompsoni*, Ann. Nat. Hist.; *Anabæna circinalis*, Phillips.

Plate CXCVIII, figs. 33–35, three specimens from many variable forms; fig. 36, *Oscillaria* filaments resulting from the development of this *Sphaerozyga*.

SPHAEROZYGA SACCATA, Wolle.

Thalli forming elongated, vertical, submembranaceous tubes, closed at the apex, 2–4 inches long and about one-fourth inch thick, in clusters of 10–15 more or less, attached to pond weeds (*Potamogeton*, etc.,) in shallow water at margins of pond, or to the bottom where the water is not more than a few inches deep. Each tube contains numerous filaments, erect, parallel or slightly curved, composed of oblong or cylindrical aeruginous cells, closely connected; heterocysts oval or subglobose yellow; spores numerous, cylindrical, dull aeruginous, nearly twice as long as wide.

Diameter of filaments, 4–5 μ.

Diameter of spores, 7 μ.

Diameter of heterocysts, 6 μ.

Frequent in Cranberry Pond, New Jersey.

Specimens, No. 397, Wittrock and Nordstedt's *Algæ Exsiccatæ.*

Plate CXCIX, fig. 1, a normal cluster of saccate forms; fig. 2, detached tubes floating; figs. 3–5, various specimens of filaments as contained in the tubes.

SPHAEROZYGA SMITHII, (Thwaites) Wolle.

Trichomes straight, included in a definite gelatinous sheath, usually single but sometimes two or three in a sheath; joints subspherical, about as long as wide or a little longer. Heterocysts subspherical or oval. Spores cylindrical, unequal in length, usually about twice as long as wide, with the ends rounded.

Diameter of cells, 4–6 μ; heterocysts, 8–9 μ; spores, 9-12 μ.

Syn. *Dolychospermum Smithii*, Thwaites; *Anabæna Smithii*, Thur.

This plant might also be placed to the genus *Hilsia*, Kirch., having often two or three filaments in a sheath, but in general character it is too much like a *Sphaerozyga* to be separated. It is not strictly in accord with *S. Smithii* of Thwaites, but the deviation is more pardonable in a plant of this genus than it would be to make a new species of it. Other changes in the character of the cells are worthy of note. The cells instead of remaining as in the young state rather longer than broad, become about three times as broad as long, evidencing a tendency to change and develop an *Oscillaria* or a *Lyngbya*-form.

Plate CXCIX, figs. 17–19, typical filaments; figs. 20–22, filaments two or three in a sheath; fig. 23, cells dividing and increasing in width; fig. 24, two filaments more advanced toward the character of *Oscillaria*.

Genus 96, APHANIZOMENON, Morren.

Thallus somewhat membranaceous, free swimming, aeruginous or light pure blue, or becoming olive; trichomes medium size, a little attenuated towards the apex, agglutinated parallelly and densely in fascicles; articulations cylindrical, very closely connected, pale blue, nearly colorless, and delicately granular. Spores elongated, cylindrical, rounded at the ends, pale blue or somewhat olive, smooth.—*Borzi.*

APHANIZOMENON FLOS-AQUAE, Allman.

Fully described by the generic character.

Diameter of vegetative cells 3.5–5.5 μ; 1–2 times as long as broad; diameter of spores, 5–5.5 μ; 6–12 times longer than the diameter.

Gathered this species only once; from a reservoir of rain-water.

Syn. *Limnochlide flos-aquae*, Kg.; *Sphaerozyga flos-aquae*, Rab.; *Byssus flos-aquae*, Linn.

Plate CXCVIII, figs. 7, 8, agglutinated filaments, floating; figs. 5, 6, specimens of spores.

Genus 97, NODULARIA, Mertens.

Trichomes usually distinctly vaginate, with closely compressed disc-shaped joints, collected in a gelatinous or membranaceous, irregularly diffused stratum. Heterocysts intercalated at regular intervals; vegetative joints nearly equal, transversely compressed. Spores fuscous, or golden yellow, globose, slightly compressed.

NODULARIA PALUDOSA, Wolle.

Filaments single or in smaller clusters on marshy grounds; trichomes nearly straight, of a beautiful aeruginous color; articulations short, about half as long as wide, granular. Heterocysts nearly globose, yellow.

Diameter of cells or filaments, 6–8 μ.

This plant is evidently very closely related to *Anabœna*; sometimes it has a sheath, but this appears soon to dissipate. *Anabœna cupressaphila* can scarcely be separated from this *Nodularia* except that the former has not, usually, the heterocysts at regular intervals; they are distinct also in habitat. These forms are noted merely provisionally. The *Nodulariae* of Europe occur only in brackish waters and are found in considerable masses; can not be the same plant observed here.

Syn. Earlier authors classified these forms as *Spermosira.*

Plate CXCVIII, figs. 3, 4, after specimens from Colorado and from Pennsylvania.

Genus 98, CYLINDROSPERMUM, Kg.

Thallus like that of *Sphaerozyga*, trichomes sheathless. Heterocysts terminal, single; spores originate in the cell next the heterocyst.

CYLINDROSPERMUM MACROSPERMUM, Kg.

Trichomes curved or nearly straight, pale aeruginous, more or less interwoven; joints globose or elliptic, often mixed with others, somewhat cylindrical; cell contents usually somewhat granular. Heterocysts terminal, globose or slightly oblong. Spores elliptic-oblong, or oblong cylindrical; dark green or yellowish brown, or darker brown when matured; granular, twice as long as broad.

Diameter of vegetative cells, 3–4 μ; heterocysts somewhat larger; spores, about 14 μ.

Syn. *Anabæna impalpebralis*, Hass.; *Cyl. sphaerospermum*, Rab.

Plate CXCIX, figs. 6–8, normal appearance of the filaments; fig. 14, Wood's figure.

In ditches and on wet ground.

CYLINDROSPERMUM LIMNICOLA, Kg.

Filaments slightly curved, pale aeruginous, forming a thin membranous thallus; on garden and other soils in damp, sultry weather; very near the last, but slightly more slender in filaments and spores. Probably merely a variety of the same.

Syn. *Cyl. minutum*, Wood.

Plate CXCIX, fig. 11, cells often very close, with ends compressed, presenting the appearance of *Oscillaria;* figs. 9, 10, after specimens from an almost dried up shallow ditch; many of the spores dropped off; the filaments seem to be true *Oscillaria;* fig. 12, Wood's figure of his *Cyl. minutum.*

CYLINDROSPERMUM FLEXUOSUM, Rab.

Stratum gelatinous, aeruginous, indefinitely expanded; filaments equal, mostly flexuous and interwoven, often circinately or fasciately convulate; sometimes straightish and in bundles; articles oblong, more or less contracted at the joints. Heterocysts subglobose, rarely hirsute; spores oblong-cylindrical, 2–3 times longer than broad, distinctly granular.

Diameter of cells, about 4 μ; spores, about 10 μ.

On dripping rocks, and on wet ground, Pennsylvania.

Cylindrospermum comatum, Wood.

Growing on the ground, forming a gelatinous stratum of an aeruginous color; filaments flexuous, equal, intricate, not spiral; joints shortly cylindrical, equal to or more than twice as long as wide; mostly separated; pale aeruginous, obscurely granular, terminal cells subglobose; spores oblong-cylindrical, about twice as long as wide, granular, yellowish-brown; membrane thick, distinctly granulate.

Diameter of filaments, 3 μ; spores, 10 μ.

There appears to be but little to commend this plant for a new species, but in a supplementary remark the author adds, "The terminal cells are remarkable for being abundantly provided with long, flexible, hair-like processes, upon the ends of which are minute globular bodies. These appendages are so minute as to make it difficult to determine their structure." If these hair-like processes are anything more than the result of the contraction of the gelatinous covering of the cell, they will constitute a good distinguishing feature.

Plate CXCIX, fig. 16, a copy of Wood's figure.

SECTION V.—OSCILLARIEÆ.

Simple filaments with or without sheath, singly or forming extended strata, without heterocysts and without spores, not terminating in a hair-point.

Multiplication takes place, first by *hormogons*, parts of internal trichomes which slide out of the end of a sheath, or which are scattered by the dissolution of the sheath; each small part, consisting of but a few cells, quickly starts a new growth, develops new filaments like the one from which it was separated; this applies particularly to *Oscillaria*, *Lyngbya* and *Symploca;* secondly by means of gonidia developed usually in the cells of the parent plant.

Genus 99, CRENOTHRIX, Cohn.

Filaments distinctly articulate, colorless, surrounded by a gelatinous envelope.

Propagation by means of microgonidia, and macrogonidia; the former developed by the longitudinal division of the cytioplasm into two or three series of cells, and scattered by the diffluence of the sheath; the latter formed in single series in the filaments and ejected.

CRENOTHRIX POLYSPORA, Cohn.

Filaments slightly increased in thickness towards the apices; colorless, or sometimes changed to reddish or ochraceous as the result of incrustation by solutions of iron.

Attached, or floating in small mats.

The only plant of this genus hitherto recognized is near, if not identical with *Hypheothrix Kuehniana*, Rab. It received prominence through Prof. Cohn, 1870, who was interested in the examination of the water-supply of the city of Breslau, Silesia, and wrote a detailed history of the mode of its development. Later, 1879, Dr. Zopf, searching into the causes of complaints of impurities in the water furnished by the city of Berlin, Prussia, took special pains to cultivate this plant, and added more facts relating to its life-history and rapid growth. It was found to prevail to an alarming extent, developing in dark places, in deep wells, in water-mains and in smaller pipes. The peculiar colorlessness, and the gelatinous consistency of the plants, suggest a relationship with some of the forms of filamentous fungi. Cohn and Zopf retain it as an Algæ.

We are not aware that the plant was recognized in this country until recently, 1886. It was found in somewhat limited quantity, near the inlet to Lake Chautauqua, N. Y., whence part of the water-supply to the city of Jamestown is taken.

Plate CCIX, figs. 1–3, a part of a filament with cytioplasm divided longitudinally, turning into microgonidia, and developing in part, from the gonidia before separation from the filament, two groups or clusters of young typical plants; figs. 4–9, macrospores, or resting spores, single, or dividing into two, and these in turn each dividing, and so on, doubling the length of the filament at each division, indicating the process of growth; fig. 10, part of filament under higher magnification showing the arrangement of the cells; figs. 11, 12, cells, macrospores, sliding out of the sheath; fig. 13, microgonidia gather in masses, imbedded in gelatinous mucus, *Palmella*-like; fig. 14, a small *Palmella* mass, gonidia developing into plants; figs. 15–17, three parts of filaments with cytioplasm dividing longitudinally, magnified about 600 diameters; fig. 18, a caespitose cluster as of common occurrence.

Genus 100, CHAMÆSIPHON, A. Br. and Grun.

Short, tubular, parasitic, aeruginous cells with thin, colorless, but distinct sheath.

Propagation by means of one-celled gonidia.

CHAMAESIPHON INCRUSTANS, Grun.

Tubes short, contracted at the base, forming a short stipe; younger plants have apex closed, rounded; later open; sheath indistinct.

Diameter of tubes, about 4 μ; length, 16–17 μ.

In ponds, parasitic on submerged plants.

Plate CC, fig. 3, young plants often thickly clustered, forming an incrustation.

CHAMAESIPHON CONFERVICOLA, A. Br.

Tubes from the base narrow cylindrical, or sometimes slightly swollen, solitary or in clusters.

Diameter of cells, 3–4 μ; length, 25–35 μ.

Parasitic on larger forms of algæ, ponds.

Plate CC, figs. 1, 2.

Genus 101, LYNGBYA, Ag. et Thur.

Filaments enclosed singly in a sheath, simple, or only exceptionally exhibiting the appearance of the beginning of ramification where the trichome issues from the side of the sheath; often combined, forming a membranaceous stratum.

This genus, as it now stands, emended by Thuret, includes all the plants of the genus *Phormidium*, Kg.; *Siphoderma*, Kg.; and the sheathed forms under *Lepothrix*, Kg.; *Hypheothrix*, Kg.; *Amphithrix*, Kg.; *Leibleinia*, Kg.

Propagation takes place by means of hormogons, which slide out of the sheaths; the disc-formed cells, singly or in short series divide and multiply and then develop sheaths, thus reproducing the plant.

Another mode appears to be that the single disc-forms produce gonidia from which spring *Mastigonema*-forms, which develop *Lyngbya* filaments. Compare Plate CLXXVI, figs. 6, 7, 8, and description. Forms like fig. 1, (same Plate) are of frequent occurrence, parasitic on *Lyngbya Wollei*, probably young growths of the plant. Perhaps these statements should be made with some degree of hesitation. Some of the *Mastigonema*-forms have been shown to be young conditions of different varieties of

Phycochromes (*Cyanophyceæ*); it can not therefore be considered incongruous to suppose that the same or similar forms may develop *Lyngbya*; nevertheless more evidence is sought.

A third method of propagation is a direct development of *Anabæna*-forms. See notes under the description of the genus *Anabæna*.

LYNGBYA AESTUARII, Liebm.

Trichomes rigid, flexuously curved, blue green or with age brownish, densely interwoven in aeruginous tufts, or extended strata floating on brackish water, or spreading on moist earth near the sea shores. Joints 3–4 times shorter than their diameter; scarcely constricted; sheaths pellucid, hyaline, becoming brownish; at first scarcely lamellose, later distinctly lamellose.

Diameter of trichomes, 20–28 μ.

Forma MINUS.

Smaller forms on soils with less moisture, but evidently the same species.

Diameter of filaments, 12–15 μ.

Plate CCII, figs. 1, 2, after specimens from Absecom, and Perth Amboy, New Jersey.

Syn. *Lyngbya aeruginosa*, Ag.; *L. curvata*, Rab.; *L. majuscula*, (British Seaweeds.)

In brackish water, abundant near the eastern coast of Jersey.

Plate CC, figs. 11–16, from specimens collected in various places near the coast of New Jersey, and in Florida.

LYNGBYA CINCINNATA, Kg.

Filaments floating in loosely caespitose cluster, or often singly in marshy places; in masses greenish black, often faded, brownish. Trichomes aeruginous, interrupted; articulations short, 3–4–6 to diameter. Older plants distinctly lamellose.

Diameter of trichomes, with sheath, 25–30 μ.

Has much of the appearance of the last, but is purely a fresh-water plant and occurs at high elevations in Colorado; on Mt. Mansfield, Vt., and similar localities.

It is not the plant known by the same name which occurs in ditches and pools, sometimes as a *Scytonema*, sometimes as a *Chrysostigma*, and sometimes assuming the character of a *Lyngbya*. Compare *Scytonema cincinnata*.

Syn. *Calothrix lanata*, Kg.; *Lyngbya discolor*, Krypt. Badens.

Plate CC, figs. 4, 5, after specimen from Mt. Mansfield, Vt.

LYNGBYA MAJUSCULA, Harv.

A marine plant, densely intricate, crisp; trichomes rigid, flexuously curved, frequently interrupted, dull olivaceous or pale steel-color; sheath close, articulations 6–8 to diameter. Sheath distinctly lamellate in older plants.

Diameter of filaments, including sheath, 30–38 μ.

Collected in the vicinity of the City of New York, but it has a wide range.

Plate CC, figs. 9–10, New York specimens.

LYNGBYA WOLLEI, Farlow.

Forms smaller or larger tufts attached to river stones; the more sluggish the water the larger the extent of the growth, even to masses yards in diameter and a foot or more in thickness. Usually brownish black; but when older somewhat faded, more olive or brown or yellowish. Articulation primarily about 4 to diameter, after division 6–8. Sheath firm, and lamellate in older forms.

Diameter of filaments variable, from 40–45 μ to 50–60 μ.

Widely distributed from Massachusetts to Florida, and westward to Minnesota. The largest masses occurred to personal observation, in ponds, New Jersey. In one instance in pond near Stanhope, the floating mass was fully ten yards long, 2–3 yards wide, a foot or more in thickness, and so densely matted, it was impossible to break through with a row-boat.

Plate CC, figs. 6, 7, 8, fragments of filaments which were a foot, more or less, in length.

LYNGBYA VERMICULARIS, (Kg.) Rab.

A marine plant, forming extended floating mucose strata on ponds filled by the flow of high tides. Color dull or dingy tea green, or olivaceous; often faded. Trichomes very unequal in size, flexuously curved, often vermicular, pale aeruginous. Articulations of smaller filaments, 2–4, of larger forms, 6–8 to diameter. Sheaths very thin, not lamellate, often gelatinous, colorless.

Diameter with sheath, very variable in the same cluster, 13–32 μ.

This is a distinct form in the disparity of sizes, some more than twice as thick as others; in the gelatinous strata, and in the thin and close sheaths.

It does not strictly represent the plant of (Kg.) Rab., but has so much in common, have adopted the name for it.

It is near *L. aestuarii*, but separated by the thin and often gelatinous sheaths; in the mixture of sizes of filaments, and color of strata; not deep aeruginous; neither is it sub-membranaceous, as that plant.

The features may be largely characteristic of young developments from *Anabæna*-like filaments, as explained under the description of the genus *Anabæna*.

LYNGBYA PALLIDA, (Naeg.) Kg.

Forming a firm membranaceous stratum, pale rose or darker red color. Trichomes rather straight or slightly curved, subparallel, or sometimes flexuously curved and interwoven; in older condition faded, or yellowish brown. The filaments at first bright aeruginous, but soon change; usually they occur intermixed in color; aeruginous, pink, darker red, yellow, and almost colorless. Articulations equal to half as long as wide. Sheaths ordinarily rather wide, widen with age, finally lamellate and fibrillous.

Diameter with sheath varying from 40–80 μ.

Syn. *Hypeothrix pallida*, (Naeg.) Kg.; *Phormidium pallidum*, Naeg.

Exposed wet soil, old roadways, old meadow grounds, New Jersey, Virginia, Florida, Pennsylvania.

Plate CCII, figs. 26–31, various stages of growth.

LYNGBYA NAVEANUM, Grun.

Occurs in thin strata, dull green, or olivaceous brown. Trichomes dull aeruginous; articulations often indistinct, $\frac{1}{2}$–$\frac{1}{3}$ as long as wide. Sheaths close, but widen with age; firm, colorless. Filaments more or less parallel, internal trichomes frequently interrupted.

Diameter of filaments, with sheath, 15–18 μ.

Marsh grounds, Florida; Crystal Bay, Canada; pools, Pennsylvania.

Plate CCI, figs. 1, 2, from Pennsylvania specimens; figs. 3, 4, Florida specimens.

LYNGBYA OBSCURA.

Free swimming in solitary filaments, but frequently forming a thin dark aeruginous, almost black, stratum. Articulations distinct, $\frac{1}{3}$–$\frac{1}{6}$ as long as wide; primarily bright aeruginous, later some shade of brown. Sheath in younger plants colorless and thin; older plants thicker, yellowish or yellow brown, and lamellate.

Diameter of filaments, 12–18 μ.

Appears closely related to the submarine forms of *L. aeruginosa*, Ag., *L. pannosa*, Kg., and *L. aestuarii*, Liebm., but beside electing fresh-water, it is thinner. According to Kirchner the sheath is often very much wider than has come under my notice. *L. bicolor*, Wood, is the same plant.

Plate CCI, figs. 5–10, from specimens from Bean Lake, Canada; ponds, Vermont; Pennsylvania; New Jersey; Alabama, and Florida.

LYNGBYA PHORMIDIUM, Kg.

Filaments much interwoven, forming mats of considerable size, of dirty aeruginous color; articulations nearly as long as wide, light aeruginous, or turning yellowish brown. Sheaths colorless, moderate in thickness, not lamellate.

Diameter of filaments, 7–9.5 μ.

Syn. *Phormidium Lyngbyaceum*, Kg.; *Symploca phormidium*, Thur.

On wet marsh bottoms.

Plate CCI, figs. 22–26, filaments somewhat variable in thickness.

Var. RIVULARIS, Wolle.

Filaments in larger or smaller tufts, from 1–6 inches long. Attached to river stones in shallow, flowing water, waving with the currents. Filaments often six inches long, the extremities bright blue-green, lower parts changing to yellow-brown or fading entirely, becoming colorless. Articulations usually indistinct, sub-equal in length and width.

Diameter of trichomes, including the narrow sheath, 8–9 μ.

River Lehigh, Bethlehem, Pa.

LYNGBYA ARENARIUM, (Kg.) Rab.

Forming a thin membranaceous stratum, beautiful green, not lamellose, trichomes lightly curved, pale aeruginous. Articulations 3–4 to diameter. Apices of filaments obtuse conical, straight. Sheaths often soft, gelatinous.

Diameter of filaments, 8–10 μ.

Moist low grounds near Atlantic Coast.

Plate CCI, figs. 27–29, specimens from New Jersey, near Atlantic City.

LYNGBYA RUPESTRE, (Ag.) Kg.

Stratum compact, rather velvety, gelatinous, shortly radiating, bright blue green, or becoming dark steel blue, the lower strata becoming discolored and fibrillose; trichomes rigid, rather flexuous, a little torulose towards the apex; articulations equal, or nearly equal in length and breadth; very finely punctate, extreme apex paler or colorless.

Diameter of filaments, 7–8 μ.

Syn. *Phormidium rupestre*, Kg.; *Oscillaria rupestris*, Ag.

Plate CCII, figs. 5–8, from specimens collected by J. D. Smith, on rocks, falls of Deep Creek, Maryland.

LYNGBYA SUBTORULOSA, (Breb.) Wolle.

Forming a firm, aeruginous-steel color, membranaceous stratum; trichomes rather straight, subtorulose, pale aeruginous; articulations nearly equal in length and breadth, the joints somewhat contracted and hyaline. Sheath firm, granulate and mucose.

Diameter of filaments, 7–8 μ.

Syn. *Phormidium subtorulosa*, Breb.; *Ph. lacustre*, Naeg.

From moist grounds, Florida.

Plate CCII, figs. 3, 4, Florida.

LYNGBYA MEMBRANACEA, (Kg.) Thur.

Forming a firm leather-like expanded stratum, blackish brown or olivaceous color. Filaments distinctly articulate. Articulations before division as long or one-half longer than wide; light aeruginous or light brown; end cells slightly attenuate, sheath colorless and thin.

Diameter filaments, 4–9 μ.

Kirchner finds two forms which he denominates—*genuina* and *inaequalis*. The former, with filaments of nearly uniform thickness; the other very variable in size.

Syn. *Phormidium membranaceum*, Kg.

Collected by F. Hosford, Charlotte, Vermont.

Plate CCI, figs. 11–13.

LYNGBYA VULGARIS, (Kg.) Kirch.

Stratum thin, more or less expanded, mucilaginous, dark steel blue, purplish, olive, brown or turning yellow, opaque or shining; by age becoming thickened; trichomes straight, rigid, distinctly sheathed, joints as long as broad or shorter;

dissepiments delicately granulated, apex somewhat attenuated, now and then somewhat curved.

Diameter of filaments variable, 5–9 μ.

Kirchner makes the following four of Kuetzing's species, forms of *Lyn. vulgaris*, viz.:

Myochroa, Kg., stratum blue-black; *fusca*, Kg., stratum dark-brown; *lutea*, Kg., stratum yellow-brown; *publica*, stratum aeruginous.

Syn. *Phormidium vulgare*, Kg.; *Oscillaria autumnalis*, Eng. Fla.; *Conferva decorticans*, Dillw.; *Oscillaria decorticans*, Grev. Fla. Edin.; *Humida decorticans*, Gray.

Frequent on moist soil from Maine to Florida.

Plate CCI, figs. 14–20, parts of filaments from various localities.

LYNGBYA JULIANA, Menegh.

Fasciculately caespitose, blackish green, dull violaceous or pale steel color; more or less radiating; trichomes somewhat flexuously curved; internally frequently interrupted; articulation $\frac{1}{2}$–$\frac{1}{3}$ as long as wide; apices attenuated, straight, obtuse.

Diameter of filaments, 5–6 μ.

Syn. *Phormidium Julianum*, Rab.

Sandy soil, somewhat influenced by marine waters, Florida; Alabama.

Plate CII, figs. 20, 21.

LYNGBYA TINCTORIA, Kg.

Forming a purple stratum; or dried, violet steel; substratum membranaceous, lamellose, faded. Trichomes fasciculately congested, long, waving; apices more or less attenuated; articulations primarily twice as long as wide, later subequal; cytioplasm granulate aeruginous.

Diameter of filaments, 8–9 μ.

This properly represents a river plant of Sweden and Norway. It has much in character with our *L. Phormidium*, var. *rivularis*. The plant here represented is from Arizona and was identified from a dried specimen, having for guide merely diameter of filaments, length of cells, and color. Needs farther observation.

Plate CCII, figs. 22, 23, filaments from Arizona specimen.

LYNGBYA CATARACTA, (Rab.) Wolle.

Forms a thick, firm gelatinous, extended stratum, measuring one-half inch, more or less, in thickness; pachydermate membranaceous, bluish-green, velvety; trichomes slightly curved, articulations shorter than the diameter. Apices straight, obtuse or rarely barbed.

Diameter of filaments, 3–3.5 μ.

Syn. *Phormidium cataractum*, Rab.

Frequent at waterfalls, mill dams, etc., sometimes in cushion-like masses, two or more inches in thickness; ordinarily not so thick, but 6–12 inches in extent.

Plate CCII, figs. 18, 19, from a Pennsylvania specimen.

LYNGBYA RETZII, (Ag.) Kg.

Stratum broadly expanded, rather compact, green-black or deep olive, shining, parts changing to brownish, shortly radiating; trichomes rather straight, bright aeruginous, indistinctly articulate; articles about half as long as wide; apices slightly attenuated, obtuse, straight.

Diameter of filaments, 4–5.5 μ.

Syn. *Oscillaria Retzii*, Ag.; *O. laevigata*, Vauch.; *Phormidium Retzii*, Kg.

Wet soil, South Carolina; wet rocks, Charlotte, Vermont.

Plate CCII, figs. 15–17, from marsh grounds.

LYNGBYA PAPYRINA, (Kg.) Kirch.

Stratum thin paper-like, sometimes shortly radiating, with a pallid or brownish fibrillose substratum, formed from the interlaced empty sheaths; trichomes equal, joints nearly equal or a little shorter than their diameter; granulated at their junction, apex obtuse, straight.

Diameter of trichomes, 5–7 μ; with sheath, 7–9 μ.

Syn. *Oscillaria papyrina*, Bory; *Phormidium papyrinum*, Kg.; *Ph. papyraceum*, Rab.; very near also to *Lyngbya vulgaris*.

Plate CCII, figs. 9–11, specimen from the vicinity of New Haven, Connecticut.

LYNGBYA INTERRUPTA, (Kg.)

Forming a membranaceous, aeruginous-green, mucous stratum, scarcely radiating; substratum somewhat membranaceous, decolored; trichomes flexuously curved, yellowish green, interrupted; sheath continous firm; articulations half as long as wide, homogeneous or finely granulate at joints; apices straight, obtuse.

Diameter, 5–7 μ.

Plate CCII, figs. 12–14, specimen from Charlotte, Vermont. Habitat not furnished by the collector.

LYNGBYA INUNDATA, Kg.

Stratum deep blue green, with a whitish grumous membranaceous substratum; trichomes curved, rather rigid, pale blue green, rarely fasciculate, sheaths narrow, joints shorter than their diameter, dissepiments not granulated, extreme apex straight, obtuse.

Diameter of filaments, 4 μ.

Syn. *Phormidium inundatum*, Kg.; *Oscillaria autumnalis*, Carm.

Margins of wayside ditches and the like.

Plate CCII, figs. 24, 25. Not infrequent.

LYNGBYA OCHRACEA, (Kg.) Thur.

See *Leptothrix ochracea.*

LYNGBYA MURALIS, Ag.

Filaments somewhat rigid, thickish, tortuous, very long, interwoven into a bright, grass-green stratum, annuli strongly defined. See *Ulothrix murale.*

This plant, originally classified (1824) as a *Lyngbya*, does not, by the term *grass-green*, belong to this division of algæ. It is evidently a *Ulothrix*, and was so acknowledged by Kuetzing. He called it *Hormidium murale.* Nearly all of Agardh's other species were identified by Harvey (1857), and obtain at this time; they are marine plants and hence not quoted here.

Genus 101, SYMPLOCA, Kg.

Trichomes articulate, simple or only exhibiting the beginning of ramification, more or less distinctly sheathed, ascending from a prostrate base, agglutinated together in erect or anastomosing fascicles or wick-like clusters, often involved in a matrical gelatin.

SYMPLOCA LUCIFUGA, Harv.

Dark aeruginous green, or more frequently dark olive, fascicles 3–4 *mm* high, approximate, subuliform; apex at length pennicillate; trichomes single or twin in a sheath, aeruginous; articulations equal or a little longer than broad, granulate; sheaths broad, pellucid, colorless, smooth, soon disappearing.

Diameter of trichomes, 3–4 μ; including sheath, 8 μ.

Syn. *Oscillatoria lucifuga*, Hass.; *Calothrix lucifuga*, Carm. MSS.

Not infrequent on shaded clay banks; affects cooler weather; Pennsylvania and New Jersey. No doubt widely distributed.

Plate CCV, fig. 8, two vertical fascicles greatly magnified; figs. 9, 10, natural size and usual growth; figs. 11, 12, single filaments in sheath.

SYMPLOCA FRIESIANA, (Ag.) Kg.

Stratum dull green or blackish, composed of vertical, subuliform fascicles, 10–15 *mm* high; trichomes pale blue-green, distinctly articulated; articles about as long as wide. Sheaths rather wide, colorless.

Diameter of trichomes, 4–6 μ; with sheath, 8–12 μ.

The only habitat for this species was discovered by Colonel Macoun, on old wood, Canada.

Plate CCV, fig. 13, a caespitose cluster; figs. 14, 15, two single filaments. The trichomes are often twin in a sheath.

SYMPLOCA FUSCESCENS, Kg.

On earth and stones, aeruginous, changes to dull yellowish or brown. Trichomes with age pale olive or yellow-aeruginous. In every respect very near *S. lucifuga*, except in size; fascicles only 2 *mm* high.

Diameter of trichomes, 2–3 μ.

Plate CCV, figs. 8–12, drawn for *S. lucifuga*; for the present plant, one-half the dimensions may be imagined. Probably it is a mere form of former.

Genus 102, MICROCOLEUS, Desm. et Thur.

Trichomes similar to *Lyngbya*, but two or more, and often many included in a sheath, which is primarily closed at the end; later it opens and sometimes divides into shreads. Sheath ample, colorless, rarely indistinct. Have included under this genus *Chthonoblastus*, Kg.; *Hydrocoleum*, Kg.; *Dasygloia*, Thwaites.

MICROCOLEUS (DASYGLOIA) AMORPHA, (Thwaites) Wolle.

Forming a thin gelatinous membrane on dripping rocks, amorphous; sheaths of the trichomes at first thin, then more gelatinous and thicker, cohering. Internal trichomes aeruginous, slender, simple. Sheath variable with age. First barely discernible, then twice the diameter of the trichomes.

Most frequently only one in a sheath, but sometimes two or three.

Diameter, without sheath, 10–13 μ.

Unlike the European, "coalescing in a solid gelatinous mass as large as a swan's egg;" this plant forms a thin, olive, or dark aeruginous green membrane, skin-like, on trickling rocks, Glen Onoko, Pennsylvania. Have gathered it here, always in the same condition, a number of successive summers.

Syn. *Dasygloia amorpha*, Thwaites; *Microcoleus variecolor*, Kirch.; *Schizothrix variecolor*, Rab.

Plate CCIV, figs. 1, 2, several simple filaments; figs. 3–6, young plants spirally coiled, gradually opening as they develop into forms as figs. 1, 2; figs. 7, 8, 9, sheaths with one or more trichomes included.

MICROCOLEUS PULVINATUS, Wolle.

Thallus large cushion-like, often 6–8 or more inches in diameter; about two inches thick, somewhat hollow in the center; dark olive brown; gelatinous membranaceous; readily lifted from the water without breaking. Trichomes one, two or three in a sheath.

Diameter of trichomes, 5–6 μ; sheaths, 12–20–30 μ.

The thalli, of all possible sizes from one to ten inches in diameter, are attached to stones and grasses, looking like boulders in the bottom of a mill race with rapidly running water; Bamber, New Jersey. This peculiar growth occurred on repeated visits to the locality in different years.

Plate CCIV, figs. 13, 14, two small thalli; figs. 10–12, sheaths with one, two, and three trichomes.

MICROCOLEUS TERRESTRIS, Desm.

Stratum more or less expanded, deep blue-green, or steel blue, or changing to olive and then to a brownish red; membranaceous, mucilaginous; trichomes equal, collected in filiform fascicles, sometimes much elongated, extruding from the opening of a common sheath in a penicillate manner, articulations equal in length and breadth. May be divided into two varieties, viz.:

1. *repens*, Kg., trichomes, 5–6 μ in diameter, ends of sheath open.

2. *Vaucheri*, Kg., trichomes, 4–5 μ, ends closed or torn.

Syn. *Chthonoblastus repens*, Kg.; *Microcoleus repens*, Hass.; *Vaginaria vulgaris*, Gray; *V. chthonoplastes*, Grev.; *Chthonoblastus Vaucheri*, Kg.

Plate CCV, figs. 16, 17, var. *repens.*

Plate CCIII, figs. 7, 8, 9, var. *Vaucheri.*

MICROCOLEUS ANGUIFORMIS, Harv.

Stratum thin, skin-like, aeruginous; trichomes flexuous, often twisted in dense fascicles; articulations nearly twice as long as wide, sometimes indistinct; often attenuated near the apices, special sheath very delicate; universal sheath narrow, thin, colorless, ends open.

Diameter of trichomes, 3.5–4; fascicles, 30–40 μ or more.

Syn. *Chthonoblastus anguiformis*, Kg.; *Ch. lacustris*, Rab.; *Mic. chthonoplastes*, Thur.

Both affect moist earth, borders of pools and the like.

Plate CCV, fig. 1, a peculiar coil from small pool, Atsion, New Jersey. Plate CCIII, figs. 5–9, different conditions which represent alike the present and the preceding species (*M. terrestris*). When the trichomes measure 3.5–4.5 μ, the plant is recognized as of the present species, and when they measure 5–6 μ, it would be termed *M. terrestris.* They run together, and are often not separable.

MICROCOLEUS GRACILIS, Hass.

Thallus membranaceous, skin-like, expanded, green, aeruginous, or with age dark olive green, blackish. Trichomes many included in a general sheath, which is usually wide, yellow or colorless, articulations variable, one to three times as long as wide.

Kirchner suggests three varieties. *viz:*

Var. SALINUS, Kg.

Thallus thin, blackish green.

Var. LYNGBYAI, Rab.

Thallus bright aeruginous, often lamellose.

Var. AERUGINEUS, Rab.

Diameter of trichomes, 2.8–3 μ; general sheath of fascicles often 140 μ.

Syn. *Microcoleus marinus*, Harv.; *Chthonoblastus salinus*, Kg.; *Oscillatoria chthonoplastes*, Eng. Bot.

Plate CCIII, figs. 10, 11, from specimens from swamps, Dakota.

Microcoleus hyalinus, (Kg.) Kirch.

Stratum pale aeruginous, thin, sometimes encrusted, expanded, also in solitary fascicles among other algæ. Trichomes slender, single, or a few in a sheath; articulations about as long as wide, light aeruginous, sheaths comparatively wide, colorless, hyaline; often divided at the ends leaving the impression of a branched filament.

Diameter of trichomes, 1–1.5 μ; sheaths, 7–10 μ.

Syn. *Schizothrix hyalina*, Kg.

Plate CCIII, figs. 3, 4, specimens from wet ground, South Carolina, from ponds New Jersey, on *Sphagnum;* wet rocks, Pennsylvania, etc.

Not infrequent, but question whether it is a normal, vegetative condition of a plant. Has the appearance of a faded, dried and contracted form. Measures are often considerably more than quoted, but the character of the plant remains the same.

Microcoleus Ravenelii, Wolle.

Forming a stratum on old pasture grounds, dark violet or aeruginous. Trichomes of equal thickness, solitary, or two or three somewhat twisted, in a common sheath, aeruginous, changing to golden brown or chestnut color. Sheaths of younger plants close and colorless; of older plants thicker and firmer, of golden brown color, lamellate; ends usually empty and coming to a sharp point; articulations subequal, or two to three to a diameter, distinct.

Diameter of trichomes, 12 μ; with sheath, about 15 μ; sheaths with two or more trichomes proportionately wider.

Plate CCIII, figs. 12–14, specimens from pasture grounds near Houston, Texas, collected by H. W. Ravenel.

This form is nearest *Hydrocoleum Brebissonii*, Kg. But beside being a larger plant it affects moist ground, not flowing river waters.

Microcoleus heterotrichum, (Kg.) forma Americana, Wolle.

Forms a dense gelatinous stratum on large, partially submerged, stones in swamps; deep olive black; trichomes more or less twisted; two forms in the same sheath. Primarily the diameter of the main internal trichome is 12–14 μ; with sheath, 18–20 μ; later the sheath widens to 25–38 μ; then more slender moniliform trichomes become evident, entwining the larger one. The diameter of the smaller ones is 3.5–4 μ. Color of larger trichome aeruginous granular; smaller ones the same as sheath, which is light yellow to brownish red, smooth when young, becomes fibrillose with age.

Syn. *Hydrocoleum heterotrichum*, Kg.; *Inactis homœotricha*, (Kg. Thur.) Kirch.

Plate CCV, figs. 2, 3, two younger filaments; fig. 4, an older filament showing the two forms of trichomes; sheath smooth; fig. 5, more advanced in age, the sheath becomes lamellate and fibrillose.

From swamp near Bethlehem, Pa.

Genus 103, OSCILLARIA, Bosc.

Filaments straight, or slightly curved, rarely circinate and spirally convolute except in very young condition; branchless and without a discernible sheath. Color mostly bright aeruginous, but often changes to violet or steel blue. All, in good vegetative state, are more or less motile and involved in a thin matrical mucilage; joints disc-shaped in front view.

The mystery of the oscillating and creeping movements of the *Oscillaria* has evoked many theories, but none, hitherto, have received a general approval. Some of the most recent thoughts come from Dr. A. Hansgirg, Professor in the Royal University of Prague, several of which we quote, before adding a simple idea of our own, and that perhaps not quite original. His first experiments were made to obtain the relationship of the movements to light. The filaments of *Oscillaria Froelichii*, placed in complete darkness were found to have lost on the second day their mucilaginous envelope and to have sunk to the bottom of the vessel. The twisting and creeping movements, however, continued until the seventh or eighth day, becoming gradually weaker. The more sensitive filaments of *O. aerugineo-coerulia* lost their power of motion more rapidly.

In direct sunshine the movements were more lively than in diffused day-light. An increase of temperature of the water also promoted the rapidity of the movements.

The separate filaments of the same cluster move with different degrees of rapidity, depending not only on the warmth and light but also on the age of the filament. The quality of the water, whether river, spring, or stagnant water has also an effect.

The twisting, oscillating or nodding movements, the author believes to be due, not to their growth, but to osmotic changes in the cell contents. The creeping movements, he holds, can not be due to protrusions of the internal protoplasm, since each filament is enveloped in a gelatinous sheath, which is not composed of protoplasm. The cells also exhibit motion when the envelope itself is at rest. The movements must originate in the protoplasmic contents of the cells themselves and are probably of the same nature as those of the sarcode in the so-called *pseudo*-podia of rhizopods and other protozoa."

Life, whether vegetable or animal, is a mystery to the philosophic mind; to attempt a detailed explanation of cause and effect would be presumptuous, but a remark or two may not be out of place. By the careful observation of living plants the process of cell-multiplication can be readily detected in the larger forms. Ordinarily the split of a cell commences on one side and then continues from the opposite side; a number of cells dividing at the same time will have the tendency to throw the end of filament out of line, first on one side and then on the other, thus producing the vibratile motion. The process of creeping may be conceived in connection with growth, and yet it may not satisfactorily explain every movement. The apparent correspondence between the rapidity of growth, and that of the creeping filaments is not without significance. Larger forms of *Oscillaria* are found to grow by cultivation at the rate of about one-half inch in an hour. The creeping of the same filaments progresses at the same rate, age of the filaments and other circumstances corresponding, hence the reasonable inference of relation between the two movements.

A.—Articulation of filaments often indistinct.

OSCILLARIA SUBTILISSIMA, Kg.

Filaments often solitary, but also forming a yellowish green stratum, sometimes convolute; cell contents light yellow-green.

Diameter of threads, 1–1.5 μ.

Not infrequent on wet, marsh grounds.

Plate CCVI, fig. 1.

OSCILLARIA TENERRIMA, Kg.

Filaments thicker than the preceding; ends somewhat attenuated and bent; cell contents light aeruginous or with tendency to olive.

Diameter, 1.8–2.5 μ.

In ditches, among decayed vegetable matter.

Plate CCVI, fig. 2.

OSCILLARIA DETERSA, Stiz.

Forming reddish olive, diffused strata; trichomes rather rigid, densely intricate, oscillating freely; slightly curved, rufescent; articulation distinct or indistinct, equal to one-half longer than the diameter; apices somewhat bent, obtuse.

Diameter, 2 μ.

Stagnant waters, Rochester, New York.

OSCILLARIA AMPHIBIA, Ag.

Filaments straight, forming a membranous stratum, light green, apices obtuse, straight, vibrating actively, articulation equal or subequal; cell contents light blue-green.

Diameter of trichomes, 1.8–2.8 μ.

Coating wood subject to hot waste water from steam engines.

Plate CCV, fig. 3, from hot water, temperature of about 110° Fahrenheit.

B.—Articulations about as long as wide.

OSCILLARIA ELEGANS, Ag.

Filaments slender, straight or slightly curved, forming a dense floating stratum; threads radiating, bright aeruginous green, or with age somewhat olivaceous; apices attenuated, curved. Articulations about equal in length and breadth; cell contents light aeruginous, finely granular or homogeneous.

Diameter of filaments, 2.8–3 μ; rarely 3.5 μ.

Plate CCVI, fig. 4, from specimens floating on spring water; also attached to water grasses.

OSCILLARIA ANTLIARIA, Juerg.

Thallus gelatinous, broad, submembranaceous, dark steel blue or turning to olivaceous; filaments rather rigid, straight, often tranquil, sometimes oscillating, curved at the attenuated apex, articulations indistinct, about as long as wide; cell contents pale steel-blue; nearly homogeneous.

Diameter of filaments, 4.5-5.5 μ.

Syn. *Oscillaria parietina*, Vauch.; *O. autumnalis*, Kg.

Around pumps, cisterns, etc.

Plate CCVI, fig. 8, rather frequent.

Oscillaria chlorina, Kg.

Sometimes swimming on the water as a dirty greenish stratum, sometimes diffused in the water; filaments straight, actively moving, either articulated and having the cytioplasm filled with blackish granules, or else neither articulate nor granulate; cytioplasm hyaline, almost colorless, or with a faint greenish tint; ends of filaments straight, obtusely rounded; joints about equal to the diameter.

Diameter of filaments, about 3 μ.

Collected by Dr. H. C. Wood, on brick-ponds, near Philadelphia.

Oscillaria gracillima, Kg.

Trichomes straight, curved and sometimes coiled, solitary, or forming a thin membranaceous stratum. Threads obtusely rounded at the apex, often bent. Cell contents light aeruginous, articulations not always distinct, about as long as wide.

Diameter of filaments, 2.7–3.2 μ.

Plate CCVI, fig. 6, from specimen floating on pond.

Oscillaria leptotricha, Kg.

Trichomes scattered, or collected in a very thin blue green stratum, slender, slightly curved, indistinctly articulate, joints twice as long as wide, or after division equal; very minutely punctate at the periphery; attenuated at the ends, which are straight, curved or deflexed; cell contents pale blue, or green.

Diameter of threads, 3 μ.

Plate CCVI, fig. 7, filaments collected in ditches of brackish water, New Jersey. Prevails in fresh-water also.

C.—Articulation one-half as long as wide.

Oscillaria violacea, Wallr.

Filaments long, straight, radiating, forming a gray-violet membranaceous stratum, ends of filament somewhat reduced, and often drawn out to a thin point; articulations $\frac{1}{2}$–$\frac{1}{4}$ to diameter, which is, 4–4.7 μ.

Most frequent in green-houses.

Plate CCVI, fig. 10.

Oscillaria aerugineo-coerulea, Kg.

Forming a submembranaceous, mucous stratum, bright blue-green; filaments long, nearly straight, radiating, oscillating, articulations as long or half as long as the breadth; dissepiments finely granulate; apices obtuse or slightly attenuate; cell contents bright aeruginous.

Diameter of filaments, 4–5 μ.

Plate CCVI, fig. 9, not infrequent in stagnant or sluggish waters.

OSCILLARIA CRUENTA, Grun.

Filaments light aeruginous imbedded in gelatinous masses which are hyaline or somewhat tinted with green or purple. Filaments primarily closely coiled, but soon unroll, remaining somewhat tortuous. Articulations often indistinct; after division about one-half longer than broad.

Diameter of trichomes, 5 μ, a little more or less.

Plate CCVII, figs. 1–3, parts of ordinary trichomes; figs. 4–7, young coiled trichomes.

Plate CCVI, fig. 5, parts of filament of a gathering of a previous season, varying from 4–6 μ.

Unlike usual forms of *Oscillaria*, this was gathered several successive years (1882—1885) imbedded in large submerged, almost hyaline, firm, gelatinous masses of irregular form, averaging about the size of a man's head. These occurred in a mountain spring at about 1500 feet elevation. Beside the filaments, there are scattered through the masses spherical cells by twos and by fours, constituting them *Tetraspora gelatinosa*, Desv. An effort to identify a relationship between the filaments and the *Tetraspora* cells was not successful, although there is a striking similarity in the purplish tint of the two.

OSCILLARIA SUBFUSCA, Vauch.

Forming a somewhat dense stratum, dark olive or nearly black, short rayed. Filaments nearly straight, with ends sometimes attenuated and furnished with two short cilia. Articulations, ½–1 times as long as wide. Cell contents light aeruginous.

Diameter of filaments, 4.6–6.6 μ.

Plate CCVI, figs. 11–13, several varieties of filaments.

OSCILLARIA BREVIS, Kg.

Forms a thin, aeruginous stratum, filaments longer or shorter, somewhat attenuated near the ends, and slightly bent; cells $\frac{1}{3}$ or $\frac{1}{2}$ as long as broad; cell contents bright aeruginous.

Diameter of filaments, 4.5–5 μ.

Plate CCVII, fig. 8, filaments from an extended stratum on a shaded deposit of mud after an inundation; Buffalo, New York.

Oscillaria tenuis, Ag.

Forming a bright green or aeruginous or with age brownish stratum, short or elongate, radiating; filaments straight, rather rigid, more or less endowed with active motion; articulations usually distinct, half as long as broad or before division twice this length; apex slightly attenuated, obtuse, curved or straight; cell contents light or darker aeruginous, finely granular.

Diameter of filaments, 5.5–6.5 μ.

Syn. *Oscillaria viridis*, Kg.; *O. contexta*, Carm.; *Oscillatoria tenuis*, Hass.

Rabenhorst quotes nine varieties of this species, depending mostly on color of stratum, habitat, length and diameter of cells, but all comprehended in the diagnosis above.

Dripping mossy rocks, pools, margins of ponds or free swimming.

Plate CCVI, fig. 14, sample of filaments which make up the stratum.

Oscillaria Cortiana, (Pollini) Kg.

Forming dark aeruginous extended, floating strata on hot water, 110–120° Fahrenheit. Dries with a bright luster. Filaments straight, fragile, apices slightly attenuated, obtuse; articulations equal or subequal; three to five end joints somewhat curved; cell contents light aeruginous, granular.

Diameter of filaments, 6–7 μ.

Plate CCVI, fig. 15, from specimens found in quantity floating on hot waste-water at a large steam mill, near Bethlehem, Pa.

Oscillaria limosa, Ag.

Affects limous grounds and forms an extended, thin, mucilaginous, radiating green stratum; filaments rigid, straight, actively oscillating, aeruginous or with age olive or brownish; articulations usually as long as wide, but later only half as long; apex obtuse, straight or curved, cell contents light aeruginous, homogeneous or slightly granular.

Diameter of filaments, 6–7.75 μ; more rarely 8–9 μ.

Syn. *Conferva limosa*, Roth; *Oscillaria Adansonii*, Vauch.; *O. tenuis*, var. *limosa*, Kirch.

Rabenhorst enumerates ten varieties, differing chiefly in color; as *laete aeruginosa*, Kg.; *rufa*, Kg.; *fuscescens*, Rab.; *chalybea*, Kg.; *subfusca*, Kg.; *amethysteo-chalybea*, Kg.; others in form and habitat, as *uncinata*, Ag.; *fontana*, Kg.; *animalis*, Kg.; and *circinate*, Rab.

Plate CCVI, fig. 16, merely a few ends of trichomes of which thousands are interlaced to compose a stratum as usually observed on moist, muddy soils.

Oscillaria natans, Kg.

Filaments often interwoven into a bright aeruginous stratum, but more frequently, (var. *cryptarthra*, Kg.,) solitary and long, twining around water plants; or free swimming in ponds of quiet waters; ends of filaments somewhat attenuated, apices obtuse. Articulations distinct, nearly as long as wide, more rarely only half as long. Sometimes slightly contracted at the joints. Cell contents light aeruginous or changing to olivaceous.

Diameter of cells, 6.5–8.2 μ.

Plate CCVI, fig. 19, parts of filaments, frequent in many ponds of New Jersey.

Oscillaria chalybea, Mertens.

Free swimming, long radiating; stratum broadly expanded, obscure blue-green or steel blue color. Filaments pale steel blue, changing to olivaceous, lightly flexuous; articulations distinct $\frac{1}{3}$–$\frac{1}{4}$ as long as wide; ends of filaments somewhat curved, apices usually obtuse, rarely rostellate. Cell contents light steel blue; granulate.

Diameter of cells, 7–8 μ.

Plate CCVI, figs. 17 and 21, fragments of filaments collected from wet grounds, Florida.

Oscillaria anguina, Bory.

Stratum thin, membranaceous, green or dark blue-black, filaments thicker than the last, straight or curved; cells usually about half as long as wide, slightly contracted at the joints; contents light aeruginous; apices bluntly rounded.

Diameter of filaments, 9–11 μ.

Our plants are nearest, var. *dulcis*, Kg. This diagnosis includes also *O. subsalsa*, Ag.

Plate CCVI, fig. 18, three parts of filaments from a gathering made in Florida.

OSCILLARIA NIGRA, Vauch.

Stratum more or less compact, ample, broad, mostly floating, but frequent also on planks surrounding ponds and on wet earth; blackish green with long radii. Trichomes straight or slightly curved, obtusely rounded, or more rarely attenuated and sometimes bearded. Color of articulations usually blackish blue, or dilute black; length same as breadth before division; later ½ or ⅓ as long as broad; dissepiments usually distinctly granular.

Diameter of filaments, 9–10 μ.

Plate CCVI, fig. 20, one of our most common forms.

D.—Articulations less than half as long as wide.

OSCILLARIA PERCURSA, Kg.

Trichomes solitary, scattered, or united, forming a thin stratum, blue-green; filaments radiating, straight or curved at the apices; dried filaments longitudinally plicate. Articulations ⅓–¼ as long as broad, here and there interrupted; dissepiments distinctly, ornately granular; cytioplasm dilute aeruginous.

Diameter of cells, 15 μ, or slightly more or less.

Plate CCVI, figs. 22, 23, four parts of trichomes from a collection made in Central Florida.

OSCILLARIA FRŒLICHII, Kg.

Stratum dark steel blue, or dark olive green, often elongated, radiating, opaque, shining. Trichomes nearly straight, even, not attenuated; cells 2, 3, or 4 times shorter than the diameter, after division 6–8 times shorter; aeruginous, brown or green.

A frequent and variable species.

The following have been suggested as varieties:

1.—Var. *genuina*, Kirch. Stratum dark aeruginous; filaments with ends nearly straight; diameter 15–18 μ.

2.—Var. *viridis*, Zeller. Stratum green, diameter 15 μ; ends somewhat curved.

3.—Var. *dubia*, Rab. Stratum bright aeruginous, diameter of filaments, 13 μ, ends straight.

4.—Var. *ornata*, Rab. Stratum dull steel blue; diameter of filaments, 10 μ.

5.—Var. *fusca*, Kirch. Very dark olive brown, cell contents olive green, otherwise like first form.

6.—Var. *caerulea*, Kg. Trichomes light blue.

7.—Var. *violascens*, Rab. Stratum dark steel blue, shining; trichomes beautiful violet steel, articulations 2–4 to diameter.

8.—Var. *neglecta*, Wood. Near the latter. Filaments dilute purplish lead color, or leaden-gray. Stratum blackish purple.

Plate CCVII, figs. 9, 10, from forms most frequent. Common on sluggish waters, pools, and the like.

OSCILLARIA MAJOR, Vauch.

Stratum aeruginous or dark steel blue. Filaments thicker than the preceding, straight, ends slightly attenuated; cells $\frac{1}{4}$–$\frac{1}{3}$ as long as wide, with ends bluntly rounded; contents steel blue.

Diameter of filaments, 19–22 μ.

Plate CCVII, figs. 11, 12, specimens from borders of ponds and pools.

OSCILLARIA GRATELOUPII, Bory.

Stratum aeruginous, long radiating; trichomes nearly straight, subfragile, unequal in diameter; thicker filaments, 18–20 μ. Articulations $\frac{1}{3}$–$\frac{1}{4}$ as long as wide; dissepiments ornate, with usually two series of granules. Ends of filaments straight, broadly rounded.

Only habitat hitherto observed, vicinity of New York City, submarine waters.

Plate CCVII, figs. 13–15, various sizes as they were found intermingled.

OSCILLARIA BONNEMAISONII, Crouan.

Stratum more or less extended, dark aeruginous or olivaceous; filaments long radiating, dark aeruginous, flexuously curved, interwoven; articulations one-fourth to one-fifth as long as wide, dissepiments distinctly granular, ends attenuated, curved, apex rounded.

Diameter of filaments, 23–28 μ.

Wet soil, recently inundated, Pennsylvania.

Plate CCVII, figs. 16, 17, two ends of motile filaments.

Oscillaria littoralis, Carm.

Stratum thin membranaceous, aeruginous, shortly radiating; filaments rigid, endowed with active motion, vividly oscillating; articulations 4–5 to a diameter; dissepiments granular; ends straight, broadly rounded; light aeruginous.

Diameter of trichomes, 12–15 μ.

Salt water marsh pools, New Jersey, Florida, and probably along the whole Atlantic Coast.

Plate CCVII, figs. 18, 19, two parts of trichomes, from New Jersey.

Oscillaria princeps, Vauch.

Stratum aeruginous or dark blackish green, long rayed; trichomes straight or slightly curved, somewhat thinner towards the ends, apices broadly rounded; articulations one-fourth to one-fifth as long as broad; cell contents steel-blue.

Diameter of filaments, 30–45 μ.

Syn. *Oscillaria taenivides*, Bory; *O. aeruginea*, Mart.

Pools and ponds.

Plate CCVII, figs. 20–22, specimens of usual appearance.

Oscillaria imperator, Wood.

Occurring in an olive-black, mucous stratum, mostly swimming; with long rays; trichomes straight or straightish, light green or deep olive, tranquil, or oscillating slowly; moving with a gliding motion. Ends somewhat attenuate, broadly-sub-truncate at the apices, slightly curved; articulations 6–12 times shorter than the diameter, slightly contracted at the joints; cytioplasm homogeneous, olive green; sometimes granular.

Diameter of trichomes, normal form, 50–56 μ; smaller forms, 38–45 μ.

The principal distinction between this species and the preceding (*princeps*) is in the articulation which is very variable; the former averages 4–5; the present 9 to diameter. The diameter is more also.

Frequent in ponds and pools from Maine to Florida.

Plate CCVIII, figs. 3, 4, the typical form; figs. 1, 2, a smaller variety; articulation, 6–10 times shorter than broad.

Genus 104, BEGGIATOA, Trevis.

Filaments simple, slender, like *Oscillaria*, vibrating (?) cell contents colorless.

The plants of this genus are of doubtful value. The filaments are usually clustered and attached, color dull white, or glossy silver or chalk white. They are found in sulphurous waters; abounding in localities like Clifton Springs, New York; Sulphur Springs, Niagara; Glen Cove Springs, Florida; artesian wells, Florida, and probably more or less in all sulphur springs. The same plants in fresh-water springs would be classed as *Leptothrix*. The white appearance is abnormal, produced by the chemical action of the sulphur water. Normally the filaments are without distinct transverse divisions; in younger stage, light aeruginous, or light yellowish brown; after a longer subjection to the action of the sulphur in the water the color disappears, and the filaments become silver white. The cytioplasm loses its vitality, becomes opaque, white to the unaided eye, but black under the microscope, because it does not transmit rays of light; in this condition it contracts lengthwise, breaks into short sections, equal or subequal to twice as long as wide, producing a semblance of articulation.

The chemical effect of sulphur springs is to destroy colors, acting as a bleaching agent; it does not affect all colors equally. Chlorophyl green plants are not usually changed by it, neither decided aeruginous colored plants, as *Oscillaria*.

Rabenhorst describes ten or twelve European species of BEGGIATOA, of which we identify only two forms; these we retain as representatives of the genus, although we recognize in them mere forms of *Leptothrix*.

BEGGIATOA NIVEUM, Rab.

Usually forming extended caespitose floccose, silver white, glistening strata; filaments slender, indistinctly articulate when in vegetative condition; later the cytioplasm solidifies and contracts, separating into parts 1–2 times as long as broad, presenting the appearance of an articulate filament.

Diameter of filaments, 1–1.5 μ.

Frequent in sulphur springs, Niagara.

Syn. *Leptonema nivea*, Rab.

Plate CCVIII, figs. 8, 9. From cliffs, Niagara, dripping sulphurous water.

Beggiatoa leptomitiformis, (Menegh.) Trevis.

Habitat, strata, and filaments, in character with the preceding, but trichomes stouter and usually in larger masses.

Diameter of filaments, 1.8–2.5 μ.

Syn. *Oscillaria leptomitiformis*, Menegh.

Larger sulphur springs, New York and Florida.

Plate CCVIII, figs. 6, 7, clusters of filaments, and separate ones under higher magnification.

Genus 105, LEPTOTHRIX, Kg.

Filaments simple, very slender, articulation none or indistinct, without oscillating movement.

Leptothrix tenax, Wolle.

Stratum sometimes expanded, attached to submerged stones, forming loosely interwoven masses, six or more inches in diameter, at other times in small caespitose, pulvinate clusters on wet rocks. Filaments slender but strong, tough, from one-half to six inches long; often forming firm membranes. Color of trichomes primarily light aeruginous, but soon changing to a dull yellow or light brown. Articulation rarely observed, as long as wide. Sheath close.

Diameter of filaments, 3.5–4 μ.

Sluggish or stagnant waters, wet slate, and other rocks, from Vermont to Florida.

Plate CCIII, figs. 1, 2, from Pennsylvania specimens, six to eight inches long. Described in Bull. Tor. Botanical Club, 1878, as *Hypheothrix tenax*.

Leptothrix calcicola, Kg.

Stratum dull aeruginous; filaments strongly curved and closely interwoven, rather fragile; aerial, sometimes forming a glossy stratum, more frequently a dull, dark aeruginous coating on old walls.

Diameter of filaments, 2.25–3.25 μ.

Syn. *Hypheothrix calcicola*, Kg.; *Oscillaria calcicola*, Ag.; *Leptothrix muralis*, Kg.

Plate CCVIII, fig. 21, stratum slightly enlarged.

Leptothrix aeruginea, (Kg.) Kirch.

Stratum thin, membranaceous, bright aeruginous; filaments irregularly intertwined; articulation rather indistinct, somewhat longer than wide.

Diameter of filaments, 1.8–2.25 μ.

Syn. *Hypheothrix aeruginea*, Kg.

Ponds, springs, about basins of thermal water.

LEPTOTHRIX HERBACEA, Kg.

Stratum somewhat herbaceous green, not so decidedly aeruginous, and not membranaceous as the last. Filaments slightly flexuously curved, upright growth, caespitose, subpulvinate; often faded at the base, while bright green above. Sheath close. The preceding differing only in the strata, the one being thin smooth, membranaceous, and the other more of a loose irregular upright growth.

Diameter of filaments, like the last, 1.8–2.25 μ.

Very abundant on the wood-work around the artesian well, Charleston, South Carolina. In smaller quantity on wet wood, aqueducts, etc.

This species, so much in size and other features like the last named (*L. aeruginea*), may be a mere form of it.

Plate CCVIII, fig. 13, a caespitose cluster under low power, and part of a filament under high magnification.

LEPTOTHRIX HINNULEA, Wolle.

Stratum light fawn colored, flocculent caespitose, waving, 6 *mm* thick. Filaments flexible and contractile, indistinctly vaginate, not articulate, 10–15 *mm* long; light yellow-brown, or colorless.

Diameter, 1.25–1.75 μ.

In trenches hot waste-water from steam mills.

Syn. *Beggiatoa hinnulea*, Wolle. Bull., Tor. Bot. Club, November, 1877.

Plate CCVIII, fig. 5, a flocculent cluster.

LEPTOTHRIX CAESPITOSA, Kg.

Caespitose, erect, aggregate; filaments flexuously curved, apices attenuated, dilute aeruginous, later brownish yellow, waving, homogeneous or more rarely indistinctly articulate.

Diameter, 2–2.75 μ; length, 125-200 μ.

Attached to submerged wood or stones. Frequent in ponds and ditches.

Plate CCVIII, figs. 11, 12, clusters under low power and parts of trichomes under higher power.

LEPTOTHRIX TINCTORIA, Kg.

Fasciculate-caespitose, about 6 *mm* (¼ inch) long, deep amethyst, or purple-green; trichomes rigid, equal, distinctly articulate, pale steel blue; articulations as long as broad; sheath close, colorless.

Diameter of filaments, 1.75–2.25.

Attached to submerged plants.

Syn. *Hypheothrix tinctoria*, (Ag.) Rab.; *Calothrix tinctoria*, (Persoon) Ag.

Plate CCVIII, fig. 16, a usual appearance.

LEPTOTHRIX RIGIDULA, Ag.

Stratum composed, usually, of segregate or subapproximate clusters; light, dilute aeruginous. Filaments flexuously curved, articulate or homogeneous.

Diameter of trichomes, 1.25–1.75 μ; length, 100–130 μ.

Syn. *Leptomitus divergens*, Kg.; *Hygrocrocis rigidula*, Kg.

In stagnant, or sluggish waters, parasitic on aquatic plants.

Plate CCVIII, fig. 15.

LEPTOTHRIX LAMINOSA, Kg.

Stratum often broadly expanded, membranaceous lamellose, on the surface aeruginous or olivaceous, below faded yellowish or colorless. Trichomes flexuously curved, interwoven, and sometimes spirally coiled, homogeneous or articulate; articles subequal.

Diameter, 1.75–2 μ.

Syn. *Oscillaria laminosa*, Ag.; *Hypheothrix laminosa*, Rab.; *Oscillaria labyrinthiformis*, Ag.

Stagnant waters, ponds and ditches.

Plate CCVIII, fig. 17, a specimen with filaments gently curved; fig. 18, filaments coiled.

LEPTOTHRIX BULLOSA, Wolle.

Thallus subspherical, gregarious, dilute straw color or yellowish white. Filaments simple, in part densely interwoven into very tough globular, or oval, hollow bodies, 4–8 *mm* in diameter. Trichomes pale aeruginous, often faded and contracted.

Diameter 1.5–2. μ; sheath about twice as wide.

In shallow, sluggish waters, Susquehanna River, Harrisburg, Penna.

Syn. *Hpyheothrix bullosa*, Wolle, Bulletin, Tor. Bot. Club, 1877.

Have been hesitating whether to place this singular plant here or with *Microcoleus*. Filaments rarely appear divided, and contain two trichomes (internal), but as a whole the plant has most in character with the present genus.

Plate CCVIII, fig. 19, spherical bodies surrounded by loose wool-like threads, natural size. also three fragments of filaments largely magnified.

LEPTOTHRIX OCHRACEA, Kg.

Forming cloud-like, floating, fragile masses of an ochery color. Trichomes very slender, in short, fragmentary parts, scattered. Not articulate.

Diameter of trichomes, about 2 μ.

Syn. *Lyngbya ochracea*, Thur.; *Conferva ochracea*, Dillw.; *Oscillatoria ochracea*, Grev.

Not infrequent in small pools, produced in rust colored cloud-like masses. The filaments are very slender and usually scattered in broken fragments. A very insignificant form, and of doubtful value. Dillwyn represents the filaments branched; so are most of our specimens. Sheaths and articulations indistinct. The whole seems more in character with a filamentous lichen, than an algæ. Prevails in small pools from Massachusetts to Florida. The position given this plant by Thuret, Kirchner and others, does not appear justifiable, unless the European form is quite distinct. Dried specimens do not appear unlike ours.

Plate CCII, figs. 32, 33, filaments sometimes decidedly branched; Plate CCVIII, fig. 14, filaments simple.

Genus ASTEROTHRIX, Kg.

Filaments indistinctly or sometimes distinctly articulate, more or less rigid; cruciformly branched, nude, ends acute cuspidate or obtuse, somewhat genuflexuous. Propagation unknown.

ASTEROTHRIX CREGINII, Wolle.

Filaments short, light bluish green; branches at right angles, cross-like; articulation usually distinct, somewhat moniliform.

Diameter of filaments, 2–4 μ.

Found thickly scattered through a deposit of fine siliceous sand in Norton County, Kansas. Reported by Prof. F. .W Cregin.

A peculiar form, seems fitly placed with this genus, although unlike any of the three species named by Rabenhorst. For the establishment of a good species corroborative specimens are desirable.

Plate CCIX, figs. 22–25, filaments in their normal appearance under a magnification of 500 diameters.

Asterothrix Pertyana, Naeg.

A form much larger than the preceding and otherwise distinct, is described by Naegeli, found with *Confervae* in Switzerland. The figure is transcribed to close a vacant part of Plate CCIX, figs. 20, 21.

Genus 106, SPIRULINA, Link.

Trichomes articulated, spirally twisted, more or less motile, *Oscillaria*-like, usually surrounded by a somewhat liquid, colorless mucilage.

Spirulina Jenneri, Kg.

Trichomes solitary or in interwoven masses, distinctly articulated, spirals lax, a turn occurring in every 20–24 μ; cells about as long as wide; color light or darker aeruginous.

Diameter of trichomes, 7–8 μ.

Syn. *Spirillum Jenneri*, Hass.; *Arthrospira Jenneri*, Hedw.

In stagnant waters, usually only solitary filaments.

Plate CCX, fig. 2, two short parts of trichomes.

Spirulina tenuissima, Kg.

Trichomes very thin; flexuous, densely or more loosely spiral, endowed with active motion, joints indistinct, forming a lubricous stratum, light aeruginous, on the bottom of warm sulphur springs.

Diameter of spirals, 4–5 μ, making 5–7 turns in space of 25 μ.

If not strictly identical in every particular with the European forms described under this name, our plant is very near to it, and entirely unlike all others.

Frequent in sulphur springs, Clifton, New York, and Glen Cove Springs, Florida.

Plate CCX, fig. 3.

Spirulina duplex, Wolle.

Trichome a slender, flat, strap-like, continuous band. When untwisted forms a complete ring. Normally it is flattened and twisted, with 1–4 or more turns. Breadth of band (trichome) 2 μ; length, when twisted, 75–200 μ.

Frequent in pool near Minneapolis, Minnesota.

Plate CCX, figs. 4, 5.

Genus 107, SPIRILLUM, Ehrb.

Trichomes short filiform, imperfectly articulated, spirally twisted, curved snail-shell-like or sub-cylindrical.

SPIRILLUM UNDULA, (Muell.) Ehrb.

Trichomes short, rather stout; twisted, making 1–1½ turns, hyaline, distinctly articulate.

Stagnant pools.

Plate CCX, fig. 1.

Family XIX.—CHROOCOCCACEÆ.

Unicellular forms of plant-life, which divide into daughter cells and separate, forming families involved in a mucous, or gelatinous, amorphous thallus. Cells divide and redivide through many generations.

All the forms of this family are probably mere conditions of development of higher forms. Many of them are thus clearly connected with filamentous plants, as shown on the preceding pages, but others have not been so satisfactorily traced to their origin or to their destiny; we therefore retain the older classification as a means for reference to the various forms.

Some of these unicellular forms run through many, even to hundreds of generations, before reproducing the original plant; and often before the whole cycle is complete, conditions of temperature, moisture or other essential prove adverse to development, they pass away without reproducing. Artificial cultivation is attended with so many difficulties, little has been gained by many earnest efforts. The life-history of the plants needs to be studied in their own haunts.

Genus 108, GLOEOTHECE, Naeg.

Cells cylindrical, oblong, rounded at the ends; cells divide transversely into two nearly spherical daughter cells. The cells occur singly or two or more included in a vesiculiform, colorless tegument. After repeated division, one family with tegument may occur within another enlarged tegument also with family.

Gloeothece confluens, Naeg.

Stratum gelatinous, usually pale reddish yellow, or greenish; cells mostly single; sometimes two in a tegument, 1½–2 times as long as wide before division; later often nearly spherical; cytioplasm greenish, tegument wide, colorless.

Diameter of cells, 1.6–2.25 μ; with tegument, 9–10 μ.

On wet rocks.

Plate CCX, fig. 6.

This and other forms of the genus are conditions in the development of *Sirosiphon* and *Scytonema*. Compare Plates CLXXXIV, CXC and CXCI.

Genus 109, APHANOTHECE, Naeg.

Cells longer than broad, near the last (*Gloeothece*), but having the teguments usually confluent, forming a rather firm gelatinous body in which the cells are imbedded.

Aphanothece prasina. A. Br.

Thallus gelatinous more or less globose, tuberculose, size of a cherry, usually floating, dark bluish green; cells 1½–2 times as long as wide, aeruginous or light bluish green.

Cells 4–6 μ wide by 8–11 μ long.

Syn. *Coccochloris stagnina*, (West. and Wall.) Rab.; *Aphanothece Mooreana*, Lagerh.; *Palmella Mooreana*, Harv. See page 193.

Plate CCX, figs. 9, 10, a thallus, and single cells.

Aphanothece pallida, Rab.

Thallus gelatinous, soft, 4–6 *mm* thick, forming small masses; light green with a tint of blue, cells elliptic, 1½–3 times as long as wide, pale aeruginous.

Diameter of cells, 3.5–8.0 μ.

Syn. *Palmella pallida*, Kg.

On wet, or marshy ground, Pennsylvania.

Plate CCX, figs. 7, 8, a thallus and individual cells.

Genus 110, SYNECHOCOCCUS, Naeg.

Cells elongated or cylindrical, membrane thin, singly, or in series of two or more.

SYNECHOCOCCUS AERUGINOSUS, Naeg.

Cells $1\frac{1}{2}$–2 times as long as broad, solitary or two joined end to end; cytioplasm aeruginous.

Diameter of cells, 7–16 μ.

On wet rocks.

Plate CCX, fig. 11, a number of cells variable in size.

Genus 111, MERISMOPEDIA, Meyen.

Cells globose, or at the time of division oblong, 4, 8, 16, 32, 64, or 128 associated in tabular families of a single stratum, forming a quadrate, plane, free swimming thallus.

MERISMOPEDIA GLAUCA, Naeg.

Thallus more or less limited, light aeruginous or sometimes glaucous green. Cells globose, or more or less oval or oblong as they approach division. Thallus composed of 4–64 cells, rarely more.

Diameter of cells, 3–5 μ.

Syn. *Gonium glaucum*, Ehrb.; *Mer. nova*, Wood.

Not infrequent in ponds or sluggish waters.

Plate CCX, figs. 12–15, various sizes of cells, not different species, but conditions of the same plant.

MERISMOPEDIA CONVOLUTA, Breb.

Thallus membranous, visible to the unaided eye, more or less folded or convolute; families often composed of 256 geminate cells, arranged in subfamilies, sometimes two of these families conjoined with a composite family; cells spherical or oblong. Cytioplasm homogeneous, bluish green.

Diameter of cells, 4–4.5 μ.

Shallow pools, forming a distinct layer upon the muddy bottom, or separating and then floating on the surface.

Plate CCX, fig. 14, may represent a small family of 64 cells. A thallus often contains hundreds of these.

European works describe numerous species separated by no more distinctive features than sizes of cells, and of families, or color of cytioplasm, as *violacea*, *aeruginea*, and *ochracea*, all of which appear to represent mere conditions of the same plant.

Genus 112, COELOSPHAERIUM, Naeg.

Thallus spherical, vesicular, hollow; containing many small cells which are associated in families or scattered at the periphery, immersed in a mucous stratum.

Multiplication takes place by means of the peripheral cells, which enlarge and escape through the external membrane and develop daughter cells; also by the constriction and division of maternal cells.

COELOSPHAERIUM KUETZINGIANUM, Naeg.

Families spherical, cells globose or subglobose, geminate, or quaternate or scattered, loosely disposed; cell contents aeruginous, delicately granulose.

Diameter of cells, 2–5 μ; families 60 μ more or less in diameter.

In ponds and pools; stagnant waters.

Plate CCX, fig. 16.

Genus 113, CLATHROCYSTIS, Henfr.

Thallus, a microscopic gelatinous body, primarily solid, then saccate and later clathrate; fragments of the broken thalli occurring in irregularly lobed forms, composed of a colorless matrix in which are imbedded large numbers of very small cells.

Multiplication takes place by the division of the cells within the thallus as it increases in size.

CLATHROCYSTIS AERUGINOSA, Henfr.

Cells aeruginous. Families singly, or a number united forming a thallus which soon becomes largely perforated, breaks and then dissolves. Often floating in large strata as a glaucous green scum on fresh water pools.

Diameter of cells, 2.5–3.5 μ; families, 30–130 μ.

Syn. *Microhaloa aeruginosa*, Kg.; *Microcystis Ichthyoblabe*, Kg.; *M. ichthyolabe*, Breb.; *Polycystis aeruginosa*, Kg.

Plate CCX, figs. 17, 18, two perforated thalli; fig. 19, when dissolved the cells float in mass.

Genus 114, GOMPHOSPHAERIA, Kg.

Cells wedge-shaped, peripheral 2–4–8 associated in radiating families, nestling in jelly, covered with a tegument and forming a globose, free swimming thallus. Cells divide alternately in three directions.

GOMPHOSPHAERIA APONIA, Kg.

Thallus microscopical, at first light, or darker aeruginous, but soon fades or changes to a yellow, or orange color, (var. *aurantiaca*, Bleisch).

Diameter of cells about 4 μ; length, 10 μ; diameter of family, 50–75 μ.

Frequent in small pools.

Plate CCX, fig. 20, two developed forms; figs. 21, 22, young conditions.

Genus 115, MICROCYSTIS, Kg.

Cells very small, numerous, densely aggregated into globose bodies, surrounded by a thin membrane, forming families, usually single, but rarely several surrounded by a universal tegument; cell division in three directions alternately.

A condition of frequent occurrence in the process of development of higher forms, specially of *Scytonema* and *Sirosiphon*.

MICROCYSTIS PROTOGENITA, (Bias.) Rab.

An old name which may be applied to various forms which would come under this genus. The families are ordinarily subspherical, measuring from 15–75 μ in diameter. Cells, which crowd the teguments more or less, are 4–6.5 μ in diameter; in color primarily aeruginous, but changeable to light yellow, to orange, and sometimes to purple.

Occurring on moist timbers, outside of old water tanks, moist ground, and trunks of trees. All of them are evidently mere conditions of development of higher plant-life. Confer with figures of *Scytonema* and *Sirosiphon*, Plates CLXXXVII; CLXXXVI; CXCI.

Plate CCX, fig. 23.

Genus 116, ANACYSTIS, Menegh.

Cells spherical, innumerable in mucous strata; primarily the cells are enclosed in smaller families, by very delicate teguments which quickly dissolve, and are only rarely visible.

The forms of the present genus differ from those of the last (*Microcystis*) in not having the families so distinctly separated, and enclosed in so firm teguments. The former are solitary or gregarious, the latter are united, massed together. The former is easily traceable in its life-history; the latter is very uncertain.

ANACYSTIS PULVEREUS (Wood) Wolle.

Cells very small, whitish-blue-green, irregularly subglobose, oval or angular, associated in families. Thalli composed of very numerous and densely crowded families, irregular, sometimes confluent, mostly surrounded by a false hyaline tegument; aggregated into a bright glaucous, or whitish-blue-green pulverulent stratum.

Diameter of cells, 2–3 μ.

Syn. *Anacystis glauca*, Wolle; *Pleurococcus pulvereus*, Wood.

Forms an extended stratum over the bottom of limestone springs. The stratum is in places nearly an inch in thickness, and when lifted by the hand is found to be loose and crumbly. Found by Dr. Wood in Centre County. Found in abundance also in Northampton and Lehigh Counties, Pennsylvania, where limestone springs abound.

Plate CCX, fig. 25, imperfectly represents a small part of a stratum.

ANACYSTIS MARGINATA, Kg.

Families usually globular, sometimes flattened, often many united, and flowing together, surrounded by a thin colorless tegument. Cellules crowded, spherical, but sometimes by mutual pressure, somewhat angular, light aeruginous. The margins of the families colorless.

Diameter of cellules, 3–4 μ; families, 80–300 μ.

Found in ponds of stagnant waters.

Syn. *Mycrocystis marginata*, Kirch.

ANACYSTIS BRUNNEA, (Naeg.) Wolle.

Thallus gelatinous-membranaceous, light brown. Cells, single or twin, crowded, tegument false, or diffused; cytioplasm pale yellowish-brown, or greenish-brown; finely granular. Cells very small, 1 μ diameter; families 4–10 μ; often much more in diameter up to 50–60 μ.

The whole forming brownish olive floating masses in stagnant waters.

Syn. *Palmella brunnea*, A. Br.; *Aphanocapsa brunnea*, Naeg.

This form is not quite identical with Naegeli's description; it is very near. I adopt the name to avoid a new term for a very vague condition.

Later observations show this form to be an old condition of *Clathrocystis*.

Genus 117, POLYCYSTIS, Kg.

Cellules globose, united into spherical families which cluster together, grape-like.

POLYCYSTIS ICHTHYOBLABE, Kg.

Thallus membranous, aeruginous, or with a reddish tinge; cells globose, crowded. with light aeruginous contents. Families usually about 50 μ; sometimes as large as 110 μ diameter.

Diameter of cells, 2–3 μ.

Not frequent; occasionally in small pools.

Plate CCX, fig. 24, a small cluster of family-cells.

Genus 118, GLOEOCAPSA, Naeg.

Cells usually spherical, or before division somewhat oblong, with wide vesiculiform tegument, this cell undergoing division into two daughter cells. Each has a distinct tegument, the whole being surrounded by the tegument of the mother cell. This process is often repeated, the original tegument remaining and surrounding the family thus formed. Cell membrane often very thick, mostly lamellated; strata not infrequently separating; colorless or colored; cell contents aeruginous, bluish green, steel blue, reddish, yellowish, fuscous, etc. Division in three directions.

Rabenhorst, in his *Flora Algarum*, describes more than sixty forms as species and varieties. These unicellular forms are very changeable in color and in details of construction, number and size of cysts. The same cells may be at one time aeruginous, then change to a light yellow or orange color; or crimson or scarlet. Sometimes they form a crustaceous stratum, and then they occur in soft gelatinous masses, so abundant, they may be stripped from dripping, partially shaded rocks, by handfuls. Occurring in so many different conditions, and varying so much under different circumstances, it may be readily conceived how the many stages of development, found at different times and by different persons, gave rise to the record of the many forms as species.

It is now clearly evident that all of these so-called unicellular plants constitute nothing more nor less than conditions in the plant-life of higher forms. This fact has already been shown under the head of *Sirosiphon;* also illustrated on Plates CXC; CXCI; CXCIV; CXCV. They are the spores, or macrogonidia of forms of *Sirosiphon;* they have their origin in the filaments, and again develop the same forms. Similar cells may occur also in the development of plants of other genera, as *Scytonema;* (compare Plate CLXXXIV, fig. 41), but they appear specially confined to *Sirosiphon.*

In the process of development there are several modes, the one more direct than the other. The former is shown on Plate CXCV, figs. 5–9, also on Plate CXCIV, figs. 4–10; the other involving the same principle yet more indirect. The microgonidia, scattered by the decay of the membranes of the cells of the filaments, begin to develop and soon present an appearance as Plate CXCI, figs. 15, 16. These small, almost colorless cells, grow and produce larger cells, with a single central nucleus (fig. 17), which next divides and they appear with two nuclei or cells; these develop into the full-grown cells, (figs. 19, 20). Plate CCX, figs. 26–31, illustrate more fully the advancing stages of growth of *Gloeocapsa magma,* (Breb.) Kg., from micro- to macrospores. We take these as good representative forms, to serve to illustrate a few of the species (?) which have been recorded by various authors; many differing only in color, which in itself can not be taken as a characteristic feature. It is too inconstant. A few of the forms of this genus may be quoted for illustration, as follows:

GLOEOCAPSA MAGMA, (Breb.) Kg.

Forms a grumous thallus, purplish brown; teguments coppery brown, or brownish red; central cell aeruginous.

Plate CCX, figs. 26–31.

GLOEOCAPSA POLYDERMATICA, Kg.

Thallus gelatinous dirty green or olive, becoming brownish. Tegument hyaline, lamellose. Cell (central) aeruginous.

Plate CCX, figs. 29–31, represent the features, not color.

GLOEOCAPSA CORACINA, Kg.

Thallus crustaceous, nearly black; tegument very pale violet, distinctly lamellose; cell aeruginous.

GLOEOCAPSA AERUGINOSA, (Carm.) Kg.

Thallus crustaceous, glaucous green; teguments thick colorless, rather indistinctly lamellose; cells aeruginous.

Plate CCX, figs. 27, 28, differing in color from the others.

GLOEOCAPSA RALFSIANA, (Harv.) Kg.

Thallus gelatinous, dark purple brown; tegument intense purple brown; cells light aeruginous.

Plate CCX, figs. 29–31, merely a change of color.

GLOEOCAPSA SHUTTLEWORTHIANA, Kg.

Thallus gelatinous, dark rufous brown, tegument thick, orange red to pale orange, rarely colorless; cells pale aeruginous.

GLOEOCAPSA SANGUINA, (Ag.) Kg.

Thallus effused, gelatinous, blood red, becoming blackish brown. Tegument intense blood red, in the middle pale red, extremes colorless; cell aeruginous.

Plate CCX, figs. 29, 30, another change in color.

GLOEOCAPSA RUPESTRIS, Kg.

Thallus dark brown, crustaceous, rather hard. Tegument thick, lamellose, yellow, golden brown, or becoming pale and colorless; cells aeruginous.

Figs. 27, 28.

GLOEOCAPSA ARENARIA, Rab.

Thallus mucous, somewhat olive colored. Tegument thick, spherical, colorless, somewhat lamellose; lamella diffluent. Cells aeruginous.

Plate CCX, figs. 22, 28, well represent the form of this condition.

GLOEOCAPSA ATRATA, Kg.

Thallus crustaceous, mucous, black. Tegument thick, hyaline; 2–3 times broader than the central, aeruginous cell.

Plate CCX, figs. 27, 28, differing in thallus from others—older conditions.

GLOEOCAPSA SPARSA, Wood.

Scattered in a mucous stratum composed of various algæ. Inner tegument yellowish brown, rarely colorless or lamellate; external tegument achromatic, scarcely visible.

Plate CCX, figs. 29–31, only another condition of *G. magma*.

Beside these forms I find notes scattered on the pages of my Sketch-books, covering observations for more than ten years, of at least ten to twenty more forms identified with forms in Rabenhorst's long list. They have no value as plants, hence do not name them. The above are briefly quoted to show how easily species may be multiplied by a too close notice of non-essential phases.

As we have a number of species of *Sirosiphon*, from various habitats as moist rocks, trunks of trees, earth and water, it is but reasonable to suppose that the macrogonidia may vary as well. The large quantities observed belong to *S. pulvinatus*. Macrospores of other species of *Sirosiphon* were too few to enable us to determine any distinctive features. A general and variable character appears common to all of them.

Genus 119, APHANOCAPSA, Naeg.

Cells spherical, with a thick, soft colorless tegument, confluent in a homogeneous mucous stratum; cells divide as in *Gloeocapsa*.

APHANOCAPSA GREVILLEI, (Hass.) Rab.

Thallus gelatinous, globose, densely aggregated, more or less confluent, dirty green, from olive to brownish with age and when dry; cells spherical or elliptic, somewhat crowded, singly or in pairs; tegument quickly diffluent; cytioplasm light aeruginous.

Diameter of cells, 3.5–5 μ.

Syn. *Coccochloris Grevillei*, Hass.; *Palmella botryoides*, Grev.; *Palmella Grevillei*, Berk.; *Botrydina Grevillei*, Menegh.; *Byssus botryoides*, Huds.; *Pleococcus Grevillei*, Trevis.

Submerged stones, in shallow pond water.

Plate CCX, figs. 38, 39, a small thallus, natural size, and a cell greatly magnified.

APHANOCAPSA VIRESCENS, Rab.

Thallus gelatinous, more or less expanded, dirty green or olive, becoming brownish; cells rather pale aeruginous, scattered singly or some in pairs. Tegument rather indistinct.

Diameter of cells, 5.5 μ.

Syn. *Sorosporium virescens*, Hass.; *Aphanocapsa parietina*, Naeg.

On wet stones or rocks.

Plate CCX, fig. 33, part of a thallus, natural size; figs. 34–37, cells greatly magnified, which are referred with some hesitancy to this species. They were found separated from the thallus, floating in pond of somewhat stagnant water. They are not unlike the teguments and cells which make up the thallus, but larger.

Genus 120, CHROOCOCCUS, Naeg.

Cells spherical or more or less angular from mutual pressure; solitary, or united in small families, without being enclosed in a distinct tegument. Cell contents aeruginous or pale bluish green, also yellow and orange.

Propagation by division, alternately in three directions.

The cells represented under this genus are more simple than those of *Gloeocapsa*, and not so numerous.

Rabenhorst describes 25; Kirchner 9, and Cooke in his *British Algæ*, has only two. They are not of rare occurrence, usually intermingled with other forms to one or the other of which they are evidently related. Dr. Itzigsohn, in his superb work on the Life-history of *Hapalosiphon* (1853), shows that *Chroococcus* cells are closely related to this plant, and then remarks: "I have observed these dimorphose *Chroococcus* cells associated with species of *Tolypothrix*, and believe that all the forms described as *Chroococcus*, are nothing more or less than spores of *Nostoceæ*."

Dr. Hansgirg of the University of Prague, also, in a recent paper (1885) of fifty pages on the *Polymorphismus der Algen*, shows that almost all, if not every one, of the forms of the family of *Chroococcaceæ*, Rab., including *Chroococcus*, Naeg.; *Gloeocapsa*, (Kg.) Naeg.; *Aphanocapsa*, Naeg.; *Synechococcus*, Naeg.; *Gloeothece*, Naeg., etc., are closely related to more highly developed forms; that is to say most, if not all of the so-called unicellular aeruginous algæ, *Cyanophyceæ*, have their origin in filamentous plants breaking up into single cells like those which develop them.

Dr. Hansgirg's paper (German) commends itself as a very valuable contribution to all interested in the study of the morphology and life-history of Fresh-water Algæ.

As an illustration of the forms known as *Chroococcus*, several species are quoted.

CHROOCOCCUS TURGIDUS, Naeg.

Cells spherical, oblong ellipsoid, or more or less angular from compression; single, twin, ternate, or quaternate (rarely eight) associated in families; tegument thick, often somewhat lamellate; colorless. Cell membrane thin. Cell contents primarily bright aeruginous; later becoming brownish.

Diameter of cells, 13–25 μ.

Syn. *Protococcus turgidus*, Kg.; *Haematococcus binalis*, Hass.; *Chroococcus multicoloratus*, Wood.

On moist rocks, and other wet places.

Plate CCX, figs. 40, 41.

CHROOCOCCUS RUFESCENS, (Breb.) Naeg.

Stratum mucous, brown-yellow; cells spherical, or oblong, 2–4 consociated into families. Tegument colorless; cytioplasm finely granular, reddish, or yellowish brown.

Diameter of cells, 12–16 μ.

Moist rocks.

Syn. *Pleurococcus rufescens*, Breb.; *Protococcus rufescens*, Kg.

Plate CCX, fig. 43.

CHROOCOCCUS COHŒRENS, Naeg.

Cells oblong; twin, or in fours with a distinct hyaline tegument. Cell membrane thin. Cytioplasm blue-green.

Diameter of cells, 3–6 μ.

Syn. *Protococcus cohœrens*, Kg.; *Pleurococcus cohœrens*, Breb.; *C. refractus*, Wood.

On damp walls, rocks, etc.

Plate CCX, fig. 42, different forms and sizes of cells.

CHROOCOCCUS THERMOPHILUS, Wood.

These cells were found in connection with *Hydrurus occidentalis*, Harv. (*Nostoc calidarium*, Wood) and are probably the macrogonidia of *Hydrurus*.

Benton Springs, Owen's Valley, California.

ADDENDA.

A few specimens received while the preceding pages were passing through the press, call for the following few notes.

Class RHODOPHYCEÆ.

Genus GELIDIUM, Lam.

Purple or red sea-weeds with a cartilaginous or horny, opaque frond, without joints. Fronds flattened, irregularly branched.

Gelidium corneum, Lam.

Fronds flattened, rigid, several times pinnate; a very variable plant about an inch in height, (Pacific Coast plants 3–4 inches high). Spores imbedded in irregular clusters near the ends of the branches.

Twelve or more varieties of marine forms of this species have been described, but none affecting inland waters. F. A. Anderson collected specimens in a rapid mountain stream, Montana. They were attached to river stones. The specimens received were small in size and limited in number; more have been requested for confirmation of our identification, but cannot reach us in time for notice on these pages. Seems but reasonable that where *Enteromorpha* abounds, *Gelidium* may flourish also.

Class CHLOROPHYCEÆ.

Docidium Ehrenbergii, Ralfs. V. Des. U. S., p. 159.

Diameter 10–12 times longer than broad, having usually two, or rarely three slight inflations at the base of the semicells; ends truncate, bordered by three to five minute tubercles which give the end view a crenate appearance. Empty cells show they are punctate; rarely distinctly granulate. Semi-cells very slightly tapering from the base to the apex.

Diameter of cells, 20–22 μ, about twelve times longer than broad.

Measures taken from cells distinctly granulate, collected by A. C. Stokes in Cypress Swamps, Florida.

CLOSTERIUM NASUTUM, Nord. V. Des. U. S., p. 41.

Specimens of this species from Cypress Swamps, Florida, appear perfectly straight and somewhat thicker and longer than the forms heretofore noted. Apical vacuole distinct. Chlorophyl arranged in five or six fillets; centrally separated.

Diameter, 83 μ; length, 7 times more than the breadth.

Collected by A. C. Stokes.

MICROSTERIAS FIMBRIATA, Ralfs. V. Des. U. S., p. 109.

Fruiting specimens, not heretofore observed, were received from Rochester, New Hampshire, collected by W. N. Hastings. The plants are uniformly smaller than the measure given (Des. U. S., p. 110), measuring only 125 μ, but corresponding with the smaller measures of Ralfs, Rabenhorst and Kirchner. They have much in common, in form, with *M. papillifera* as figured by Cooke; but this species is bordered with papillæ, not sharp teeth, and the granules at the margins of the lobes are papillæ, not distinct spines, as in *M. fimbriata*.

Zygospores are orbicular, spinulose ; spines rather slender, elongate, scattered, mostly furcate at the ends, and sometimes notched below the middle; furcate ends, with tips recurved.

Diameter of cells, about 125 μ; length slightly more; zygospores average 75 μ, without spines ; 125 μ, with spines.

ENTEROMORPHA INTESTINALIS, var. PROLIFERA, Ag.

To page 107 may be added this variety. Have fine specimens, collected by F. W. Anderson in a rapid stream, 4000 to 5000 feet elevation, Montana. Primarily it is attached to river stones; later floating in masses.

Prevails also in salt marshes, Nebraska.—*C. E. Bessey.*

CHAETOPHORA ENDIVIAEFOLIA. See page 117.

This form is reported from Montana, very common everywhere.

Tetraspora cylindrica, Ag. See p. 190.

Sometimes attains extraordinary dimensions. F. W. Anderson reports it from Montana as forming in a mountain torrent (Belt River), long jelly-like fronds, very slippery and easily ruptured; length varies from one to ten feet; diameter from a slender thread to an inch or more wide; bright green. In connection with this plant-form, Mr. Anderson relates the following:

There is a species of garter snake peculiar to the mountains, that just gorges itself upon this plant; grasping with its extended jaws an end of a long tube it draws it in little by little until perfectly full, then most amusingly it will shake it as a little terrier will shake a rat. These snakes are seldom over two feet long; to see them tussling with a long slippery alga many times longer than themselves, in the swift current, is quite ludicrous.

Cladophora callicoma, Kg.

Filaments much, and often fasciculately branched, ordinarily 8–16 *cm* long, bright yellowish green; cells cylindrical, six to sixteen times longer than thick; membrane rather thin; cytioplasm somewhat loose, irregularly spirally arranged. Spore-bearing cells usually only one-half as long as the sterile cells.

Diameter of stems, 50–70 μ; branchlets, 22–25 μ.

From rapid waters mountain stream, 4000 to 5000 feet elevation, Montana. Collected by F. W. Anderson, who reports it forming, and growing in long ropes 3–10 feet long, undulating in the flowing water and beautifully waving its lateral branches.

GLOSSARY.

Acaulescent. Stemless, or apparently so.
Acaulis. Stemless.
Achromatic. Colorless.
Acicular. Needle-shaped.
Aculeate. Prickly; beset with aculei.
Acuminate. Tapering to a point.
Aeruginous. Of the color of virdigris; blue green.
Agamo-hypnospores. Neutrally formed resting spores.
Agamospore. Spore formed neutrally without fecundation.
Agamosporous. Bearing spores without fecundation.
Agamous. Destitute of sexes.
Agglomerate. } Heaped or crowded into a
Aggregate. } dense cluster, but not cohering.
Alternate. Two organs so placed as not to be opposite to each other.
Amoeboid. Resembling an amoeba.
Amorphous. Without definite form.
Amylaceous. Resembling starch.
Anastomose. The opening of one vessel into another, applied to threads or tubes which become confluent, and form an irregular net-work.
Androgonidia. Peculiar zoogonidia produced by female plants from which male plants are developed.
Androsporangium. Sporangium enclosing spores of male plants, or androspores.
Androspore. A special kind of zoospores produced in cells, which originate the dwarf males in Oedogonium.
Annulate. Marked with rings.
Antheridia. Certain reproductive organs supposed to be analogous to anthers or fecundative.
Antrorse. Directed upward or forward.
Apical. Relating to the apex or tip.
Apiculate. Ending with a short point.
Appressed. Lying flat against or together for the whole length.
Arcuate. Bent like a bow.
Areola. An angular space with an elevated margin.
Articulate. Composed of joints.
Asperous. Rough to the touch.
Axile. Relating or belonging to the axis.
Axillary. In or relating to an axil.
Azygospore. Spore produced without copulation.

Barbate. Bearded; beset with long and weak hairs.
Base. The extremity by which an organ is attached to its support.
Bi or *Bis.* As a prefix to Latin words, two, twice or doubly.
Bicornate. Two horned.
Bidentate. Having two teeth.
Bifid. Two cleft.
Bifurcate. Two forked.
Bilobed or *bilobate.* Of two lobes, or cleft into two segments.
Binate. In pairs.
Botryoid. In clusters, like a bunch of grapes.
Bullate. Blistered or puckered.

Caespitose. Growing in tufts, with many stems from one root.
Caeruleus. Sky blue or pure blue.
Canalicaulate. Channeled or with longitudinal grooves.
Capillary. Thread-like, resembling hair.
Capitate. Head-shaped, or collected in a head.
Carpogon. See *Oogonia.*
Carpospore. Spores produced (by conjugation) in a sporocarpium.
Cartilaginous. Hard and tough like cartilage.
Cauloid. Resembling, or analogous to, a stem.
Caulescent. Having an obvious stem.
Cellulose. The material, chemically considered, of which the wall of the cell consists.
Chlorophyl. The green coloring matter of leaves, and of green algæ.
Chlorophylose. Resembling chlorophyl-green.
Ciliate. Furnished, or fringed with hairs.
Cilium, cilia. Hairs or bristles placed marginally.
Cinereous. Ash-gray.
Circinate. Curled round, coiled or spirally rolled-up.

Circumscissile. Cut round transversely.
Clados. Greek for branch, whence Chladophora, branch-bearer.
Clathrate. Latticed, or perforated like a window.
Clavate. Club-shaped.
Coenobium. A community of a definite number of individuals united in one body.
Como. Literally a head of hair. A tuft of hairs of any kind.
Concentrically. In rings, with a common center.
Cordate. Heart-shaped.
Confluent. Blending into one; passing by degrees the one into the other.
Connate. United congenitally.
Continuous. The reverse of articulated or interrupted.
Contorted. Twisted; or bent or twisted on itself.
Corniculate. Furnished with a little horn.
Coriaceous. Of a leathery consistency.
Corrugate. Wrinkled or in folds.
Cortex. Rind or bark.
Corticate. Coated with a bark or with an accessory bark-like covering.
Crenate. Notched or scalloped.
Cruciate. Cross-shaped.
Crustaceous. Hard and brittle, or forming a crust.
Cuneate. Shaped like a wedge.
Cuspidate. Tapering gradually to a sharp stiff point.
Cyathiform. Cup-shaped; in the form of a goblet or wine-glass.
Cylindrical. Elongated and with circular cross-section; in the form of a cylinder.
Cytioderm. Cell membrane.
Cytioplasm. Cell contents.

Decompound. Several times compounded or divided.
Decussate. In pairs alternately crossing.
Deflexed. Bent or turned abruptly downward.
Dehiscence. Splitting into regular parts.
Denticulate. Minutely toothed; having denticulations or diminutive teeth.
Derma. Greek for skin or surface of a plant or organ.
Diaphanous. Nearly transparent.
Dichotomous. Forked equally.
Diffluent. Readily dissolving.
Diœcious. When the male organs are borne on one plant and the female on another.
Disciform. Depressed and circular, like a disc or quoit.
Dissepiment. A partition or division.
Dorsal. Relating to the *dorsum* or back.

Echinate. Beset with bristles.
Ellipsoidal. Nearly elliptical.
Emarginate. With a notch cut out of the margin.
Encysted. Enclosed in a cyst or bladder.
Endochrome. Coloring matter of cells.
Endophytal. Growing within plants.
Endosmose. The inward current between fluids of different densities when separated by a membrane.
Endospore. The inner coating of a spore.
Epigynous. Seated upon the female plant.
Epiphytal. Growing upon plants; parasitical.
Epizoic. Growing upon animals.
Excentric. Out of the center; one-sided.
Exserted. Protruding beyond or out of.
Extrorse. Directed outward.
Exosporium. The outer membrane or the coat of a spore.

Falcate. Scythe-shaped or sickle-shaped.
Fascicle. A little bundle.
Fasciculate. In little bundles from a common point.
Fastigiate. Said of branches when parallel, clustered, and erect.
Ferrugineous or *ferruginous.* Colored to imitate iron-rust.
Fibrillose. Furnished or abounding with fibers or fibrils.
Fibrous. Composed, or of the nature of fibers.
Filiform. Thread-shaped, long, slender and terete.
Flagelliform. Like a whip-lash.
Flavescent. Yellowish or pale yellow.
Floccose. Bearing or clothed with locks of soft hairs or wool.
Fulvous. Tawny; orange yellow and gray mixed.
Furcate. Forked, or divergently branched.

Geminate. Twin; in pairs; two side by side.
Geniculate. Bent abruptly; like a knee.
Glaucous. Covered, or whitened with a bloom; whitish.
Globular. Somewhat or nearly globose.
Gonidia. Propagative bodies of small size, not produced directly or indirectly by any act of fertilization.
Grumous. Consisting of clustered grains; thick, clotted.
Gynandrosporous. Bearing male and female spores.

Habitat. Habitation or dwelling-place.
Herbaceous. Of the color, or texture of an herb.

Heterocyst. Intercalated cells of a special character differing from their neighbors.
Heterogeneous. Unlike or dissimilar in kind.
Homogeneous. Of the same kind, all of one nature or kind.
Hormogon. Special reproductive bodies, usually composed of short chains of cells, parts of internal filaments.
Hyaline. Transparent; resembling glass.
Hypnosporangium. Sporangium enclosing hypnospores.
Hypnospore. Resting spores; spores which repose some time before germinating.
Hypogynous. Seated beneath the female organ.

Inclosed. Used for intercalated, or intervening.
Intercellular. Between the cells.
Interstitial. Placed between.
Isolated. Detached; placed by itself.
Isospore. Applied to spores which are all of one size, or kind in the same plant.

Joints. The articulations, or cells of filamentous plants.
Lacerate. Irregularly cleft as if torn or lacerated.
Lacuna. A depression, cavity or intercellular space.
Lamellæ. Thin plates or membranes parallel to each other.
Lamellose or *lamellate.* Formed of layers or plates superimposed.
Lævis. Smooth, not rough.
Lanceolate. Shaped like a lance; tapering at each end.
Lateral. Belonging to; borne on the sides.
Lines. Twelfth part of an inch.
Lobe. Any division of an organ, or specially a rounded division or projection.
Lobulate. Divided into small lobes, *lobelets* or *lobules.*
Lubricous. Slippery.
Lunate. Crescent-shaped.
Luteolus. Yellowish; diminutive of *luteus.*

Macrandrous. Having elongated male plants.
Macrogonidia. Large gonidia.
Mamillate. Bearing teat-shaped processes.
Matrical. Belonging to the matrix.
Medullary. Relating to the pith.
Mesospore, Mesosporium. The middle membrane of the coat of a spore.
Meter. The unity of the French measure of length, equal to 39.37 English inches. *cm* is used for hundredth of a meter. *mm* is used for thousandth of a meter. μ (the Greek *m*) for hundred thousandth of a meter. 25 μ equal to one thousandth of an inch.
Microgonidia. Small gonidia.
Mobile. Movable.
Moniliform. Necklace-shaped, contracted at regular intervals.
Monœcious. With male and female organs on the same plant.
Mucilaginous. Slimy; of the consistency or appearance of mucilage.
Mucro. A short and abrupt small tip.
Mucronate. Tipped with a mucro.
Multicellular. Composed of many cells.
Multifid. Cleft into many lobes or segments.
Multipartite. Divided into many parts.

Nanus. Dwarf.
Nanandrous. Having short, or dwarf male plants.
Nodose. Knotty or knobby.
Nodulose. Knotted or with swollen joints.
Nucleus. The central germ around which a cell is formed. Small spherical bodies contained within spores or other cells.

Obcordate. Inversely heart-shaped.
Obovate. Ovate with the broader end toward the apex.
Ochraceous. Ocher color; light yellow with a tint of brown.
Oogonia. An ovarian sac or cell bearing oospores.
Oospore. Spores produced in an ovarian sac.
Operculum. A lid; a top which separates by a transverse line of separation.
Ormogon. See *Hormogon.*
Ovate. Of the shape of the longitudinal section of a hen's egg.

Papillose; papillate. Bearing or resembling papillæ, minute nipple-shaped projections.
Parasitic. Growing on or in and living upon another plant, or animal.
Parenchyma. Compressed on hexagonal cellular tissue.
Parenchymatous. Resembling the cellular tissue termed *parenchyma.*
Parietal. Growing by or to the wall.
Parthenogenesis. Production of fertile seed without sexual impregnation.
Parthenogonidia. Gonidia produced without fecundation.
Patent. Spreading.
Pectinate. Pinnatifid, with narrow close segments, like the teeth of a comb.

Pediceltate. Having a foot or stem.
Pericarpium. Covering or tegument of fruit.
Periderm; peridermic. The enclosing membrane.
Peripheral. The outer portion of a circle.
Piliferous. Bearing hairs, hairy.
Plicate. Folded or plaited.
Plumose. Like the plume of a feather.
Polymorphism; polymorphic. Having many forms.
Primordial. Original, existing from the beginning.
Prothallus. The false thallus first formed on germination of a spore.
Pseudo-branches. False branches, or resembling branches.
Pseudo-ramose. Having false branches.
Pulvereus; pulverulent. Powdered, as if dusted with powdery matter or minute grains.
Pulvinate. Cushion-shaped.
Punctate. Dotted, either with depressions like punctures, or translucent internal glands.
Purpurasceus. Purplish.
Pyriform. Pear-shaped.

Quadri-radiate. With four radii, or rays.
Quaternate. Arranged in fours.

Radical. Belonging to or proceeding from the root.
Radicans. Rooting.
Radicel. A minute root or a rootlet.
Ramulus. A small or secondary branch.
Ramulose. Bearing many branchlets.
Recurved. Curved backward or downward.
Reflexed. Abruptly bent or turned downward or backward.
Reniform. Kidney-shaped.
Replicate. Folded back.
Resting-spore. A spore which becomes quiescent, or rests for a time, more or less long before germination.
Rhizoid; rhizome. Resembling, or analogous to a root.
Rostrate. Terminating with a beak.
Rugose. Covered or thrown into wrinkles.

Saccate. Sac-shaped; baggy.
Scalariform. Barred or crossed like the rounds of a ladder.
Scrobiculate. Marked with little pits or depressions.
Scutate. Buckler-shaped.
Secund. When parts or organs are all directed to one side.
Segment. One of the divisions into which a plane frond, such as a desmid, may be cleft.
Segmentation. Dividing into segments.
Segregate. To separate from others, or set apart.
Semi. Prefix signifying half.
Septum. A partition or division.
Septate. Separated by a partition or septum.
Serrate. Beset with antrorse teeth.
Sessile. Sitting close, without a stalk.
Seta. A bristle or bristle-shaped body.
Setiform. In the form of a bristle.
Sheath. A tubular or enrolled part of an organ, the envelope of filament, etc.
Sigmoid. Shaped like the letter *S*.
Sinus (pl. *sinuses*). A depression or notch.
Spermatozoa; spermatozoids. Thread-like bodies possessed of motion, supposed to have fecundative power.
Spermogonia. Cells which give rise to the spermatozoids.
Spinose. Furnished with spines, or of a spiny character.
Sporangium. A spore case, having spores produced within it.
Spore. The analogue of seed in cryptogams.
Sporiferous. Bearing spores within it.
Sporoderm. The coating or covering of a spore.
Stellate. Star-shaped, arranged like the rays of a star.
Sterile. Barren; destitute of fruit or fruit-bearing cells.
Stipe. A stalk, the support of a cell or organ.
Stratum. A layer or extended bed.
Striae. Fine parallel lines, streaks or grooves.
Supporting-cell. The cell below an oogonium as in *Oedogonium*.
Swarming spores. See *Zoogonidia*.
Sub. As a prefix means "almost" or "nearly."
Subulate. Shaped like an awl.
Suture. A junction or seam of union.

Tawny. Same as fulvous; dark brownish yellow.
Tegument. A covering or membrane.
Terete. Cylindrical, having a circular transverse section.
Tetraspores. Certain spores produced in fours.
Thallus. A stratum, in place of stem and foliage.
Tortuous. Bent or twisted in different directions.
Torulose. Almost synonymous with moniliform.
Trichogonia. The female reproductive organs in *Batrachospermum*.
Trichogyne. A hair-like receptive organ of reproduction.

Trichome. The thread or filament of filamentous algæ.
Trichotomous. Dividing in threes.
Truncate. As if cut off at the end.
Tuberculate. Covered with wart-like projections or excrescences.

Unicellular. Literally composed of one cell.

Vacuole. A small clear space, drop-like, seen in the interior of the protoplasm of a cell.
Vagina. A sheath; sheathing.
Variety. A sort of modification subordinate to species.
Ventricose. Swelling unequally, or inflated on one side.
Vermicular. Worm-shaped.
Verrucose. Covered with wart-like elevations.
Versicolor. Changing color, or of more than one tint or color.
Verticillate. Arranged in whorls.
Vesicle. A small bladder or air-cavity.
Vibratile. That moves to and fro, or vibrates.

Whorl. Arranged in a circle round an axis.
Whorled. Disposed in whorls.

Zoogonidia. Gonidia endowed with active motion.
Zoosporangium. Sporangium enclosing zoospores.
Zoospores. Locomotive spores.
Zygospore. A spore resulting from conjugation.

INDEX.

EXCLUSIVE OF SYNONYMS.

INDEX OF SYNONYMS.