The Ulothricaceae and Chaetophoraceae of the United States

By Tracy Elliot Hazen

Introduction

The purpose of the subjoined work is to furnish a contribution to the systematic knowledge of a group of our common but comparatively little known green algae.

This work was begun about five years ago. After a somewhat general study of the algae in field and laboratory, the conviction grew upon us that the species included in the two families here considered form the most generally neglected and misunderstood group of importance among the filamentous algae.

The chief reason for this state of affairs is, perhaps, to be found in the fact that in these groups specific and even generic distinctions, for the most part, do not rest upon fruiting characters as in other large groups (*e. g.*, in the Conjugatae and Oedogoniaceae), because there is too little diversity in such features, and also too little knowledge regarding them; but such distinctions must depend very largely upon vegetative characters. These vegetative characters are always more or less variable and this fact has given rise to two opposed tendencies, either of which leads to confusion. On the one hand, certain algologists have treated as distinct species or varieties (though generally without adequate description) all variations found, paying very little attention to the genetic connection which may exist among such forms; on the other hand, some writers have shown strong inclination to make wholesale reductions to varietal rank, without any sufficient understanding of the species so treated. The first tendency is best exemplified in the classical work of Kützing; the second began with Rabenhorst and has reached its extreme expression in the work of Hansgirg and De Toni.

The only American author who has attempted to give a complete account of the genera included in these two families is the late Rev. Francis Wolle. His work was a monumental task for a single pioneer, but, based as it was, almost exclusively on that of Rabenhorst and Kirchner, with little knowledge of exsiccatae, it

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cannot, to say the least, be considered authoritative. Of course, in the fourteen years since the publication of The Fresh Water Algae of the United States, considerable progress has been made in Europe, notably in the separation of the genera and species of *Microspora* and *Conferva*, and of *Ulothrix* and *Stichococcus*. In other genera, *e. g.*, *Stigeoclonium*, practically no advance has been made. In this country, very little critical work has been done, though the issue of a considerable number of specimens in exsiccatae, chiefly in the series of American Algae of Miss Tilden, and the Phycotheca Boreali-Americana of Collins, Holden and Setchell, has paved the way for such work and in some cases made it necessary. The well-prepared specimens of confervoid algae in the latter series have, for the most part, the weight of Professor N. Wille's determination. Any treatment of these groups, to be worthy of confidence, must be supported by a knowledge of recent literature not only, but by a good degree of familiarity with the exsiccatae and the older literature, particularly the works of Kützing. This element appears to have been lacking in the recent work of some western investigators.

One great source of confusion has been the incorrect determination of specimens, particularly manifested in the practice of forcing a given form into a certain species, or in other words, stretching a specific diagnosis so as to include specimens varying in what is believed to be unimportant details, in order to avoid burdening literature with new species. Such a policy is always pernicious in its tendency, for in a great number of cases the species in question is misinterpreted, and its characters changed so that uncertainty results, both as to the definition of the original species, and also as to the character of the form identified with it. In cases of doubt it is much less confusing to make new species, and when a reasonably clear diagnosis of a new form cannot be furnished, it should be suppressed.

METHOD OF STUDY

In general the method pursued in preparation for this paper has been inductive; the policy has been, first, to make as many collections as possible, and by careful observation and comparison, to decide upon the distinctness of the different forms, and then to

identify them, as far as possible, with previously described species, paying especial attention to the historical interpretation of the latter.

One great lack in the study of such forms as those under consideration, is the want of correlation of observations. Here, more than in higher forms, different phases of the same plant are likely to be identified as different species; again, because of a supposed resemblance between different forms, or, because two or more really diverse filaments are found growing together, they are associated under one name, without any proof of connection.

In order to obviate this difficulty, and to place species definition upon a firmer basis, we have made as thorough a study as possible, considering the large number of forms treated, of life histories. Our rule has been to make collections repeatedly from the same station, or rather from several stations, as well as to follow such collections by laboratory observation.

Extended culture is a difficult matter in the case of algae like these which generally grow in rapidly running water. Such plants usually develop differently in a stagnant culture. To fit up a laboratory with a sufficient number of tanks supplied with fresh water would be expensive and not always feasible. A method, which has proved to be of value in certain cases, might profitably be employed further. We have sometimes placed fresh specimens in glass cylinders (*e. g.*, large bottles with the bottoms knocked out), covered both ends with thin muslin, and anchored them near the surface in a running brook. Frequent examinations of such cultures may easily be made. Some plants do not take kindly to even this sort of captivity, perhaps because the change in the composition of the water is not beneficial; others may be successfully kept until after important observations have been made. Many species have refused to disclose their reproductive processes even though carefully watched, but some advance in this direction has been made.

As a rule, new species have not been proposed except in cases where repeated collections from the same stations have admitted of no doubt regarding the validity of the form in question. In one or two instances very marked forms have been described as new upon the strength of only one collection. Many specimens ap-

pearing to be simply young forms have been laid aside altogether until further light on them can be obtained.

A great effort has been made to see all literature bearing upon the families treated. Nearly all important works were to be found in the combined libraries of Columbia University and the New York Botanical Garden, or were obtained through the liberality of the latter institution. Two or three articles not otherwise obtainable were seen at the libraries of the Philadelphia Academy of Sciences and Harvard University.

All available exsiccatae have been diligently examined, including the following series: Areschoug, Algae Scandinavicae Exsiccatae; Desmazières, Plantes Cryptogames de France; Erbario Crittogamico italiano, ser. II; Hauck & Richter, Phykotheca Universalis; Kryptogamae Exsiccatae; Kützing, Algarum aquae dulcis Germanicarum Decades (part only); Rabenhorst, Die Algen Sachsens, Die Algen Europas; Wittrock & Nordstedt, Algae aquae dulcis exsiccatae; Collins, Holden & Setchell, Phycotheca Boreali-Americana; Farlow, Anderson & Eaton, Algae Exsiccatae Americae borealis; Tilden, American Algae. Naturally many of these dried specimens are very unsatisfactory, but an attempt has been made to mention all American specimens where their character could be determined with a fair degree of certainty.

A pilgrimage was made to Bethlehem, Pa., where, through the kindness of a son of the late Mr. Wolle, we were permitted to see the herbarium which formed the basis of The Fresh Water Algae of the United States. Microscopical study however, was made only in the case of the Ulothricaceae, which could be examined without danger of marring the specimens.

The specimens collected by Schweinitz in North Carolina preserved in the Torrey herbarium of Columbia University are for the most part so old or so poorly preserved as to be unidentifiable, but the collection is of less taxonomic importance than historic interest, as most of Schweinitz' names were published only in J. W. Bailey's lists without descriptions.

Of specimens from miscellaneous collectors, comparatively few have been seen, so that our work is based very largely upon our own personal collections.

In our lists of specimens under different species, the name of the collector is given in parenthesis, except in the case of our own collections, which are designated simply by a number enclosed in parenthesis. In certain cases where specimens have not been seen, records of collections have been noted in quotation marks. Exact dates have been given only in the case of specimens of other collectors. All our own collections noted have been made since September, 1897, and as there is comparatively little variation from year to year, only the month of collection is noted. Types of all new species, and duplicates of a large part of the material on which this study is based, will be deposited in the Herbarium of Columbia University at the New York Botanical Garden.

Often a better notion of a species is given by an illustration than by a very detailed description, but with illustrations so much depends on the variations of the plants and the individuality of the author, that it is a matter of convenience to have as many drawings as possible made on one system, by one person. It has, therefore, been our attempt to furnish figures of representative specimens of all forms of which fresh material has been seen. All our drawings have been made with the use of the camera lucida, and at uniform scales of magnification within the limits of a genus. For all the Ulothricaceae, *Microthamnion*, and the Herposteireae, a combination of Leitz ocular 3 and objective $\frac{1}{12}$ oil immersion was used; for *Myxonema*, ocular 3 with objective 7; for *Draparnaldia*, ocular 1 with objective 7. The drawings thus made were reduced one half in reproduction.

In nomenclature, the Rochester code has been followed generally, though perhaps not with absolute rigidity in the case of one or two generic names.

The matter of generic types has demanded considerable attention. It has been our aim in all cases to use the oldest admissible generic name that can be anchored to a definite type species; that is, the species placed first under the original description of a genus has been considered the type, and in accordance with the validity of the genus as thus founded, it has been retained or discarded.* This method has been followed because it is our con-

* For a more extended discussion of this subject, see Mem. Torrey Club, **6**: 250–252. 1899.

viction that it is the only course based on rational principles and offering a fair hope of attaining the goal of stability. How little disturbance this method makes in these groups is seen in the fact that it has appeared necessary only in two cases to displace the names current among modern algologists, namely, *Conferva* and *Stigeoclonium*.

Very few varieties have been listed, because experience has proved that many of those in current use are either mere growth forms of the species with which they are associated, or are wrongly associated with the species. Mr. Wolle was in the habit of listing all the varieties given by Rabenhorst and Kirchner, without reference to their actual occurrence in this country. These have been repeated by De Toni as American forms, and thus confusion has arisen.

A sharp distinction between variety and forma, in the technical sense, has been here understood: by the term variety, better called subspecies, is indicated a form which is well-marked in relation to the species and fairly constant in character; by the term forma we have designated a form which is sufficiently well marked to demand recognition, but which is regarded as probably only a growth state of the species.

The limits of the two families treated are drawn practically on the lines laid down by Wille in Engler & Prantl, Die natürlichen Pflanzenfamilien. The chief departures from that work are the relegation of *Trentepohlia* and *Acroblaste* to a separate family, because of their specialized sporangial cells, and the removal of *Microthamnion* from this group to what is clearly its proper place, among the Chaetophoreae. As a matter of convenience we have also arranged the microscopic genera of the Chaetophoraceae in a separate tribe, the Herposteireae, taking the name from the most highly developed of the group, a name which is at the same time most suggestive of the creeping habit of all the forms.

It is very probable that the position taken by Borzi ('89), Bohlin ('97), and Wille ('01), in removing *Conferva* (= *Tribonema*) from the Ulothricaceae to a separate family and order in close affinity with the Ophiocytiaceae, is well grounded; for the present convenience, however, of American students who have not distinguished this genus from *Microspora*, it has been temporarily retained in its old position.

METHODS OF PRESERVATION

Where cell characters are among the chief requisites for the determination of species, as is the case with many of these plants, specimens preserved on paper, according to the usual method with seaweeds, are, to say the least, extremely unsatisfactory. Indeed, one is sometimes tempted to discard such methods altogether. Nevertheless, this method is, in certain respects, of considerable value, and should be generally, though not exclusively employed; paper or mica mounts are most convenient for the herbarium to show distribution and form in the mass; furthermore, they furnish a record which is likely to be permanent, while slide mounts are more liable to deterioration or accidental injury.

For purposes of accurate study, however, and for convenience of comparison of a large number of specimens, it is necessary to have material fixed and mounted on slides, or at least preserved in bottles. Of the more elaborate methods, we have attained greatest success by fixation in Flemming's stronger solution, followed by staining in iron haematoxylin, with the addition of a light counter-stain of Congo red. Great care is necessary to prevent plasmolysis and distortion.* This method requires too much time if one desires a large series of one species for comparative study.

The following simple method has proved of great service; enough material for two or three mounts is dropped into a small bottle of Flemming's stronger solution for a few seconds or moments (the length of time varying with the delicacy of the species), then rinsed hastily, arranged on slides, and covered with a few drops of two to five per cent. solution of chromic alum; the cover-glass is laid on, the superfluous fluid removed with filter or blotting paper, and the mount sealed with colorless marine glue. Preparations made in this manner are somewhat liable to deterioration because of defective sealing, but enough mounts may

* The most useful discussion of this and similar methods is to be found in the articles by C. J. Chamberlain, Journ. Applied Mic. 1: 156. 1898; 2: 506, 543. 1899, and in the more elaborate work of F. Pfeiffer von Wellheim, Zur Präparation der Süsswasseralgen. Jahrb. wiss. Bot. 26: 674–732. 1894, and Beiträge zur Fixirung und Präparation der Süsswasseralgen. Oesterr. Bot. Zeit. 48: 53–59, 99–105. 1898. (Translation in Bull. Soc. Belg. de Mic. 24: 22–103. 1898.) See also a note by Charles Thom, Bot. Gaz. 24: 273. 1897.

easily be made to give reasonable assurance of preservation of the specimen. While these preparations are not always as well fixed as those made by more elaborate methods, they are very satisfactory for systematic purposes. They even have certain advantages and on the whole are perhaps more useful than more carefully prepared mounts ; the brief subjection to the osmic acid often renders the nuclear and chromatophore characters sufficiently clear, and the natural appearance of the cell-wall is better preserved than in material subjected to longer fixation. Furthermore branched forms can be arranged in a much more life-like manner, and delicate setae are less likely to be lost, than when specimens are passed through many washings.

For preservation in bulk, dilute formalin often gives fair or good results. A better medium, because of its more truly fixative power is Pfeiffer's solution of equal volumes of formol, pyroligneous acid and methyl alcohol. This is convenient for field use, as only a small quantity is required, and specimens may be fixed and preserved for months in it. At any convenient time the material may be removed and, after washing, preserved for staining in glycerine or alcohol. Specimens may even be mounted on the slide in chromic alum directly from this fixative, and they will show a good degree of differentiation.

DISTRIBUTION

No very extended account of the distribution of these plants can be given at present. The printed lists in the various local catalogues are too meagre to be of much value, even if the determinations could be considered reliable. Mr. Wolle's collections, though comprehending specimens from widely separated regions, furnish no very definite contribution to our knowledge of distribution, for a large part of his labels state only the habitat and not the locality in which the specimens were collected. It is to be presumed that most such specimens were collected in the vicinity of Bethlehem, Pa. No general request for specimens from botanists of different sections has been made, because of the difficulty of positive determination of dried specimens.

Our personal collections have been made largely in Greater New York and its immediate vicinity, extending to the palisade

region of New Jersey; lesser collections have been made in Vermont, eastern Massachusetts and Connecticut. Sufficient time has been spent in these different regions to warrant a rough comparison. The region about New York appears to be by considerable the richest in number of species. The region about Boston possesses a good number of species, but brief visits at different seasons have made it appear doubtful if even a thorough exploration would disclose as great variety as is to be found around New York. Litchfield county, Connecticut, is a disappointing region. The very numerous streams would lead one to expect to find a large number of forms. However, during a trip across the county in September very few Chlorophyceae except *Spirogyra* and *Oedogonium* were found; in the spring months some very interesting forms were collected, but no great number could be obtained.

In Vermont, from summer explorations in the vicinity of Burlington and Grand Isle, and investigations during more than a year at St. Johnsbury, we have been forced to the conclusion that there is no great number of forms of common occurence. Possibly more might be seen in the western part of the state in the spring, but the pools and streams there are much less affected by the summer heat than those about New York, and consequently one would not expect a great difference between the spring and summer algal floras. Indeed, *Draparnaldia*, which disappears entirely from New York streams during the summer has been found at St. Johnsbury in August, so that a larger number of species of *Myxonema* also might be expected.

In the vicinity of New York so many of the streams are nearly or quite exhausted during the summer months that one would not expect at that season to find many of these pure-water loving plants. Nevertheless even during the hottest days in the fountain basins and watering-troughs there is a sufficient abundance of material to keep one busy in collecting and comparing different forms, particularly of *Myxonema*, and it is hardly to be supposed that the whole number of these summer forms is here treated.

It is to be regretted that there has been necessity for assuming so critical and perhaps apparently pugnacious an attitude toward the work of others, and in particular Americans, but possibly

their work might have had a more trustworthy character if it had been dealt with more critically during its progress. Indeed, we have been keenly sensible of the lack of criticism upon our own work. It is, perhaps, too easy to find fault with the work of others, and not so easy as one could wish to make great improvement upon their work. The meagerness of the older and of some recent descriptions where the only important characters are size and shape of cells, often makes it a matter of great difficulty to determine species. We have endeavored to emphasize cytological and especially chromatophore characters as much as possible, but often one cannot find important distinctions of that nature, and is forced to rely largely on cell-measurements to separate species which, after careful observation, he is convinced are distinct. It has been particularly disappointing, in the attempt to make synopses of species, to find that even now the use of cell-measurement is one of the most convenient means of separation and has been resorted to in a much greater degree than had been expected.

It is a pleasure to make grateful acknowledgment of the encouragement and counsel, as well as sympathetic companionship in laboratory and field, of Professor L. M. Underwood and others of the Botanical Department of Columbia University, and to express our thanks to those who have furnished specimens for study, and given guidance in collection, notably Mr. F. S. Collins, Mr. Isaac Holden, Professor G. E. Stone, Dr. David Griffiths, and Dr. M. A. Howe.

ORDER CHAETOPHORALES *

Family **ULOTHRICACEAE**

The thallus consists normally of a simple, unbranched, filament of uninucleate cells, which are all (the basal cell only, when

* This new name for the order which has been known as Confervales is proposed by Wille (Nyt Mag. for Naturvid. 39: 1–22. 1901), because the latter name is rendered unsuitable in consequence of the removal by recent authors of the genus *Conferva* from the Ulothricaceae. The name of the order Confervales Borzi, including the new family Confervaceae, the Ophiocytiaceae, etc., is confusing in view of the older order Confervales, and ought, moreover, to be changed because the genus *Conferva* Lagerh. should be known as *Tribonema* Derb. & Sol.

Professor Wille appears to take a backward step in the paper cited, in that the Ulothricaceae are there placed under the Ulvaceae. The two families are closely related, and possibly almost overlap, but it seems more convenient to retain both.

present, excepted) capable of division and of transformation into sporangia. Each cell contains one band-shaped or reticular, or one to several disk-shaped chromatophores. Vegetative reproduction by breaking apart of the cells to form new filaments. Asexual reproduction by means of zoöspores which germinate immediately or after a period of rest, by akinetes, and by aplanospores. Sexual reproduction through isogamous fertilization or conjugation of gametes of similar size and character.

Synopsis of Genera

Filaments attached; chromatophore a homogeneous, zonate band, with one to several pyrenoids. I. ULOTHRIX.

Filaments not attached; chromatophore a parietal disk or plate, with one pyrenoid. II. STICHOCOCCUS.

Filaments generally not attached; chromatophore granular, covering more or less completely the whole cell wall, containing starch but no pyrenoids. III. MICROSPORA.

Filaments attached only when young; chromataphores several, disk-shaped, without starch. IV. TRIBONEMA.

With the exception of *Ulothrix* and *Stichococcus* the genera of this family are not closely related. These two may be considered as having a common origin from a unicellular form, or the former may be derived from the latter. *Microspora*, in its chromatophore structure at least, shows some affinity with *Rhizoclonium* of the Cladophoraceae, although it is always distinguished from the latter by the absence of pyrenoids, and the single nucleus.

Tribonema in all probability had a different origin and is apparently more closely related to the Ophiocytiaceae than to the other genera of the Ulothricaceae.

I. ULOTHRIX Kützing, Flora, **16**: 517–521. 1833

Hormiscia Aresch. Act. Reg. Soc. Sci. Upsal. III. 6[1]: No. 2. p. 12. *p. p.* 1866. Not Fries, Flor. Scan. 327. 1835.

Including *Hormospora* Bréb. Ann. Sci. Nat. Bot. III. **1**: 25. 1844. (?)

Filaments consisting of a single series of uninucleate cells, all (except the rhizoid-like basal cell) capable of division and reproduction. Chromatophore a homogeneous parietal band (some-

times not completely encircling the cell), enclosing one to several pyrenoids.

Asexual reproduction by means of zoöspores, formed to the number of 1–4 in any cell; they are 4-ciliate, furnished with a red eyespot, and germinate immediately, forming a holdfast. Akinetes are also formed.

Sexual reproduction through conjugation of biciliate gametes of which 8 or more may be formed in a cell.

Inhabitants of fresh and salt water. Type, *U. tenuissima* Kütz. [Etym. οὖλος, crisped, and θρίξ, hair.]

European algologists like Hansgirg and DeToni, who have contended for the prevalence of *Hormiscia* over *Ulothrix* on the ground of priority, appear to have overlooked the real date of *Ulothrix*. It is referred to by Kützing himself in the Species Algarum as founded on *U. tenuissima* Kütz. Alg. Dec. *144*. 1836. Actually, the genus was founded three years earlier by the description of this species as the type (*i. e.*, the first in order), and the addition of well-known *Conferva* species, notably *C. zonata* Web. & Mohr. Unquestionably, then, *Ulothrix* has the claim of priority over *Hormiscia* Fries, 1835.

As a matter of fact the two genera should never have been treated as synonymous, for *Hormiscia* originally included only *Conferva penicilliformis* Roth and *C. Wormskioldii* Flor. Dan., both of which have recently been acknowledged to belong to *Urospora* Aresch. rather than to *Ulothrix*. Rabenhorst ('47) at first employed *Hormiscia* in its correct, restricted sense; but in his final work (Flora Europaea Algarum) he adopted the erroneously enlarged sense of Areschoug ('66), who had placed with *Hormiscia penicilliformis* (Roth) Fries, *Ulothrix zonata* (Web. & Mohr) Kütz., a species which never belonged in such an affinity. At the same time Areschoug had established a new genus *Urospora* on a supposed new species *U. mirabilis*. In 1874 Areschoug discovered that his *Urospora mirabilis* was identical with *Hormiscia penicilliformis* (Roth) Fries, but instead of reducing his genus *Urospora* to synonymy, as he should have done, he created the new combination *Urospora penicilliformis*.

The fact that *Hormiscia* has been recently employed in the incorrect sense inaugurated by Areschoug and continued by Rabenhorst, does not militate against the necessity of reviving it

in its original sense, viz., for the species now recognized under *Urospora.**

Hormiscia in this sense is distinguished from the marine species of *Ulothrix* by the larger size of its filaments, the chromatophore consisting of a more or less spiral band or of a somewhat reticular parietal plate, and above all by the zoöspores which are narrowed at the posterior end into a pointed tail-like process. This genus (as *Urospora*) has been removed to the Cladophoraceae by Wille ('90), on account of the multinucleate character of the cells, and therefore does not receive detailed treatment here.

Synopsis of Species

Fresh-water species.	
Filaments 11–45 μ in diameter, pyrenoids several.	
Mature filaments 25–45 μ in diameter.	1. *U. zonata.*
Cells 15–20 μ in diameter, ½ as long.	2. *U. tenuissima.*
Cells 13–16 μ in diameter, 1–2 times as long.	3. *U. aequalis.*
Cells 11 μ in diameter, ¼–½ as long.	4. *U. oscillarina.*
Filaments 5–9 μ in diameter, one pyrenoid in a cell.	
Cells 7.5–9 μ in diameter.	5. *U. tenerrima.*
Cells 5–6 μ in diameter.	6. *U. variabilis.*
Salt or brackish-water species.	
Diameter 6–15 μ, cell-wall thin.	7. *U. implexa.*
Diameter 10–25 μ, cell-wall thickened.	8. *U. flacca.*

1. ULOTHRIX ZONATA (Web. & Mohr) Kütz. Flora, **16**: 519. 1833; Phyc. Gen. 251. *pl. 80.* 1843; Spec. Alg. 347. 1849; Tab. Phyc. **2**: *pl. 90. f. 2.* 1852. Dodel, Jahrb. wissen. Bot. **10**: 417–450. *pl. 31–38.* 1876. Wolle, F. W. Alg. 133. *pl. 117.* 1887. Chodat, Beitr. Krypt. Flor. Schweiz, 1^3: 267. *f. 183.* 1902.

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* The North American species, then, are as follows:

1. HORMISCIA PENICILLIFORMIS (Roth) Fries, Flor. Scan. 327. 1835.

Conferva penicilliformis Roth, Cat. Bot. **3**: 271. 1806.

Urospora mirabilis Aresch. Nov. Act. Reg. Sci. Upsal. III. 6^1: No. 2, p. 16. 1866.

Urospora penicilliformis Aresch. Nov. Act. Reg. Sci. Upsal. III. 9^1: No. 1, p. 4. 1874.

2. HORMISCIA WORMSKIOLDII (Fl. Dan.) Fries, *l. c.* 328.

Conferva Wormskioldii Fl. Dan. *pl. 1547.* 1816.

Urospora Wormskioldii Rosenvinge, Bot. Tidssk. **18**: 57.64. 1892.

3. HORMISCIA COLLABENS (Ag.) Rabenh. Deutsch. Krypt. Flor. 2^2: 115. 1847.

Conferva collabens Ag. Syst. Alg. 102. 1824.

Hormotrichum collabens Kütz. Phyc. German. 205. 1845.

Conferva zonata Web. & Mohr, Naturhist. Reise Schwed. 97. *pl. 1. f. 7.* 1804. Lyngb. Tent. Hyd. Dan. 136. *pl. 45.* 1819. Agardh, Syst. Alg. 90. 1824.

Conferva lucens Dillwyn, Brit. Conferv. *pl. 37.* 1805. Eng. Bot. *pl. 1635.* 1806.

Myxonema zonatum Fries, Syst. Orb. Veg. **1**: 343. 1825; Flor. Scan. 329. 1835. Rabenh. Deutsch. Krypt. Flor. **2**^{2}: 99. 1847.

Lyngbya zonata Hass. Brit. F. W. Alg. 220. *pl. 59.* 1845.

Hormiscia zonata Aresch. Act. Reg. Soc. Sci. Upsal. III. **6**^{1}: No. 2. p. 12. *pl. 2.* 1866. Rabenh. Flor. Eur. Alg. **3**: 362. 1868. Cooke, Brit. F. W. Alg. 179. *pl. 69.* 1883. De Wild, Flor. Alg. Belg. 36. *f. 12.* 1896; Flor. Buitenz. **3**: 57. *f. 7.* 1900.

The filaments form yellowish-green, fluctuating masses, .5–2 dm. in length; cells cylindrical or somewhat swollen, 11–45μ in diameter, ⅓–1½ (in young filaments 3) times as long; the cell-wall at first thin, with age growing thicker, especially in the circumferential region of the septations, so that the larger cells appear to be constricted at the joints; chromatophore forming a broad or narrower girdle, enclosing several large pyrenoids (*pl. 20. f. 1–4*).

EXSICC.: Phyc. Bor. Am. *19. A.* Fairfield, Conn., Jan. 1894. (I. Holden); Not *19. B.* (=*Microspora amoena*). Tild. Am. Alg. 7. Minneapolis, Minn., April, 1894; *131.* (var. *valida* Näg.) Lake Superior, Minn., Jul. 1896. (A. H. Elftman).

On stones or wood, in quiet or rapid waters.

VERMONT: St. Johnsbury, April (672); North Hero, June (681); Alburg, Lake Champlain; 30 June (683).

CONNECTICUT: Derby, April (538); Thomaston, May (567).

NEW YORK: Williamsbridge, April (95, 294); Woodlawn, May (596), Bronx Park, May (373); Central Park, March (260), April (323, 525, 84), May (104, 381, 382, 386, 594), June (614, 619).

NEW JERSEY: Nordhoff, May (356).

IDAHO: Nez Perces county, 1896 (A. A. Heller).

Small forms of this species make their appearance in the drinking fountains and horse troughs of New York in early spring. At first one would be inclined to refer these forms to some smaller species, but prolonged observation of the development is suffi-

cient to convince one of their relation, as young forms, to this largest species of the genus.

In May the rocky borders of the lake in Central Park become fringed with a growth which rapidly develops into the typical *U. zonata.* We have never found this growth early in the season, and it disappears soon after the first hot days at the end of May or in June.

A number of species and varieties of European authors have not been satisfactorily distinguished as more than growth forms of *U. zonata.* Such are *U. pectinalis* Kütz., *U. inaequlis* Kütz., *U. zonata attenuata* (Kütz.) Rabenh., *U. zonata varians* (Kütz.) Rabenh., *U. zonata valida* (Näg.) Rabenh., and *U. zonata rigidula* (Kütz.) Hansg.

2. ULOTHRIX TENUISSIMA Kütz. Flora, **16**: 518. 1833; Phyc. Gen. 252. 1843*

Ulothrix tenuis Kütz. Phyc. Germ. 197. 1845; Spec. Alg. 347. 1849 (Not *U. tenuis, ibid.*, 346); Tab. Phyc. **2**: *pl. 89. f. 1.* 1852. Rabenh. Flor. Eur. Alg. **3**: 366. 1868. Cooke, Brit. F. W. Alg. 182. *pl. 70. f. 6.* 1883. Wolle, F. W. Alg. 134. *pl. 118. f. 1. 2.* 1887.

Myxonema tenuissimum Rabenh. Deutsch. Krypt. Flor. **2**^{2}: 99. 1847.

Hormiscia tenuis De Toni, Syll. Alg. **1**: 165. 1889. Hansg. Prod. Alg. Böhm. **2**: 213. 1892.

Dark green; vegetative cells always thin-walled, 15–20 μ (rarely 25 μ) in diameter in mature filaments, generally about half as long or shorter, sometimes in younger filaments as long as the diameter, cylindrical, not at all constricted at the septations; chromatophore broad; zoösporiferous filaments somewhat moniliform (*pl. 20. f. 5, 6*).

In running water in brooks and watering troughs.

NEW YORK: Central Park, April (265, 535), May (380).

NEW JERSEY: Fairview, April (297).

Numerous specimens that were at first referred to this species, have been proved, after subsequent collection in the same stations,

* Kützing abandoned this name first given to the species without any expressed reason, but probably because he felt that it was not properly descriptive of the plant after he added to the genus several species that were smaller in respect to diameter.

to be younger forms of *U. zonata.* In the two stations above quoted, however, we have never been able to find typical specimens of *U. zonata.* We feel compelled, therefore, to retain this species for the present, although the remark of Hansgirg, that it apparently belongs in the cycle of forms of *U. zonata*, may be justified by future investigation.

U. tenuissima differs from typical forms of *U. zonata*, besides being of a smaller diameter, in its deeper green color, in its generally shorter cells and in its thin cell-wall. Nevertheless, certain young forms of *U. zonata* show a most perplexing similarity to the form described above.

3. ULOTHRIX AEQUALIS Kütz. Phyc. Germ. 197. 1845; Spec. Alg. 347. 1849; Tab. Phyc. **2**: *pl. 89. f. 1.* 1852; Rabenh. Krypt. Flor. Sachs. **1**: 264. 1863. Wolle, F. W. Alg. 134. *pl. 118. f. 3–5.* 1887.

Myxonema aequale Rabenh. Deutsch. Krypt. Flor. $\mathbf{2}^2$: 99. 1847.

Hormiscia aequalis Rabenh. Flor. Eur. Alg. **3**: 363. 1868.

Filaments bright green in color; cells 13–16 μ in diameter, 1–2 times as long.

In a rapidly flowing brook, attached to stones, Woodlawn, New York, May (571B).

This specimen, when collected, was strikingly different in appearance from *U. zonata*, but deteriorated speedily. When the station was revisited a few days afterward to obtain material for drawing and further study, all traces of the plant had disappeared.

A specimen distributed as *Hormiscia aequalis* Tild. Am. Alg. *132*, is *Microspora* sp.

4. ULOTHRIX OSCILLARINA Kütz. Phyc. Germ. 197. 1845; Spec. Alg. 346. 1849; Tab. Phyc. **2**: *pl. 88. f. 1.* 1852. Rabenh. Flor. Eur. Alg. **3**: 366. 1868. Wolle, F. W. Alg. 137. *pl. 118. f. 34–36.* 1887. (?)

Conferva oscillatorioides Agardh, Disp. Alg. Suec. 29. 1812; Syst. Alg. 89. 1824. (?) Not Kütz. Alg. Dec. *54.* 1833 (= *Gloeotila oscillarina* Kütz. Phyc. Gen. 245. 1843 = *Stigeoclonium setigerum* Kütz. Phyc. Germ. 198. 1845).

Ulothrix oscillatorioides Crouan, Flor. Finist. 122. 1867. (?)

Hormiscia oscillarina DeToni, Syll. Alg. **1**: 167. 1889.

Cells about 11 μ in diameter, and $\frac{1}{4}$–$\frac{1}{2}$ as long, or equal to the diameter in length; chromatophore a broad band.

EXSIC.: Phyc. Bor. Am. *613*, Melrose, Mass., Aug. 1890, floating in a ditch (F. S. Collins).

When we visited this station in May, 1901, with Mr. Collins, no *Ulothrix* was to be seen; possibly this is unlike most species of this genus in being a summer form.

A specimen labelled *U. oscillarina* from Wisconsin in the Wolle herbarium is *Tribonema* sp.

In regard to the name of this species, it is probable that Agardh's form ought to be used. The specimen issued as *Conferva oscillatorioides* Ag. (Desmaz. Pl. Crypt. de France, *1353*) agrees closely with Mr. Collins' plant; but as we have no means of determining with certainty the character of Agardh's plant, Kützing's name is here retained, as being the one in current use.

5. ULOTHRIX TENERRIMA (Kütz.) Kütz. Phyc. Gen. 253. *pl. 9. f. 1.* 1843; Phyc. Germ. 197. 1845; Spec. Alg. 346. 1849 (Excl. var.); Tab. Phyc. **2**: *pl. 87. f. 1.* 1852. Rabenh. Krypt. Flor. Sachs. **1**: 264. 1863; Flor. Eur. Alg. **3**: 366. 1868. Gay, Rech. sur Alg. Vert. *pl. 12. f. 119.* 1891.

Conferva tenerrima Kütz. Linnaea, **8**: 346, 347, 361. *p. p.* 1833.

Myxonema? tenerrimum Rabenh. Deutsch. Krypt. Flor. 2^2: 99. 1847.

Ulothrix subtilis tenerrima Kirchner, Krypt. Flor. Schles. 2^1: 77. 1878. Wolle, F. W. Alg. 136. *pl. 118. f. 17.* 1887.

Hormiscia subtilis tenerrima DeToni, Syll. Alg. **1**: 160. 1889.

Ulothrix tenuis Kütz. Spec. Alg. 346. 1849. (?)

Filaments forming light green silky or floccose masses often 1 dm. long; cells cylindrical, 7.5–9 μ in diameter, $\frac{2}{3}$–1 $\frac{1}{3}$ times as long; cell-wall very thin; chromatophore zonate or contracted to one side of the cell, with one pyrenoid (*pl. 21. f. 3, 4*).

On the sides of an iron fountain basin, and in a wooden watering-trough, St. Johnsbury, Vermont, September and October (645, 651).

The chromatophore in the actively vegetative state is zonate, and the appearance of a filament is then like a miniature specimen

of *U. zonata.* When kept in stagnant water the chromatophore becomes reduced to a small plate, and the filament looks very much like that of *U. variabilis.* From the latter, however, it seems always to be distinguishable by its greater diameter. It might seem at first sight that this is only a large form of *U. variabilis,* but from careful observation of the living plants the points of distinction are convincing though not easily described.

The plant did not make its appearance in the two stations where we have observed it earlier than August, and probably not until during September. The chromatophores seemed to be somewhat injured by the first frosts; whether the plant would have been killed before winter could not be determined, because of the fact that the water was drained from both basins at the approach of cold weather.

6. ULOTHRIX VARIABILIS (Kütz.) Kütz. Spec. Alg. 346. 1849; Tab. Phyc. 2: *pl. 85. f. 3.* 1852. Rabenh. Krypt. Flor. Sachs. 1: 263. 1863; Flor. Eur. Alg. 3: 365. 1868. Cooke, Brit. F. W. Alg. 182. *pl. 70. f. 4.* 1883. (?) Wittrock; Nordensk. Stud. och Forskning. *pl. 3. f. 27, 28.* 1883. (?)

Hormidium variabile Kütz. Phyc. Germ. 192. 1845.

Ulothrix subtilis variabilis Kirchner, Krypt. Flor. Schles. 2^1: 77. 1878. Wolle, F. W. Alg. 136. *pl. 118. f. 15, 16.* 1887. (?)

Hormiscia subtilis variabilis DeToni, Syll. Alg. 1: 160. 1889.

Filaments forming floccose masses: cells 5–6 μ in diameter, ½–1 ½ times as long, often square in optical section; cell-wall very thin and delicate; chromatophore rarely covering more than half the cell-wall, sometimes taking the form of a rectangular plate, sometimes that of an angular mass contracted into one corner of the cell; the pyrenoid small but distinct (*pl. 21, f. 5–7*).

In brooks and in stagnant waters.

MASSACHUSETTS: Ipswich, May (557).

NEW YORK: East Chester, May (590).

NEW JERSEY: Undercliff, Bergen county, April (278), May (369, 427*B*, 574).

It is a matter of great difficulty, if not impossible, to obtain from the exsiccatae any valuable evidence as to the essential character of such species as *Ulothrix tenerrima, U. variabilis,* and *U. subtilis;* the last two we have been unable to restore from dried specimens

so as to show any particular difference between their chromatophore characters. It is also generally difficult to find authoritative points of separation in the original descriptions of such fine species.

In the description, however, of *U. variabilis*, the following phrases are used: "nucleis cellularum quadratis saepius angustis pectinatim dispositis" (Kützing, '49). "Zellinhalt aufangs genau quadratisch" (Rabenhorst, '63), and "cytioplasmate initio semper quadrato-contracto (Rabenhorst, '68). Now the chromatophore of the form identified above as this species would hardly be called square, but it is generally contracted and placed on one side of the cell. Furthermore, so far as one can judge from the illustration given by Kützing ('52), our specimens conform to his species.

We believe, therefore, that there is no question as to the correctness of the above description for *U. variabilis* and of the distinctness of this form from *U. subtilis* (= *Stichococcus subtilis* Klerck.). There is certainly no question as to the specific distinctness of the two forms above described from that which is hereinafter identified as *Stichococcus subtilis*.

Illustrations like that of Wittrock ('83) for this species and that of Wille ('85) for *U. variabilis* f. *marina*, in which the chromaophore has a homogeneous, square appearance, were undoubtedly made from material not well preserved. They show exactly the similarity of appearance which is to be found in dried specimens of small forms of *Ulothrix* and *Stichococcus*.

7. ULOTHRIX IMPLEXA (Kütz.) Kütz. Spec. Alg. 349. 1849; Tab. Phyc. **2**: *pl. 94. f. 2.* 1852. Hauck; Rabenh. Krypt. Flor. Deutschl. **2**: 440. 1885. Reinbold, Schrift. Nat. Ver. Schles.-Holst. **8**: 129. 1889. Batters, Trans. Berwick. Nat. Club, — (35). 1889. Foslie. Tromsö Mus. Aarsh. **13**: 143. 1890. Collins, Bull. Torrey Club, **18**: 336. 1891.

Hormidium implexum Kütz. Bot. Zeitung, **5**: 177. 1847.

Ulothrix Ligustica Dufour, Erb. Critt. Ital. I. *1032* (*fide* De Toni).

Bangia? confervoides Zanard. Atti R. Ist. Ven. **6**: 249. *pl. 2.* 1847.

Ulothrix? confervoides DeToni & Levi, L'Algarium Zanardini, 134. 1888.

Ulothrix submarina Kütz. Spec. Alg. 349. 1849; Tab. Phyc. **2**: *pl. 94. f. 3.* 1852.

Hormiscia implexa Rabenh. Flor. Eur. Alg. **3**: 364. 1868. DeToni, Syll. Alg. **1**: 168. 1889.

Ulothrix flacca Dodel-Port, Illust. Pflanz. 148. *f. 28.* 1883.

Ulothrix subflaccida Wille, Vid.-Selsk. Skrift. **1900**[6]: 27. *pl. 3. f. 90–100.* 1901. (?)

Light green, forming dense tufts or masses of interwoven and contorted filaments; cells cylindrical or slightly swollen, 6–15 μ in diameter, about as long as broad or somewhat shorter; cell-walls thin; chromatophore band often incomplete (approaching the parietal dish of *Stichococcus* in appearance), inclosing one pyrenoid (*pl. 21, f. 1, 2*).

EXSIC.: Phyc. Bor. Am. *115A*, Bridgeport, Conn., May, 1893 (I. Holden); *115B*, Malden, Mass., June, 1892 (F. S. Collins).

On rocks, or less frequently on grasses, in regions more or less exposed to fresh water.

NEW HAMPSHIRE: Little Boar's Head, 4 May, 1902 (F. S. Collins).

RHODE ISLAND: Mackerel Cove, Conanicut Island, 21 April, 1898 (F. S. Collins).

CONNECTICUT: Bridgeport, May (570).

NEW YORK: Larchmont, October (520); New Rochelle, May (586).

NEW JERSEY: Undercliff, April (275, 308).

This species seems to furnish a point of connection between the more strictly marine species, *U. flacca*, and the series of exclusively fresh water forms. Batters ('89) states that *U. implexa* grows on rocks near high-water mark exposed to the drip of fresh water. We have always found it well covered with water, fresh or salt. At Bridgeport it grows near the mouth of tidal creeks where the water is nearly as salt as in the sound. At New Rochelle it seems to grow mostly below the tidal line, but at the mouth of a stream of such force that the salt water influence would be largely modified. In the other two stations it was growing near the mouth of streams exposed to salt water only during the flow of the tide.

U. implexa was reported from Florida by Wolle, Bull. Torrey Club, **6**: 287. 1879.

The species seems to be less abundant than *U. flacca*, but it is probable that in some cases it has been confused with the latter or with fresh water forms.

Professor Wille ('01) has apparently described under the new name *U. subflaccida* the form which has long been identified as *U. implexa*. His reasons for rejecting, or at least holding in abeyance, Kützing's name (chiefly on the ground that it cannot be determined from literature just what Kützing's species was) seem to be insufficient. Many current names cannot be vouched for with absolute certainty, but until their modern application is proved to be incorrect it is less confusing to retain them. One point emphasized by Professor Wille is that the habitat of *U. implexa* as given in the Tabulae Phycologicae is "in Gräben"; but he seems to have overlooked the original description (Bot. Zeitung, 1847) where it is stated that the species is found "in submarinis, inter *Rhizoclonium interruptum*,"—exactly the sort of habitat where we find our *U. implexa*. The illustration in Tabulae Phycologicae is not bad for our species, when it is remembered that it was made (probably) from dried material.

8. ULOTHRIX FLACCA (Dillw.) Thuret; Le Jolis, Mem. Soc. Imp. Sci. Nat. Cherb. **10**: — (56). 1864. Farlow, Mar. Alg. 45. 1881. Reinbold, Schrift. Nat. Ver. Schles.-Holst. **8**: 129. 1889. Foslie, Tromsö Mus. Aarsh. **13**: 144. *pl. 3. f. 1–3.* 1890.

Conferva flacca Dillwyn, Brit. Conferv. *pl. 49.* 1805. Eng. Bot. *pl. 1943.* 1808. Lyngb. Tent. Hyd. Dan. 144. *pl. 49 A.* 1819. Aresch. Phyc. Scand. Mar. 205. 1850.

Lyngbya Carmichaelii Harv.; Hook. Brit. Flor. **2**[1]: 371. 1833; Phyc. Brit. **4**: *pl. 186 A.* 1851.

Hormidium flaccum Kütz. Phyc. Gen. 244. 1843.

Hormotrichum flaccum Kütz. Spec. Alg. 381. 1849; Tab. Phyc. **3**: *pl. 63.* 1853.

Lyngbya flacca Harv. Phyc. Brit. **1**: xxxviii; **4**: *pl. 300.* 1851.

Hormiscia flacca Aresch. Alg. Scand. *342.*

Urospora penicilliformis Aresch. Act. Reg. Soc. Sci. Upsal. III. **9**[1]: No. 1. p. 4. *p. p.* 1874. DeToni, Syll. Alg. **1**: 232. 1889.

Bright green, growing in short tufts or long tangled skeins; cells cylindrical with strongly thickened outer wall, 10–25 μ in diameter, ¼–¾ as long, the septations thin; chlorophyll-band filling the length of the cell, containing (in the vegetative condition) one distinct pyrenoid; when the cell contents are preparing for formation of zoöspores, many pyrenoids may be seen in a cell (*pl. 20, f. 7–9*).

EXSIC.: Phyc. Bor. Am. *17*, Nahant, Mass., March, 1891. (W. A. Setchell). Alg. Exsic. Am. Bor. Mystic River, Malden, Mass. (F. S. Collins). Hauck & Richt, Phyk. Univ. *729*. Mystic River, Mass., March, 1889 (F. S. Collins).

On *Fucus* and on leaves and culms of *Spartina*, etc. (rarely on rocks), between tide limits. Common on the New England coast and in New Jersey, at least as far south as Atlantic City.

MAINE: Seguin Island, Aug. 30, 1900 (M. A. Howe, *238*).

CONNECTICUT: Bridgeport, May (571).

NEW YORK: Pelham Bay, April (12), April 18, 1901 (M. A. Howe); College Point, February (250, 251); Rosebank, Staten Island, December (231, 240); Livingston, April (326).

NEW JERSEY: Undercliff, Bergen county, April (310, 533); Atlantic City, Dec. 25, 1888 (I. Martindale).

This species is very generally found growing on *Fucus;* on only one occasion have we seen it on rocks and shells. In this respect it is opposed to *Hormiscia penicilliformis* (*Urospora*) which is always found on rocks and timber, and never, so far as is known to us, on *Fucus* or grasses. Professor Wille ('01) states that at Dröbak *U. flacca* is found only on stones and rocks. He has created a new species, *U. pseudoflacca*, which seems to be distinguished from this only by such slight physiological or reproductive characteristics that we fail to see how he can determine which is the original *U. flacca.* Physiological characters are sometimes of importance, but it is questionable whether consistency would not demand the abandonment of the name *U. flacca* quite as much as that of *U. implexa.*

Like most fresh water forms, this species usually disappears during the summer, but it probably forms a more luxuriant growth in late autumn and winter, while the fresh water forms do not develop extensively except in spring.

DOUBTFUL SPECIES

ULOTHRIX MONILIFORMIS Kütz. Spec. Alg. 347. 1849; Tab. phyc. **2**: *pl. 88. f. 4.* 1852.

Hormidium moniliforme Kütz. Phyc. Gen. 244. 1843.

Hormiscia moniliformis Rabenh. Flor. Eur. Alg. **3**: 361. 1868. Cooke, Brit. F. W. Alg. 179. *pl. 70. f. 1.* 1883.

Light green, more or less crisped, torulose, 11–14 μ in diameter; cell-wall thickened.

EXSIC: Phyc. Bor. Am. *612.* East Haven, Conn., April, 1894 (W. A. Setchell).

This specimen is certainly a form of *Ulothrix* and corresponds exactly to Kützing's figure and description. Whether it is a distinct species, or only a condition of some other species with a thickened cell-wall, cannot at present be determined.

Wolle records this species as collected by Austin in sphagnum swamps in New Jersey (Bull. Torrey Club, **6**: 188. 1877), but the specimen in the Wolle herbarium is composed of *Microspora floclosa* in the akinete stage. The same may be said of *Ulothrix lacustris* Hilse; Rabenh. Alg. Eur. *1540*, which is quoted as a synonym of *U. moniliformis* in Rabenh. Flor. Eur. Alg. **3**: 361. 1868. Probably Wolle finally recognized the true character of his specimens, for no mention is made of the species in the Fresh Water Algae.

ULOTHRIX SUBTILIS THERMARUM Rabenh. Flor. Eur. Alg. **3**: 365. 1868. Hansg. Prod. Alg. Böhm. **1**: 59. 1886. Wolle, F. W. Alg. 136. *pl. 118. f. 18, 19.* 1887. DeToni, Syll. Alg. **1**: 160. 1889.

EXSIC.: Rabenh. Alg. Eur. *2568*, June, 1877. Bethlehem, Pa. (F. Wolle). Wittr. & Nordst. Alg. Exsic. *419.* Bethlehem, Pa. (F. Wolle).

ULOTHRIX FLACCIDA CALDARIA (Kütz.) Hansg. Prod. Alg. Böhm. **1**: 61. 1886.

Gloeotila caldaria Kütz. Phyc. Germ. 191. 1845; Spec. Alg. 363. 1849; Tab. Phyc. **3**: *pl. 32. f. 3.* 1853. Rabenh. Flor. Eur. Alg. **3**: 320. 1868.

Hormiscia flaccida caldaria Hansg. Flora, **71**: 265. 1888. DeToni, Syll. Alg. **1**: 162. 1889. Tilden, Bot. Gaz. **25**: 91. *pl. 8. f. 4, 5.* 1898.

EXSIC.: Tild. Am. Alg. *130*. Yellowstone Park, 1896.

These two varieties are forms of similar character, both growing in warm water, and it is very probable that they should be united into one species.

The diameter of *Ulothrix thermarum* is 5–6 μ, with cells 1–3 times as long. *Gloeotila caldaria* has a diameter of 5 μ (Kützing) (5.6–7.5 μ, Rabenh.) with cells 2–3 times as long.

Without study of fresh material it is impossible to say whether these forms belong to *Ulothrix* or to *Stichococcus*.

II. STICHOCOCCUS Nägeli, Neue Denkschr. Allgem. Schweiz. Gesell. **10**[7]: 76, 77. 1849. Gay, Rech. sur Alg. Vert. 77–79. 1891.

Ulothrix (*Hormidium*) Kütz. Spec. Alg. 349. *p. p.* 1849. Not *Hormidium* Kütz. Phyc. gener. 244. 1843.

Hormococcus Chodat, Beitr. Krypt. Flor. Schweiz, **1**[3]: 268–270. 1902.*

Filaments without a special basal cell, fine, consisting of few cells or long and *Ulothrix*-like; chromatophore a parietal curved disk or plate, usually covering not more than half of the cell-wall, containing one pyrenoid, the nucleus usually on the opposite side of the cell.

Vegetative reproduction by dissociation of the filament into single cells. Asexual reproduction through bi-ciliate zoöspores without eyespot, which are formed singly in any cell, escape through a small round hole in the cell-wall, and germinate without formation of a holdfast.

Inhabitants of damp earth, or rock, or fresh water, one species in brackish or salt water. Type *S. bacillaris* Näg. [Etym. στίχος, row, series, and κόκκος, berry.]

The genus *Hormidium* as first named by Kützing in Linnaea, **17**: 89. 1843, contained three species, *H. moniliforme*, *H. velutinum*, *H. flaccum* (Dillw.), of which the first two were *nomina nuda*. His *Phycologia generalis*, published later in the same year, in-

* The action of Chodat in proposing this new name is inexplicable. All the species included in it are placed by recent authors in *Stichococcus*, and the two genera are therefore exactly synonymous except that for the type of this new genus the species *Stichococcus flaccidus* has been selected instead of *S. bacillaris*. Equally unjustifiable in the light of recent investigation is the inclusion of the well-marked species *S. flaccidus*, *S. dissectus*, *S. bacillaris* and *S. fragilis* to say nothing of *Hormidium nitens*, as varietal forms under the single Sammelspecies *Hormococcus flaccidus*.

cluded in the genus the same species in the same order, with descriptions. In his final work, *Species Algarum* (1849), Kützing placed *H. moniliforme* in its present position in *Ulothrix*, *H. flaccum* in the genus *Hormotrichum*, and for *H. velutinum*, together with additional forms created the section *Hormidium* under *Ulothrix*. Of the three original species, the first and third are now recognized as belonging in *Ulothrix*, while *H. velutinum* is referred to *Schizogonium*. Clearly, then, Gay, ('91) was justified in abandoning the name *Hormidium*.

There are, however, several species among those referred to *Hormiscia* (*Ulothrix*) by DeToni ('89) which form, together with certain more recently described species, a group possessing characters which furnish good reason for their separation from *Ulothrix*. These were placed by Gay in the genus *Stichococcus* Nägeli ('49) because of their tendency, in common with *S. bacillaris*, toward aërial life and vegetative reproduction. Because of the supposed absence of reproduction by zoöspores this genus was placed with the Protococcaceae rather than with the Ulothricaceae. Klercker ('96) went a step farther, and added to *Stichoccocus* a form which he supposed to be *Ulothrix subtilis* Kütz., a species which is very generally aquatic.

Now in one of the best known *Stichococcus* species, *S. flaccidus* (Kütz.) Gay, Klebs ('96) found zoöspores (there seems to be no reason for doubting the correctness of the determination of the species). He therefore revived the genus *Hormidium*, because of his objection to the name *Stichococcus* as implying affinities with the Protococaceae. Our own investigations have shown convincingly that all the forms belonging to this group that are known in America, with one possible exception, at times reproduce by zoöspore formation, hence there is not the slightest doubt that the genus must be kept in the closest affinity with *Ulothrix*.

The single species in which we have not observed zoöspores is *Stichococcus bacillaris* Nägeli, the historical type of the genus. Nevertheless, as we cannot say that zoöspores are never formed in this species, which has every appearance of close affinity with the rest, and there is no other name available, it is necessary to retain these forms under the name by which they are known in recent literature.

Synopsis of Species

Cells cylindrical, hardly constricted at the dissepiments.	
Cell diameter 2.5–3 μ, 1–4 times as long, filaments short.	1. *S. bacillaris.*
Cell diameter 3–3.5 μ, 1–10 times as long, filaments elongated.	2. *S. scopulinus.*
Cell diameter 5–6 μ, 1–2 times as long; marine form.	3. *S. marinus.*
Cell diameter 5–6.5 μ, 1–3 times as long, filaments elongated.	4. *S. subtilis.*
Cells constricted at the dissepiments, or somewhat tumid.	
Cell diameter 6–9.5 μ, on damp rocks, earth, etc.	5. *S. flaccidus.*
Cell diameter 6.5–9 μ, in cascades.	6. *S. fluitans.*
Cell diameter 8–11 μ, forming holdfasts.	7. *S. rivularis.*

1. STICHOCOCCUS BACILLARIS Nägeli, Neue Denkschr. Allgem. Schweiz. Gesell. **10**[7]: 77. *pl. 4 G. f. 1.* 1849. Rabenh. Flor. Eur. Alg. **3**: 47. *f. 21.* 1868. Hansg. Prod. Alg. Böhm. **1**: 139, *f. 85.* 1886; Phyc. u. Alg. Stud. *pl. 4. f. 5.* 1887. DeToni & Levi, Notarisia, **2**: 281–283. 1887; Flor. Alg. Ven. **3**: 125. 1888. DeToni, Syll. Alg. **1**: 687. 1889. Gay, Rech. Sur Alg. Vert. 78. *pl. 11. f. 107.* 1891. Klercker, Flora, **82**: 102. *pl. 6. f. 9–13.* 1896.

Protococcus bacillaris Näg.; Kütz. Spec. Alg. 198. 1849.

Hormococcus flaccidus bacillaris Chodat, Beitr. Krypt. Flor. Schweiz, **1**[3]: 269. 1902.

Filaments pale green, fine and short (composed of 2–24 cells, DeToni), very readily breaking apart; cells cylindrical but slightly constricted at the ends, 2.5–3 μ in diameter, 1–4 times as long; chromatophore thin and pale, elliptical (*pl. 22. f. 1*).

On damp earth or rock, and on flower pots, etc., in greenhouses, Central Park, New York, June (637).

Ib. S. BACILLARIS Näg. forma **confervoidea** f. nov.

Filaments longer, often crisped, usually growing in association with masses of *Tribonema* and other confervae; cell characters as in the typical form (*pl. 22. f. 2, 3*).

Filaments scattered or in small floccose masses, in pools or gently flowing water.

MASSACHUSETTS: Pine Banks Park, Melrose, April (550).

NEW YORK: Botanical Garden, April (534B); Central Park, May.

NEW JERSEY: Ridgefield, April (298).

So far as can be seen this form differs from the type only in the length of the filaments and in its habitat. Neither this nor the typical form has been studied sufficiently to make it possible abso-

lutely to connect the two in life history; but as there is every reason to believe that this is only a form which has been favored by a more abundant supply of water, we feel obliged to make this disposition of it. As it is a generally distributed, though not abundant form, one may better call attention to it than ignore it.

2. **Stichococcus scopulinus** sp. nov.

Filaments forming long, bright green, lubricous masses; cells cylindrical, not constricted at the dissepiments, 3–3.5 μ in diameter, 1–10 times as long: cell-wall very thin: chromatophore narrow, pale green, without a distinct pyrenoid: asexual reproduction, by means of a single zoöspore formed in each cell, more frequent than the vegetative mode (*pl. 22, f. 4–6*).

Hanging in skeins from dripping rocks, Morningside Park, New York, April (263, 321A, 285, 353 *p. p.*, 531).

This species is distinguished from *Stichococcus bacillaris* f. *conferviodea* usually by longer cells, and by its manner of growth in long dense masses of straight filaments instead of in scattered, crisped filaments or small floccose masses, as in that form.

It is usually abundant at the type station during the winter and early spring. Later it gives way to *S. subtilis*, but careful and repeated observations have furnished convincing evidence that it is not a young stage of that plant, but a distinct species.

Stichococcus scopulinus does not long persist in the filamentous state when brought into the laboratory; very soon it either breaks up into the coccoid state or forms zoöspores abundantly.

3. **Stichococcus marinus** (Wille)

Ulothrix variabilis Kütz. (?) forma *marina* Wille, Dijmphna-Togtets Zoöl.-bot. Udbytte, 87. *pl. 13. f. 8.* 1885. (?)

Filaments dark green; cells cylindrical, 5–6 μ in diameter, 1–2 times as long; chromatophore a roundish or oblong plate, pyrenoid indistinct.

One zoöspore is formed in a cell and escapes through a small round aperture (*pl. 21, f. 8, 9*).

EXSIC.: Phyc. Bor. Am. *615*. Ash Creek, Bridgeport, Conn., August, 1895 (I. Holden), incorrectly quoted as *U. variabilis* Kütz. var. *marina* Wille, Rhodora, **2**: 12. 1900.

In tangled masses about culms of *Spartina*, in company with *Ulothrix implexa;* bank of Yellow Mill Pond, Bridgeport, Conn.,

18 May, 1901 (570B). Mt. Desert, Maine, July 17, 1900 (F. S. Collins).

The figure accompanying Professor Wille's original description of this form leads us to doubt whether our American specimens should be identified with it. There is no question, however, that both of the Connecticut specimens are the same species and also no question, in our judgment, that they should be referred to *Stichococcus* rather than to *Ulothrix*.

Professor Wille's identification of the specimen issued in the Phycotheca was not based, of course, upon living material, a condition which is essential to a critical treatment of such fine species. Under the kind direction of Mr. Holden, we made a careful attempt to duplicate the specimen from the same station, but in vain. In a tidal creek of the same harbor, however, where the conditions were exactly similar, we obtained material which was undoubtedly of the same species as that collected by Mr. Holden.

From a careful study of this fresh material in comparison with exsiccatae, the species proves to be more closely allied to *Stichococcus subtilis* than to *Ulothrix variabilis*. The cells are frequently longer than in the latter species, the chromatophore is more like that of *S. subtilis* and lacks the clearly refractive pyrenoid characteristic of *Ulothrix*. The appearance of the chlorophyll was decidedly different from that of *U. implexa* with which this species was associated, and showed the bluer tint which is more characteristic of many *Stichococcus* species. The fact that only one zoöspore was formed in a cell, while not conclusive proof, points to *Stichococcus* rather than *Ulothrix*, for filaments of *U. implexa* possessing only a slightly larger diameter contained several zoöspores in a cell. On the whole, therefore, we are convinced that the species belongs in *Stichococcus*.

4. STICHOCOCCUS SUBTILIS (Kütz.) Klercker, Flora, **82**: 103. 1896

Ulothrix subtilis Kütz. Phyc. Germ. 197. 1845; Spec. Alg. 345. 1849; Tab. Phyc. **2**: *pl. 85. f. 1.* 1852. Rabenh. Flor. Eur. Alg. **3**: 365. 1868. Kirchn. Krypt. Flor. Schles. **2**[1]: 77. *p. p.* 1878. Wille, F. W. Alg. 135. *pl. 118. f. 9, 10 p. p.* 1887. Chodat, Beitr. Krypt. Flor. Schweiz, **1**[3]: 268. 1902.

Hormiscia subtilis DeToni Syll. Alg. 1: 159. *p. p.* 1889.

Filaments long, often forming extended bright green, lubricous masses; cells cylindrical, not constricted at the dissepiments, 5–6.5 μ (rarely 8 μ) in diameter, 1–3 times as long; cell-wall thin; chromatophore elliptical, containing a rather small pyrenoid. Zoöspores are formed freely at certain times; the cells break apart for vegetative propagation less readily than in any other species (*pl. 21, f. 10–13*).

EXSIC.: Phyc. Bor. Am. (*Ulothrix subtilis*), *614A.* Medford, Mass., June, 1892; *614B.* Melrose, Mass., August, 1898 (F. S. Collins); *614C.* Nantucket, August, 1895 (W. A. Setchell).

On moist or dripping cliffs, on rocks of cascades, in watering-troughs and in quiet waters.

VERMONT: St. Johnsbury, August to October (642, 647).

MASSACHUSETTS: Melrose, April (549).

CONNECTICUT: Thomaston, September (494), May (543); Plymouth, October to May (665, 521, 523); Watertown, May (561, 562).

NEW YORK: Botanical Garden, April (534B); Morningside Park, April (264, 285B, 321B, 353), May (425), June (616), November (512); Central Park, June (617, 637A).

NEW JERSEY: Long Branch, September (477); Undercliff, Bergen county, December (232), April, May (528C, 368, 427A, 576).

PENNSYLVANIA: Bethlehem, June (444).

The filaments of this species show a greater stability than those of any other, with the possible exception of *S. rivularis.* Only rarely are zoöspores seen; sometimes in warm weather they are developed rather freely. The plant is capable of enduring the greatest extremes of dryness or immersion; it vegetates on rocks until their faces become quite dried up in the summer, and, on the other hand, it presents a luxuriant growth amid the icy waters of a watering-trough or in a frozen cascade in winter. Several filaments from drying rock appeared to be forming akinetes in preparation for the summer, but where the water supply is favorable, probably the plant continues to grow during the whole year.

This species perhaps is the one most nearly related to *Ulothrix*, yet its chromatophore and pyrenoid, in the state of active growth, always have the typical *Stichococcus* character. Further-

more, physiologically it behaves like other species of *Stichococcus*, in that its cell-walls do not become gelatinous like those of *Ulothrix* when kept in stagnant cultures. In describing the species under this genus, Klercker identified it with hesitation with Kützing's *Ulothrix subtilis*, but in our judgment the figure furnished by Kützing makes the identification as certain as in the case of most of our species of that date.

Of the eight or more varietal forms that have accumulated about *Ulothrix subtilis* from the time of Rabenhorst down to Hansgirg, at least three (viz., *variabilis*, *stagnorum* and *tenerrima*) belong to other genera than *Stichococcus;* it is doubtful whether some of the rest can be placed in close relation with this species as here interpreted, even if they are to be brought into the genus.

The form illustrated by Kützing (Tab. Phyc. **2**: 31. *pl. 97. f. 4.* 1852) under the name *Ulothrix rupicola* Bailey, but apparently never described, appears both from the figure and from an authentic specimen furnished by Mr. Collins, to be simply *Stichococcus subtilis*.

5. STICHOCOCCUS FLACCIDUS (Kütz.) Gay, Rech. sur Alg. Vert. 79. *pl. 11. f. 101–106.* 1891. Klercker, Flora, **82**: 104. 1896. De Wild. Flor. Alg. Belg. 94. *f. 42.* 1896.

Ulothrix flaccida Kütz. Spec. Alg. 349. 1849; Tab. Phyc. **2**: *pl. 95. f. 2.* 1852. Rabenh. Flor. Eur. Alg. **3**: 367. 1868. Wolle, F. W. Alg. 137. *pl. 118. f. 27, 28.* 1887. De Wild. Bull. Soc. Bot. Belg. **27**^{2}: 79–81. 1888.

Hormidium flaccidum Braun; Rabenh. Alg. Eur. *2480.* 1876. Klebs, Fortpflanz. Einig. Alg. 341–345. *pl. 2. f. 21–24.* 1896.

Hormiscia flaccida Lagerh. Flora, **71**: 62. 1888. Hansg. Flora, **71**: 265. *p. p.* 1888. DeToni, Syll. Alg. **1**: 161. *p. p.* 1889.

Hormococcus flaccidus α flaccida [*sic*] Chodat, Beitr. Krypt. Flor. Schweiz, **1**^{3}: 269. 1902.

Filaments rather short, forming floccose masses or interwoven strata: cells generally somewhat tumid, 6–9.5 μ (6–14 μ, Gay) in diameter, $\frac{1}{4}$–2 times as long: cell-wall thicker than in *S. subtilis;* chromatophore broad, containing a large pyrenoid.

Reproduction by zoöspores, as well as by the vegetative mode, frequent (*pl. 21, f. 14–17*).

EXSIC: Phyc. Bor. Am. *116*. Cambridge, Mass., Jan., 1890 (W. C. Sturgis).

On wet rocks and on moist bark of trees. Probably widely distributed.

MASSACHUSETTS: Reading, Aug. 28, 1898 (F. S. Collins).

NEW YORK: Central Park, April to June (315, 536, 618); Greenhouse, Botanical Garden, June.

This form at times resembles *S. subtilis*, but is generally distinguishable from that species by its shorter, tumid cells with the thicker cell-wall; it is also less aquatic in its tendencies.

We have been unable to find this species on trees, but Mr. Collin's specimen shows a luxuriant growth on willow bark.

Most recent writers have included in the synonymy of this species, or at most have considered as a variety of it, *Ulothrix nitens* Menegh.; Kütz. Spec. Alg. 349. 1849. Klebs ('**98**), however, has maintained the specific distinctness of the form as *Hormidium nitens* Menegh. in spite of the fact that morphologically it is hardly separable from *S. flaccidus*. We have seen no living specimens that could be referred to this form, and cannot, therefore, express an opinion of any weight regarding the characters, chiefly physiological, upon which Klebs grounds its specific distinctness.

The American exsiccatae, *Ulothrix* (*Hormidium*) *nitens* Rabenh. Alg. Eur. *2515*, collected by Wolle at Bethlehem, Pa., and *Hormiscia flaccida nitens*, Tilden, Am. Alg. *6*, from Minnesota, are hardly distinguishable from *S. subtilis*. The figure given by Saunders (Flora of Nebraska, *pl. 22. f. 2.* 1894) certainly has nothing to do with *Stichococcus;* it appears to be a form of *Mougeotia.*

6. STICHOCOCCUS FLUITANS Gay, Bull. Soc. Bot. France **40**: CLXXIV. *f. 1.* 1893. Klercker, Flora, **82**: 103. 1896.

Filaments yellowish-green, often much crisped and densely interwoven, torulose, sometimes geniculate, very readily breaking up into single cells; cells slightly constricted at the dissepiments, 6.5–9 μ in diameter, 1–3 times as long; chromatophore large and opaque, obscuring somewhat the dull pyrenoid. Reproduction by zoöspores infrequent (*pl. 22, f. 7–9*).

EXSIC.: Phyc. Bor. Am. *759*. Melrose, Mass., May 1, 1900 (F. S. Collins).

In cascades on oblique surfaces of rocks dashed with spray or covered by a thin sheet of water. Melrose, Mass., 28 April, 1901 (548). Undercliff, New Jersey, 9 April, 16 April, 1900 (279, 307), 20 May, 1901 (575).

The conditions in these two stations are exactly similar. On certain rocks, the plants form a cespitose covering presenting the appearance of a short *Myxonema*. By this habit and by its yellowish green color, this species is always distinguishable to the naked eye, from the long, darker green skeins of *Stichococcus subtilis*, which frequently hang from adjacent rocks. The specimens from both stations showed, in the most marked degree, the tendency to dissociation of the filaments. Within a few hours after being removed from the rapid current on the rock, a very large proportion of the filaments had broken up into single cells or chains of two to four.

Our American specimens show a distinct, though not strongly marked torulose character of the filaments, which is not mentioned by Gay, while the geniculate character emphasized by him does not appear prominent. However, as the identification of Mr. Collins' specimen was made by Professor Wille, we do not feel justified in making a different disposition of the plant without further evidence from the author of this species, and this we have been unable to obtain.

7. **Stichococcus rivularis** (Kütz.)

Hormidium rivulare Kütz. Phyc. German. 192. 1845.

Ulothrix rivularis Kütz. Spec. Alg. 346. 1849; Tab. Phyc. **2**: *pl. 86, f. 2.* 1851; not Alg. Dec. *49.* 1833 (= *Rhizoclonium*). Rabenh. Flor. Eur. Alg. **3**: 366. 1868. Wolle, F. W. Alg. 136. *pl. 118. f. 6–8.* 1887.

Ulothrix rivularis var. *cataracta* Wolle, *ibid. pl. 118. f. 29–33.*

Hormiscia rivularis DeToni, Syll. Alg. **1**: 167. 1889.

Filaments forming somewhat elongated bright green tufts, frequently geniculate, but not easily breaking apart, composed of 1–3 cells, developing rhizoidal hooks from the terminal cells and from those of the knees; cells somewhat constricted at the dissepiments, rather thick-walled, 8–11 μ in diameter, 1–2 times as long; chromatophore orbicular to elliptical or rhomboidal, with clear-cut outline, containing a large pyrenoid (*pl. 22, f. 10–13*).

On rock or earth in rapids of grassy meadow streams.

Thomaston, Conn., May (568).

This species has a superficial resemblance to *S. fluitans*, but differs from it in the strong tendency of the filaments to stability, and in the much clearer green and clean-cut character of the chromatophores, with their more distinct pyrenoid. The geniculations in this species have a much more permanent character than those of *S. fluitans;* there they appear to arise simply from the excessive tendency to dissociation of the cells, while here they arise from the irritation of cells as they are pressed upon the substratum by the current. The rhizoidal structures are here very different from the basal cells in *Ulothrix*, their cell-walls are thickened only in a slight degree, and the chromatophore retains nearly its normal character; there is every evidence that here they are always developed secondarily as tendril-like organs, and not at the germination of the zoöspore as in *Ulothrix*. Zoöspores were not formed freely in our specimens, though some cells from which they had emerged were found.

There appears to be no sufficient *raison d'être* for Wolle's var. *cataracta* since the characters on which it is founded are mentioned in Kützing's descriptions of the species.

III. MICROSPORA Thuret, Ann. Sci. Nat. Bot. III. **14**: 221. 1850. Lagerh. Ber. Deutsch. Bot. Gesell. **5**: 413–417. 1887. Flora, **72**: 207–209. 1889. Not *Microspora* Hassall, Ann. & Mag. Nat. Hist. **11**: 363. May, 1843 (=*Cladophora* Kütz. Linnaea, **17**: 91. 1843).*

Filaments simple, generally unattached and with little difference between base and apex. Chromatophore a granular band or sheet covering more or less completely the outer cell-wall and the dissepiments, sometimes perforate or reticular, without pyrenoids

* Hassall's genus *Microspora* had for its type *Conferva glomerata* L. and would supplant Kützing's *Cladophora* if it should be proved that Hassall's work was published earlier in the year 1843 than Kützing's. Probably, however, Kützing's work in the first Heft of Linnaea appeared earlier than May, the published date of Hassall's paper. Hassall ('45) himself abandoned his *Microspora* in favor of Kützing's *Cladophora*. Since, therefore, *Microspora* Hassall is never likely to be taken up again, it has been thought best to waive a too strict application of the article of the Rochester Code in regard to homonyms and to retain the only *Microspora* that has ever been in general use.

but containing scattered granules of starch. Cell-wall composed of layers of cellulose which, for the dispersal of zoöspores, pull apart in such a way as to leave sections which appear like a letter H in optical section.

Asexual reproduction by means of 2- or 4-ciliate zoöspores, one or two in each cell; also by means of 2-ciliate microzoöspores, several formed in a cell (gametes?); germination of both kinds direct. Akinetes and aplanospores are also produced.

Inhabitants of fresh water. Type *M. floccosa* (Vauch.) Thuret. [Etym. μικρός, small, and σπορά, spore.]

Thuret separated this genus from *Conferva* on account of the squared appearance of the chromatophore and the method of dispersal of the zoöspores, namely, by the pulling apart of the halves of the cell-wall.

Both genera were recognized by Rabenhorst ('63, '68) and by Wolle in his earlier study, as is evidenced by his published lists and by labels in his herbarium. Wille ('81), taking no account of chromatophore form, but making an elaborate study of exsiccatae, reunited *Microspora* with *Conferva* because he found that in certain species left in *Conferva* (*Tribonema*) the structure of the cell-wall is similar to that described for *Microspora*. It remained for Lagerheim ('87, '89) to define properly both genera by their chromatophore characters and assimilation products.

A great effort has been made to furnish a contribution to the meager knowledge of the reproductive processes in this genus, but it is a matter of great difficulty to obtain zoöspores in any species. We have seen them produced only in two cases, in *Microspora floccosa* and *M. stagnorum*. In the case of the former, only a single filament was forming zoöspores, and the number of cilia could not be made out, though the specimen was immediately fixed in osmic vapor. In *M. stagnorum* the zoöspores, which did not seem at all like gametes, had only two cilia, whereas they are usually said to be 4-ciliate.

Akinetes are frequently seen in most of the species. The filaments become moniliform, the cell-wall thickens and finally the cells fall apart as globose bodies, which, in the mass, resemble resting cells of *Chlamydomonas*. It is probable that these akinetes usually go through a period of rest before germinating.

Synopsis of Species

Filaments large, cell-walls 1.5–3 μ thick.

Cells nearly cylindrical, diameter 28–33 μ, 1–1.6 times as long. 1. *M. crassior.*
Cells nearly cylindrical, diameter 21.5–25 μ, 1–2 times as long. 2. *M. amoena.*
Cells somewhat tumid, diameter 16.5–20 μ, 1–2 times as long. 3. *M. Loefgrenii.*
Cells perfectly cylindrical, diameter 19.5–20 μ, 1–2½ times as long. 4. *M. Wittrockii.*

Filaments smaller, cell-walls thin.

Cells cylindrical, diameter 14–17 μ. 5. *M. floccosa.*
Cells cylindrical, diameter 11–14 μ. 6. *M. Willeana.*
Cells cylindrical, diameter 7.5–9.5 μ. 7. *M. stagnorum.*
Cells slightly constricted, diameter 6.7–9.5 μ. 8. *M. tumidula.*
Cells cylindrical, diameter 5.5–7 μ. 9. *M. quadrata.*

1. **Microspora crassior** (Hansg.)

M. amoena crassior Hansg. Sitz.-ber. K. Böhm. Gesell. Wiss. **1889**[1]: 129. 1889; Prod. Alg. Böhm. **2**: 223. 1893. Schmidle, Ber. Deutsch. Bot. Gesell. **11**: 544. 1893.

M. amoena crassa Schmidle, Ber. Nat. Gesell. Freib. **7**: 75. *pl. 2. f. 1.* 1893.

M. amoena forma *crassior* Wille, Rhodora, **1**: 149. 1899.*

Filaments long and dark green: cells nearly cylindrical, 28–33 μ in diameter, 1–1.6 times as long; cell-wall 2.5–3 μ thick, the lamellate structure often distinct; chromatophore dense, usually covering the whole cell-wall and obscuring the large nucleus (*pl. 23, f. 2*).

EXSIC.: Phyc. Bor. Am. *616 p.p.* Bridgeport, Conn., April, 1893 (I. Holden). (?)

Growing in thick, tangled masses in rapid water, or as scattered filaments with *M. amoena* or *M. Loefgrenii.*

NEW YORK: Larchmont, May (588); Van Cortlandt Park, June (632); Central Park, June (620), September (490), October (659).

This species is distinguished from *M. amoena*, chiefly by its

* Schmidle (1900) quotes as an additional synonym *Microspora DeToniana* Lagerh. Nuova Notarisia, **4**: 137. 1893, and states that of the three names proposed by himself, Hansgirg, and DeToni in the year 1893 it is difficult to decide which has priority. He has overlooked the fact that Hansgirg's variety was actually established in 1889. Schmidle also thinks it probable that *Conferva Raciborskii* Gutwinski (Flora Glon. Galicyi 7. *pl. 3. f. 1.* 1892; Nuova Notarisia, 3: 17. 1892) is to be identified with this form. The correctness of such an identification appears to us to be more than doubtful; certainly the form called *C. Raciborskii* by West (Journ. Bot. 31: 98. *pl. 333. f. 9.* 1893) differs widely from *Microspora crassior*, in its smaller diameter and much thicker cell-wall.

larger size and shorter cells. Judging from all specimens we have seen, it is more distinct from the latter than is *M. Loefgrenii.* In the Central Park station, where we have observed it at several different seasons, it shows a very constant character, and is never mixed with any other *Microspora.* There it is usually found with *Cladophora* and *Rhizoclonium,* in a stream gushing from and over rocky ledges to feed the lower lake.

In other cases, where it has been found in connection with *M. amoena* (588) and *M. Loefgrenii* (632), no intergrading forms have been seen, and there has been no evidence of any developmental relationship.

In two specimens of the exsiccata above quoted, nothing but *M. amoena* has been found, but Professor Wille's forma *crassior* is based on this material. His characterization of the form consists only of a statement of the diameter of the cells (without any reference to synonyms), but judging from this point alone the form is to be included here.

2. MICROSPORA AMOENA (Kütz.) Rabenh. Flor. Eur. Alg. **3**: 321. 1868. Lagerh. Ber. Deutsch. bot. Gesell. **5**: 417. 1887. DeToni, Syll. Alg. **1**: 227. 1889. Kirchn. Mik. Pflanz. 12. *pl. 2. f. 26.* 1891. Hansg. Prod. Alg. Böhm. **2**: 222. 1892. De Wild. Flor. Alg. Belg. 46. 1896.

Conferva amoena Kütz. Spec. Alg. 372. 1849; Tab. Phyc. **3**: *pl. 45. f. 5.* 1852. Kirchn. Krypt. Flor. Schles. **2**[1]: 79. 1878. Wille, Öfvers. Vet. Akad. Förhand. **1881**[8]: 21. *pl. 10. f. 57.* 1881. Hansg. Prod. Alg. Böhm. **1**: 77. 1886. Wolle, F. W. Alg. 140. *pl. 121. f. 1–5.* 1887.

Filaments forming long green skeins or tangled masses; cells nearly cylindrical, often slightly contracted at the dissepiments, 21.5–25 μ in diameter, 1–2 times as long; cell-wall 2.5–3 μ thick; chromatophore rather dense, generally covering the cell-wall and obscuring the nucleus which is 6.5–7.5 μ in diameter (*pl. 23, f. 1*).

EXSIC.: Phyc. Bor. Am. *616, p. p.*, Bridgeport, Conn., April, 1893 (I. Holden); *19B* (as *Ulothrix zonata*), Melrose, Mass., April, 1894 (F. S. Collins); Tild. Am. Alg. *139A* (as *M. floccosa*), Forest Grove, Oregon, Feb., 1896 (F. E. Lloyd).

In brooks, streaming in masses from sticks and stones on which it is caught.

MASSACHUSETTS: Middlesex Fells Reservation, July (447B); Worcester, 1887. G. E. Stone.

NEW YORK: East Chester, May (393, 590, 592); Larchmont, May (588); Staten Island, December (242).

NEW JERSEY: Undercliff, Bergen county, March (438), April (276), May (125, 573); Englewood, May (362).

Wolle remarks that this species is not frequent, but is abundant where it does occur. It is, however, rather common about New York, especially in rapid streams, and probably it is generally distributed.

3. MICROSPORA LOEFGRENII (Nordst.) Lagerh. Ber. Deutsch. bot. Gesell. **5**: 417. 1887; Flora, **72**: 208. 1889. DeToni, Syll. Alg. **1**: 229. 1889.

Conferva Loefgrenii Nordst.; Wittr. & Nordst. Alg. Exsic. *421*. 1882; Bot. Notiser, **1882**: 55. 1882.

Filaments long; cells slightly but distinctly ventricose, 16.5–20 μ in diameter, 1–2 times as long; cell-wall 2.5 μ thick; chromatophore dense and covering the whole cell-wall, the nucleus obscure, 5–6.5 μ in diameter (*pl. 23, f. 3, 4*).

Growing with *M. amoena*, or in long tangled skeins unmixed.

MASSACHUSETTS: Middlesex Fells, July (447A).

NEW YORK: Westchester county, April (351); Van Cortlandt Park, May, June (598, 632).

Some specimens of this species are so similar in appearance to *M. amoena* that it requires close study to separate the forms, and probably this is the reason why it has not before been reported from North America. The specimens found in Middlesex Fells growing with *M. amoena*, however, were most distinct from that species, always easily separable by the smaller diameter and moniliform tendency of the filaments; they seem to agree perfectly with the material which formed the type (Wittr. & Nordst. Alg. Exsic. *421*). Nordstedt's remark in describing this species, "Formâ cellularum ad *C. amoenam* Kütz. et *C. Wittrockii* accedens, structurâ membranae differt," seems superfluous, for in this type material, the normal *Microspora* membrane structure is clearly recognizable.

The form issued as *M. Loefgrenii* forma *minor* Wille (Phyc. Bor. Am. *617*, Middlesex Fells, Mass., May, 1899, F. S. Col-

lins) would seem, judging by the meager description, to be associable with *Conferva Loefgrenii Suecica* Wittr., but examination proves it to be very different from that variety as issued in Wittr. & Nordst. Alg. Exsic. *518*. 1883. In the character of the chromatophore and in other features, Mr. Collins' specimen seems to be more closely allied to *M. floccosa*.

4. MICROSPORA WITTROCKII (Wille) Lagerh. Ber. Deutsch. bot. Gesell. **5**: 417. 1887; Flora, **72**: 208. 1889. DeToni, Syll. Alg. **1**: 228. 1889.

Conferva Wittrockii Wille, Öfers. Vet. Akad. Förhand. **1881**[8]: 20. *pl. 9. f. 1–11.* 1881. (?); Jahrb. wiss. Bot. **18**: 461. *pl. 17. f. 35–42.* 1887.

Filaments forming long, silky skiens, light green in color; cells perfectly cylindrical, never constricted at the dissepiments, 19.5–20 μ in diameter, 1–2½ times as long; cell-wall thinner than in *M. amoena* and *M. Loefgrenii*, about 1.5 μ thick, not exhibiting its lamellated structure in the vegetative state; chromatophore thin, often perforated or sieve-like in appearance, sometimes retreating from one end of the cell so as to be thimble-shaped, the large nucleus (5–6.5 μ in diameter) nearly always clearly showing through (*pl. 23, f. 5–7*).

In a brook draining a swamp, Van Cortlandt Park, New York, April, May (287, 348, 415). Meadow brook, Norwich, Vermont, May, 1902 (675).

This form, which has not before been reported in this country, was observed and collected several times in the spring of 1900. It was always growing without other accompanying species than the small form *Microspora stagnorum*. During the spring of 1901, all search for it in the same brook was fruitless, but *M. Loefgrenii* was found in abundance, although during the preceding season the nearest station of the latter species was in another stream half a mile or more distant. This circumstance cast suspicion on the distinctness of the form determined as *M. Wittrockii*.

However, a very careful reëxamination of various collections preserved by different methods, has shown in the most convincing manner that the specimens in question are not to be confused with *M. Loefgrenii* or *M. amoena*. Our form is distinguished by its perfectly cylindrical cells, the thin walls of which do not show the lamellated structure until after maceration, and by its thin chro-

matophore, which permits a clear view of the nucleus, while in the related species, the nucleus is distinctly seen only after fixation or staining. Furthermore, this form always gave a very feeble test for starch, while the other species are generally rich in starch. Even in the field the much lighter green color was noticeable. The recent collection made in Vermont only confirms our view as to the distinctness of this species.

As to the definition of *M. Wittrockii* there is some confusion; for in Professor Wille's original description the species had a diameter of 12–20 μ, while in his German revision of the paper he increased it to read 20–24 μ. The specimen in Wittr. & Nordst. Alg. Exsic. *422*, seems to agree with the first description. The details given in the revised description, however, together with the accompanying illustrations, leave no doubt that our form is to be identified with this species.

5. MICROSPORA FLOCCOSA (Vauch.) Thuret, Ann. Sci. Nat. Bot. III. **14**: 221, 222. *pl. 17. f. 4–7.* 1850. Cooke, Brit. F. W. Alg. 136. *pl. 53. f. 3.* 1883. DeToni, Syl. Alg. **1**: 226. *p. p.* 1889. De Wild. Flor. Alg. Belg. 46. 1896; Flor. Buit. 63. 1900.

Prolifera floccosa Vaucher, Journ. de Phys. **52**: *pl. 4. f. 12.* 1800; Hist. Conferv. 131. *pl. 14. f. 3.* 1803. (?)

Conferva floccosa Agardh, Disp. Alg. Suec. 29. 1812; Alg. Dec. 19. 1813; Syn. Alg. Scand. 79. 1817; Syst. Alg. 89. 1824. (?) Wolle, F. W. Alg. 140. *pl. 120. f. 21–29.* 1887.

Conferva fugacissima Lyngb. Tent. Hyd. Dan. *pl. 46. f. 1–4.* 1819. (?)

Lyngbya floccosa Hass. Brit. F. W. Alg. 223. *pl. 60. f. 1, 2.* 1845. (?)

Hormiscia floccosa Derb. & Sol. Mem. Phys. Alg. 16. *pl. 5. f. 1–8.* 1856. (?)

Not *C. floccosa* Lyngb. Tent. Hyd. Dan. 138. *pl. 46B.* 1819 (=*Stichococcus?*). Kütz. Spec. Alg. 371. 1849; Tab. Phyc. **3**: *pl. 43. f. 3.* 1852. Kirchn, Krypt. Flor. Schles. **2**[1]: 79. 1878. Wille, Öfvers. Vet.-Akad. Förhand. **1881**[8]: *pl. 10. f. 47–49.* 1881. Hansg. Prod. Alg. Böhm. **1**: 75. 1886.

Not *M. floccosa* Rabenh. Krypt. Flor. Sachs. **1**: 245. 1863; Flor. Eur. Alg. **3**: 321. 1868.

Filaments forming bright green or yellowish-green floccose masses or long skeins; cells usually cylindrical, rarely slightly constricted at the joints, 14–17 μ (generally 16.5, rarely 18 μ) in diameter, 1–2½ times as long; cell-wall rather thin; chromatophore pale green, often perforated or reduced to a reticulum; zoöspores rare; akinetes 18–22 μ (mostly 19.5 μ) in diameter, spheroidal, cuboidal, or almost cylindrical in shape (*pl. 24, f. 1–4*).

EXSIC.: Phyc. Bor. Am. *864. p.p.*, Pine Banks Park, Melrose, Mass., May 15, 1901, F. S. Collins.

Floating in streams and stagnant waters. One of the most abundant of simple confervae.

MASSACHUSETTS: Melrose, April (553); Framingham, May.

NEW YORK: Van Cortlandt Park, April to June (349B, 599, 286, 634); Bronx Park, June (605, 626).

NEW JERSEY: Grantwood, March to May (437, 529, 283); Edgewater, March (66A); Weehawken, May (409).

This species, *i. e.*, the name *Microspora floccosa*, has received two divergent and apparently incompatible interpretations as indicated in the list of synonyms. By Kützing, Rabenhorst, Kirchner, Wille, and Hansgirg, it has been described as having a diameter of 7.5–10 μ. By Cooke, Wolle, and De Wildeman, the diameter is increased to 14–17 or 18 μ. DeToni combines the two conceptions, making the diameter 10–18 μ. How this difference arose, it is impossible to say.

To determine just what the original form, *Prolifera floccosa* Vauch., was, is an equally difficult matter. Probably few students of our time would venture to take the confident attitude assumed by Agardh in relation to the identity of his *Conferva floccosa* and Vaucher's species.*

As a matter of fact such a barren figure and meager description as those of Vaucher are about equally applicable to any species of *Microspora* or to most of the members of this family. For further light on Agardh's conception of the species almost the only point of value is his reference to *Conferva fugacissima* Lyngb. as a synonym. Lyngbye's figure evidently represents a *Microspora;* it is the earliest illustration of the characteristic chromatophore structure. It is doubtful if this structure could have been so well

* Agardh remarks (Alg. Dec. 19. 1812), "Species nostra certe *Prolifera floccosa* Vauch. esse videtur. Convenit enim et descriptio et pulchra icon."

made out at that early time in a form much finer than ours, though it is quite possible that Agardh collected several different forms as *Conferva floccosa*, just as any beginner now using DeToni's Sylloge for authority would do.

When we come down to the middle of the nineteenth century, we can gain a somewhat more definite idea of Thuret's idea of the species. Unfortunately, to be sure, no data as to diameter and length of the cells are furnished; but there are beautiful figures, and from the magnification given with them, it may be estimated that Thuret's type was practically the same as our specimens in respect of size (*i. e.*, 13–16 μ).

To sum up: concerning the character of Vaucher's *Prolifera floccosa* practically nothing can be determined; of Agardh's *Conferva floccosa*, we may be reasonably sure that it belongs in the genus *Microspora*, and very likely it included our species; finally, there is no good reason to doubt that Thuret's *Microspora floccosa* is the same as our species. At all events we cannot prove that this conception, which has been adopted by several modern algologists, is not historically correct.

The uncertainty of the determinations of exsiccatae, or perhaps their mixed character, is exemplified in the fact that at least three numbers issued as *Microspora floccosa*, namely, Rabenh. Alg. Sachs. *356*, Aresch. Alg. Scand. *277*, and Tild. Am. Alg. *139A*, certainly contain *M. amoena*, a much larger species than any form of *M. floccosa*. The specimen issued by Miss Tilden, Am. Alg. *139B*, seems not much different from the smaller form of the European authors and is at least very nearly allied to our *M. tumidula*.

In *Microspora floccosa*, Rabenh. Alg. Eur. *1985*, which is partly referred to *Conferva abbreviata* (Rabenh.) Wille by the latter author, we have been able to find only a form corresponding to our definition of *M. floccosa*.

6. MICROSPORA WILLEANA Lagerheim; DeToni, Syll. Alg. **1**: 228. 1887; Flora, **72**: 207. *pl. 5. f. 1–19*. 1889

Vegetative cells cylindrical, 11–14 μ in diameter, ½–1½ (rarely 2) times as long: chromatophore variable, but often more dense and containing a larger amount of starch than in *M. floccosa*; cell-wall thin; akinetes 14–16.5 μ in diameter (*pl. 24, f. 5–7*).

EXSIC.: Phyc. Bor. Am. *619*, Melrose, Mass., March, 1894 (F. S. Collins).

Forming floccose masses in brooks and in stagnant waters.

MASSACHUSETTS: Ipswich, May (558B).

NEW YORK: Botanical Garden, May (376A, 407), June (609).

NEW JERSEY: Grantwood, April (530A); Edgewater, March (66B).

It is to be suspected that Scandinavian authors would include under this name the form which we have determined as *M. floccosa.* for in the vegetative condition there is the most perplexing similarity between the two forms. Indeed we have found forms corresponding to *M. floccosa*, *M. Willeana*, and *M. stagnorum* all mixed together, and forming what looked, at first sight, like a graded series of growth forms.

Nevertheless, in the fruiting condition, *M. floccosa* is easily distinguished from *M. Willeana* by its much larger akinetes, and it is probable that by more exact and extended field study they could be better distinguished when in the vegetative state.

This problem did not present itself until too late for more thorough field observations to be made in preparation for this paper.

7. MICROSPORA STAGNORUM (Kütz.) Lagerh. Ber. Deutsch. bot. Gesell. **5**: 417. 1887; Flora, **72**: 208. 1889. Hansgirg, Prod. Alg. Böhm. **2**: 222. 1893. DeToni, Syll. Alg. **1**: 229. 1889.

Conferva tenerrima stagnorum Kütz. Alg. Dec. *56*. 1833; Flora, **16**: 700. 1833.

Conferva stagnorum Kütz. Phyc. Gener. 257. 1843. Wille, Öfvers. Vet.-Akad. Förhand. **1881**[8]: 20. *pl. 9. f. 12–27. pl. 10. f. 50.* 1881. Hansg. Prod. Alg. Böhm. **1**: 75. 1886.

Gloeotila stagnorum Kütz. Phyc. German. 191. 1845.

Ulothrix tenerrima stagnorum Kütz. Spec. Alg. 346. 1849.

Ulothrix stagnorum Kütz. Tab. Phyc. **2**: 27. *pl. 87. f. 2.* 1852. Rabenh. Krypt. Flor. Sachs. **1**: 264. 1863; Flor. Eur. Alg. **3**: 366. 1868.

Ulothrix tenerrima Rosenv. Bot. Tidssk. **11**: 121. *pl. 1. f. 1–14, 17–21.* 1879.

Filaments cylindrical; cells not at all inflated, about 8 μ (7.5–9.5 μ) in diameter, 1–3 times as long; chromatophore granular, not dense, usually not covering the cell-wall completely (*pl. 24, f. 12, 13*).

EXSIC.: Phyc. Bor. Am. 619. *p. p.*, Melrose, Mass., March, 1894 (F. S. Collins).

In stagnant water and in brooks, forming light green, floccose masses.

CONNECTICUT: New Preston, September (495).

NEW YORK: Botanical Garden, May (376B); Central Park, April (320).

NEW JERSEY: Grantwood, April (530), May (437); Edgewater, March (66 C).

The material collected in Connecticut (495) furnished interesting studies of the zoöspores. The cell-wall appeared to swell and soften, and exhibited little of the definite pulling apart in sections usually considered characteristic of this genus. The zoöspores, mostly one in a cell, were in active movement some time before they were released; to set them free the cell-wall seemed to dissolve into mucus and completely to disappear. The zoöspores had two cilia and a red eye-spot: this is contrary to the generally received description, in which it is said that the zoöspores have four cilia and no eye-spot. It is hard to believe that these were microzoöspores or gametes, formed only one in a cell as they were.

The above characterization of this species illustrates what may be regarded as a legitimate enlargement of an original description. Specimens have been found which correspond exactly to the description and type material of Kützing, having cells whose length is about equal to the diameter; by means of continued observation, it is discovered that such cells may grow to be three times as long as the diameter (or even four times as long according to Wille). By similar study the measurement of the diameter has been increased from 7.5 μ to 9.5 μ.

8. **Microspora tumidula** sp. nov.

Filaments forming dull green floccose masses or long skeins; cells nearly cylindrical but always slightly constricted at the dissepiments, 6.7–9.5 μ (generally about 7.5 μ) in diameter, 1–2 times

as long; chromatophore rather dense, covering most of the outer cell-wall; akinetes 8–11 μ in diameter, globose or flattened (*pl. 24, f. 8–11*).

EXSIC.: *Microspora floccosa* Tild. Am. Alg. *139B*, Vancouver, 1898. (?)

In brooks and stagnant pools.

NEW YORK: Van Cortlandt Park, April (288, 348B), May (415B, 600, type), June (633); Botanical Garden, May (376B); East Chester, May (393B); Staten Island, April (332).

NEW JERSEY: Hudson Heights, May (436), October (501); Grantwood, April (530D), May (283C, 429B, 579B); Undercliff, May (573A).

In respect of size, this species is similar to *M. stagnorum*, but it is always distinguished from the latter by the slight tumidity of the cells, and the more homogeneous character of the chromatophore. This seems at first sight like a somewhat superficial distinction, but in the type station, where it grows unmixed with any similar species, it has maintained a most constant character, and has always appeared so distinct that the only reasonable course is to regard it as a new species.

The larger forms of *Microspora tumidula* might possibly be identified with the *M. floccosa* of Kützing, Rabenhorst and Hansgirg, but as has been previously stated, this is probably not the true *M. floccosa*.

9. **Microspora quadrata** sp. nov.

Filaments light green, often in floccose masses; cells cylindrical, not at all constricted at the dissepiments, 5.5–7 μ (usually about 6.5 μ) in diameter, their length equal to the diameter or half as great; cell-wall very thin; chromatophore often covering the dissepiments as well as the outer wall, in an even, finely granular sheet (*pl. 24, f. 14, 15*).

Forming yellowish-green or sordid floccose masses, or fine cespitose growths, in springs, rivulets and watering-troughs.

VERMONT: St. Johnsbury, winter culture (669); July (686).

MASSACHUSETTS: Melrose, May 12, 1901 (F. S. Collins, *4001, p. p.*).

CONNECTICUT: Thomaston, May (560).

NEW YORK: Botanical Garden, May (423, type), June (443A),

September; Central Park, June (613A), October (664A); Pelham Bay Park, May (394B), September (486).

This species has been observed repeatedly in several stations, always showing a very constant character, and never mixed with other forms. It is the only *Microspora* that has been observed in the herbaceous grounds of the New York Botanical Garden, in a stream where *Spirogyra*, *Tribonema*, *Draparnaldia*, and *Myxonema* abound. It is well marked by the nearly square shape of the cells (in optical section), and by the fine bead-like edge of the chromatophore.

Young specimens collected in October showed a slightly narrowed basal cell imbedded in mucus, appearing somewhat like a small *Ulothrix* in the manner of attachment. It is probable that these plants germinated from akinetes which had lain dormant during the heat of the summer.

Microspora quadrata is perhaps very nearly allied to, if not identical with the *M. punctalis* of Rabenhorst and recent authors. There is considerable doubt, however, whether it is the *Conferva punctalis* of Dillwyn and it is almost certainly not *C. punctalis* Mueller (Nov. Act. Acad. Sci. Imp. Petrop. **3**: 90. *pl. 1. f. 1.* 1788) to which Dillwyn's figure and description supposedly applied. Mueller's species was probably a form belonging to the Mougeotiaceae. Agardh (Spec. Alg. 83. 1824) was of the opinion that *C. punctalis* Dillw. *pl. 51.* and Lyngb. *pl. 46*, was a species of *Zygnema.*

DOUBTFUL FORMS

MICROSPORA VULGARIS Rabenh. Krypt. Flor. Sachs. **1**: 245. 1863; Flor. Eur. Alg. **3**: 321. 1868.

Conferva vulgaris Kirchn. Krypt. Flor. Schles. **2**[1]: 79. 1878. Wolle, F. W. Alg. 142. *pl. 21. f. 6–13.* 1887.

CONFERVA FARLOWII Wolle, Bull. Torrey Club, **6**: 140. 1887.

C. vulgaris Farlowii Wolle, F. W. Alg. 142. 1887.

Microspora Farlowii Rabenh. Alg. Eur. *2566.* 1878.

All the above as represented in the Wolle herbarium appear to be forms of *Tribonema;* also Tilden, Am. Alg. *21.* 1894, at least for the most part. Saunder's figure of *M. vulgaris Farlowii* (Flora of Neb. *pl. 22. f. 3.* 1894) is evidently *Tribonema.*

MICROSPORA FUGACISSIMA. (Roth) Rabenh. Flor. Eur. Alg. **3**: 321. 1868.

Conferva fugacissima Roth, Cat. Bot. **1**: 176. 1797. (?) Wolle, F. W. Alg. 141. *pl. 120. f. 10–12.* 1887.

There is also very great doubt as to the true character of this form which, like most ancient species, has received a varied treatment. Mr. Wolle's specimens may be referred to *Tribonema bombycinum.*

MICROSPORA ABBREVIATA (Rabenh.) Lagerh. Ber. Deutsch. Bot. Gesell. **5**: 417. 1887.

The figures of *Conferva abbreviata* given by Wolle (F. W. Alg. *pl. 121. f. 18, 19.* 1887), like most of his illustrations of this genus, do not give any particular assistance in elucidating his notion of the species. Specimens in his herbarium bearing this name are identifiable as *Tribonema bombycinum*, hence his record may be disregarded.

This species is in such a state of confusion in European literature that it is difficult to know just how to dispose of it. Wille ('81) united *Conferva affinis abbreviata* Kütz. (Spec. Alg. 371. 1849) with *C. ochracea* Kütz. (Phyc. Germ. 202. 1845), and out of Rabenhorst's specimen of *C. affinis abbreviata* Kütz. (Alg. Sachs. *111.* 1851) made a new species, *C. abbreviata* (Rabenh.) Wille. This last name was transferred to *Microspora* by Lagerheim. DeToni combines both Wille's sets of synonyms under Lagerheim's name, but with Kützing's description.

The disposition of these names made by Wille is doubly untenable according to American rules: in the first place, *Conferva ochracea* Kütz. cannot stand in view of the earlier *C. ochracea* Roth (Cat. Bot. **1**: 165. 1797), and secondly, *Conferva abbreviata* (Rabenh.) Wille cannot be retained in the face of *Conferva abbreviata* Kütz. (Tab. Phyc. **3**: 14. *pl. 42. f. 8.* 1853).

The final disposition of these forms is a matter which can hardly be determined on this side of the Atlantic, and perhaps it is not a matter that concerns American algology.

MICROSPORA PUNCTALIS (Dillw.) Rabenh. Krypt. Flor. Sachs. **1**: 245. 1863; Flor. Eur. Alg. **3**: 321. 1868.

Conferva punctalis Dillwyn, Brit. Conferv. *pl. 51.* 1805. Kütz. Spec. Alg. 370. 1849. Wolle, F. W. Alg. 142. *pl. 121. f. 20, 21.* 1887. Not Mueller, Nov. Act. Acad. Sci. Imp. Petrop. **3**: 90. *pl. 1. f. 1.* 1788.

See *Microspora quadrata.*

MICROSPORA AMOENA forma THERMALIS Tild. Bot. Gaz. **25**: 92. *pl. 8. f. 12.* 1898.

The author remarks: "It is difficult to decide whether this plant should be classed as a *Conferva* or a *Microspora*, as the structure of the chloroplastids could not be made out." That this form having a diameter of 11–14 μ should be associated with a species ranging from 20–24μ, in a genus of such fine distinctions as *Microspora*, is a manifest absurdity. The form should have been "placed provisionally" among doubtful forms in the discoverer's herbarium, until its essential character could be determined.

MICROSPORA WEEDII Tild. Bot. Gaz. **25**: 93. *pl. 8. f. 13.* 1898; Am. Alg. *275.*

The figure furnishes a strong support to the suspicion that the author has no adequate conception of the difference between *Microspora* and *Tribonema;* the chromatophores certainly have the appearance of the latter. No satisfactory conclusion can be drawn from the poor specimens distributed.

IV. TRIBONEMA Derbes & Solier, Mém. sur Physiol. Alg 18. 1856

Conferva Lagerheim, Flora, **72**: 194–209. 1889. Not *Conferva* Linn. Sp. Pl. 1164. 1753.

Filaments at first attached by a special basal cell, later floating. Chromatophores disk-shaped, yellowish-green, without starch, but producing oil, two or several in a cell. Cell-wall thin, formed by deposition of layers composed largely of pectic acid with little cellulose. For the dispersal of the zoöspores, the cells pull apart from the middle, so that H-shaped sections are left.

Asexual reproduction through zoöspores, produced to the number of one to four in each cell; they are destitute of a red eye-spot, furnished with two cilia, one of which is short and reflexed.

Inhabitants of fresh water. Type *T. bombycinum* Derb. & Sol. [Etym. τρίβος, worn, and νῆμα, filament.]

The name *Conferva* is very ancient, going back to the time of Pliny. As a modern generic name it has received most varied treatment, and covered at different times very diverse groups of plants.

Under this name Linnaeus included a very large part of the

branching, as well as the simple, filamentous algae. He adopted the genus from Dillenius. The first species mentioned by Linnaeus, *Conferva rivularis*, is undoubtedly the oldest of his group, so far as the history of these ill-defined forms can be determined. This species, according to the synonymy of Linnaeus (Sp. Pl. 1164. 1753), is *Conferva fluviatilis, sericea vulgaris et fluitans* of Dillenius (Hist. Musc. 12. *pl. 2. f. 1.* 1741); this in turn is *Conferva Plinii* Dillen. (Cat. Plant. sponte Gissam nascentium, 199. 1719); the earliest description of *C. Plinii* that we have seen is in L'Obel's Plantarum Observationes, 664. 1576, but undoubtedly the name is of more ancient origin.

Now no one would imagine that the ancient herbalists or even Linnaeus could distinguish the numerous filamentous forms known to us only by the use of good microscopes. Indeed, the fact that Linnaeus described only two unbranched species is sufficient proof of this. *Conferva rivularis*, as collected by him, was very likely at one time a *Spirogyra* and at another an *Oedogonium*. This type species, however, as interpreted by the earlier algologists, *e. g.*, Dillwyn, Lyngbye and Mueller, is very evidently a form belonging to what is now known as *Rhizoclonium*, and has come down to us as *R. rivularis* (L.) Kütz. This identification is also confirmed by Linnaeus himself, who (Sp. Pl. Ed. 14. 1784) quotes the figure of *C. rivularis* from Flora Danica.

There is, therefore, a moderately strong argument in favor of employing the name *Conferva* for the genus *Rhizoclonium* if it is to be retained at all in modern algology. It would, perhaps, be better to reserve the name for the numerous species of confervoid algae whose character and proper position is not sufficiently known to permit their disposition in the more clearly defined modern genera.

At any rate, there is no warrant whatever for employing the name *Conferva* to designate the genus recognized under that name in Lagerheim's revision, for there is no evidence that these species were ever collected by Linnaeus, and certainly none of them were distinguished by him from other simple filamentous forms.

For Lagerheim's group of species, as for all genera, the adoption of a generic name based on a recognizable species, as a type, is essential. The earliest such name in the present case is *Tribo-*

nema Derbes & Solier (1856). This genus was based on a single species, *Conferva bombycina*, and in the diagnosis, for the first time in the history of the species, explicit mention was made of the most essential character, namely, the form of the chromatophores, although it had been previously suggested in the plates of Kützing. The method of zoöspore dispersal was also first described and illustrated by Derbes & Solier. There is, then, every reason for employing the name *Tribonema* as a memorial of the discernment of these authors.

Only a small number of forms is known to belong in this genus, and the inclusion by DeToni of a long array of species of *Conferva* and *Psichohormium* in the genus *Conferva* as emended by Lagerheim, is quite unwarranted. Probably many of these ought to be reduced to synonymy or placed on the list of indeterminables; certainly very few of them have been shown to possess the characters of the revised genus. The evil results of DeToni's wholesale grouping of species of ill-defined character may be seen in the very unreliable determinations of species by certain American writers who seem to have pinned their faith to his work. (See "doubtful forms" under *Tribonema* and *Microspora*.)

There are indications in Lagerheim's work that he contemplated reviving the name *Tribonema*, but apparently a too conservative instinct deterred him from abandoning *Conferva*.

There is very little doubt that the action taken by Borzi,* and supported by Bohlin, Blackman, and Wille, in removing this genus from the Ulothricaceae is entirely justified. The structure and composition of the cell-wall, the character of the chlorophyl, and the absence of starch all point to the close affinity of *Tribonema* with the Ophiocytiaceae.

As noted in the introduction, however, for present expediency in bringing into American literature, which has sadly confused *Microspora* and *Conferva*, the striking differences between these genera, the older arrangement has been here retained. Doubtless the easier course would have been to omit the genus, since some

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* Borzi, A. Boll. Soc. Ital. Mic. 1: 62–70. 1889.
Bohlin, K. Bih. Kong. Svensk. Vet.-Akad. Hand. 23^3: No. 3. 1897.
Blackman, F. F. Ann. of Bot. 14: 647–688. 1900.
Wille, N. Nyt Mag. for Naturvid. 39: 1–22. 1901.

may object to the displacement of a traditional name, though we believe this change is based on sound principles.

Synopsis of Species

Chromatophores usually numerous, cell-wall thin.
Diameter of filaments 6–11 μ. 1. *T. bombycinum.*
Diameter of filaments 3–6 μ. 1b. *T. bombycinum* f. *tenue.*
Chromatophores 2–4, symmetrically disposed, diameter of cells 5–6 μ. 2. *T. minus.*
Chromatophores numerous, large, cell-wall thicker, diameter of cells 11–16.5 μ. 3. *T. utriculosum.*

1. TRIBONEMA BOMBYCINUM (Agardh) Derb. & Sol. Mém. sur physiol. alg. 18. *pl. 4. f. 16–21.* 1856.

Conferva bombycina Agardh, Syn. Alg. Scand. 78. 1817; Syst. Alg. 83. 1824. Kütz. Spec. Alg. 371. 1849; Tab. Phyc. **3**: *pl. 44. f. 1, 2.* 1853. Rabenh. Flor. Eur. Alg. **3**: 323. 1868. Wille, Öfvers. Vet.-Akad. Förhand. **1881**[8]: *pl. 9. f. 41–43, pl. 10. f. 51–54,* 1881. Lagerh. Flora, **72**: 194–209. *pl. 6.* 1889. Cooke, Brit. F. W. Alg. 137. *pl. 53. f. 4.* 1883. Wolle, F. W. Alg. 142. *pl. 121. f. 8, 9.* 1887. DeToni, Syll. Alg. **1**: 216. 1889. Bohlin, Bihang Svensk. Vet.-Akad. Hand. **23**[3]: No. 3. *pl. 1. f. 1–14. pl. 2. f. 44–46.* 1897.

Conferva sordida Roth. Cath. Bot. **1**: 177. *pl. 2. f. 4.* 1797.(?) Dillw. Brit. Conferv. *pl. 60.* 1806.(?) Lyngb. Tent. Hyd. Dan. 138. *pl. 46D.* 1819.(?)*

Filaments forming a sordid, yellowish or green floccose mass, 6–11 μ in diameter when mature; cells cylindrical or somewhat inflated, 2–4 times as long as the diameter; chromatophores several in a cell, small or of moderate size, scattered or crowded, glistening oil-drops often numerous: cell-wall rather thin (*pl. 25, f. 1–3*).

EXSIC.: Phyc. Bor. Am. *620,* Malden, Mass., April, 1894 (F. S. Collins).

Common and widely distributed in stagnant and flowing waters, in spring and fall.

CONNECTICUT: Thomaston, April; Watertown, May (563); Plymouth, November (666).

* *C. sordida* Dillw. was generally regarded as a synonym or variety of *C. bombycina* by the older authors. More recently it has been considered a *Microspora.* The original description and figures allow no final judgment as to the character of the species, hence it would be better if the name were dropped unless type specimens can be found. A specimen issued as *C. sordida* Rabenh. Alg. Sachs. *110* is *Oedogonium* sp.

NEW YORK: Central Park, May (128); Van Cortlandt Park, April (347); Bronx Park, June (605, 626C); New Rochelle, November (519).

NEW JERSEY: Undercliff, April (526); Englewood, May (430); Closter, October (499); Hudson Heights, May (435C).

NORTH CAROLINA: Salem, as *Conferva sordida* (Schweinitz).

1b. TRIBONEMA BOMBYCINUM forma **tenue** nom. nov.

Conferva bombycina forma *minor* Wille, Öfvers. Vet.-Akad. Förhand. 1879[5]: 65. *p. p.* 1879. Not *C. minor* Klebs.

Cells 3–6 μ in diameter, 2–12 times as long, usually very little if at all inflated; chromatophores small, numerous (*pl. 25, f. 4–6*).

EXSIC.: Phyc. Bor. Am. *C. bombycina* f. *minor* Wille, *621 A, B.* Bridgeport, Conn. (I. Holden).(?)

Usually growing mixed with *T. bombycinum.*

NEW YORK: Botanical Garden, April (341); Van Cortlandt Park, April (347), May (418).

NEW JERSEY: Closter, October (499A); Hudson Heights (435B).

From the fact that this form or aggregation of forms is generally found associated with *T. bombycinum* and at times appears to pass into the latter, it is to be suspected that it is simply a growth stage of that species. Since, however, the evidence for this view does not amount to actual proof, the present disposition is used as a matter of convenience in designating the small forms.

A form, which, when collected, appeared to be identical with *Conferva glacialoides* Wolle, developed, after a few days, into a condition corresponding to *T. bombycinum* f. *tenue* (*pl. 25, f. 4, 5*).

It is unfortunate that Wille's name cannot be retained for this series of forms for which it is well suited from the lack of definite characters associated with it. Because Klebs made a new species out of material identified by Professor Wille as belonging to his *Conferva bombycina* f. *minor*, there is necessity for the new form name proposed above.

2. **Tribonema minus** (Wille)

Conferva bombycina forma *minor* Wille, Öfvers. Vet. Akad. Förhand. **1879**[5]: 65. *pl. 14. f. 89. p. p.* 1879; *ibid.* **1881**[8]: 21. *pl.*

9. f. 36–40. pl. 10. f. 55, 56. 1881; Jahrb. wiss. Bot. **18**: *pl. 17. f. 64–68.* 1887. DeToni, Syll. Alg. **1**: 216. 1889.

Conferva minor Klebs, Fortpflanz. Alg. und Pilz. 347. *pl. 2. f. 1–8.* 1896.

Cells generally cylindrical, sometimes very slightly swollen, 5–6 μ in diameter, 2–4 or more rarely 6 times as long as broad; chromatophores 2–4 in each cell, arranged symmetrically in pairs for the most part (*pl. 25, f. 7, 8*).

MASSACHUSETTS: Melrose, April (550A, 552B).

CONNECTICUT: New Preston, September (495A).

NEW YORK: Bronx Park, May (421), June (443C, 626B); Staten Island, April (328).

NEW JERSEY: Undercliff, Bergen county, May (428), December (233).

After a number of observations and cultures, the distinctness of this species as defined by Klebs has been confirmed. It differs markedly in the character of the chromatophores from any form of *Tribonema bombycinum.*

3. **Tribonema utriculosum** (Kütz.)

Conferva utriculosa Kütz. Alg. Dec. *114.* 1836;* Spec. Alg. 372. 1849; Tab. Phyc. **3**: *pl. 44. f. 5.* 1853. Roemer, Alg. Deutsch. *pl. 5. f. 79.* 1845. Wille, Öfvers. Vet. Akad. Förhand. **1881**[8]: 22. *pl. 10. f. 67.* 1881. Wolle, F. W. Alg. 140. *pl. 120. f. 14–16.* 1887. DeToni, Syll. Alg. **1**: 217. 1889.

C. ventricosa Kütz. Phyc. Germ. 203. 1845.

Filaments long and often irregularly inflated, but sometimes cylindrical; cells 11–16.5 μ in diameter, 1½–6 times as long; chromatophores large and often crowded: cell-wall thicker than in the smaller species (*pl. 25, f. 9–11*).

EXSIC.: Phyc. Bor. Am. *864. p. p.* (sub *Microspora floccosa*) Melrose, Mass., May 15, 1901 (F. S. Collins).

In slow or rapid streams, frequently in the outlets of swamps.

NEW YORK: Van Cortlandt Park, April (347), May (418).

NEW JERSEY: Hudson Heights, May (435C); Grantwood, May (429, 573C, 579A).

This species probably includes forms sometimes identified as *Conferva bombycina major* Wille. The original diagnosis of the lat-

* Citation from Kütz. Spec. Alg. 372.

ter form (Wittr. & Nordst. Alg. Exsic. *519*. 1883) merely furnishes a statement of the diameter, 14–16 *μ*. We have seen no form with so great a diameter that could properly be associated with *Tribonema bombycinum*.

Tribonema utriculosum as above characterized does indeed approach *T. bombycinum* in respect to the diameter of the cells, but the thicker cell-wall and usually larger chromatophores, as well as an indefinable general appearance, sufficiently distinguish it from the smaller species. By repeated observation and cultural experiments, we have become convinced of the specific distinctness of the two forms.

It is a strange fact that none of these species of *Tribonema*, elsewhere common, have been found in Vermont during more than a year of collecting.

EXCLUDED FORMS

CONFERVA FONTINALIS Berk. Glean. Brit. Alg. *pl. 14. f. 1*. 1833. Wolle, F. W. Alg. 141. *pl. 120. f. 17–20*. 1887.

Microspora fontinalis DeToni, Syll. Alg. **1**: 230. 1889. Specimens bearing this name in the Wolle herbarium are certainly a *Rhizoclonium*, and probably the same is true of Berkeley's type. Berkeley supposed he was illustrating *Conferva fontinalis* Linn., but it is very doubtful if such was the case.

CONFERVA BOMBYCINA ELONGATA Tild. Am. Alg. *21* is a *Rhizoclonium* similar to Wolle's *C. fontinalis*.

CONFERVA SESQUIPEDALIS Tild. Am. Alg. *271*. is *Zygnema* sp.

CONFERVA SANDWICENSIS Tild. Am. Alg. *462*. Hawaii, 1900, is *Rhizoclonium* sp. showing the pyrenoids very clearly and giving a strong test for starch. All these examples of incorrect generic determination show how little the true *Conferva* (*Tribonema*) has been understood in this country.

See also doubtful forms of *Microspora*.

GENERA REMOVED FROM THE ULOTHRICACEAE

SCHIZOGONIUM Kütz. (Phyc. Gen. 245. 1843), including, according to the revision of Gay ('91), *Ulothrix*-like filaments which have stellate chromatophores and exhibit a strong tendency to longitudinal cell-division, and even to form an expanded thallus, is re-

moved from this family and placed with the Pleurococcaceae, because of the absence of reproduction by zoöspores.

SCHIZOMERIS Kütz. (Phyc. Gen. 247. 1843). We cannot accept the view of Professor Wille ('90) who disposes of this genus by placing it among the synonyms of *Ulothrix*. We have found *Schizomeris Leibleinii* Kütz. growing abundantly in a watering-trough and also in bright green *Spirogyra*-like masses at the edges of a creek near Long Branch, New Jersey, in midsummer, a time when all similar *Ulothrix* forms had disappeared. Although certain young filaments were almost indistinguishable from *Ulothrix zonata*, yet in all larger filaments the characteristic brick-like arrangement of the cells was very different from anything ordinarily found in *Ulothrix*. Most striking, however, was the manner of dispersal of the zoöspores; all the dissepiments in the upper part of the thallus appeared to be softened or broken down, and the masses of zoöspores escaped through the open funnel formed by the outer cell-wall. We have little question in regard to the validity of the genus *Schizomeris*, but as its affinity seems to be with the Ulvaceae rather more than with the Ulothricaceae, further treatment of it is reserved for another place.

GLOEOTILA Kütz. (Phyc. Gen. 245. 1843). Under this name have been placed various forms having affinities with *Ulothrix* and *Stichococcus*, some of which, because of insufficient characterization, cannot be determined with any certainty. Kützing's type of this genus was *G. oscillarina* (*Conferva oscillatorioides* Kütz. Alg. Dec.). This species was finally removed by its author to *Stigeoclonium* as *S. setigerum*, so that the genus *Gloeotila* must be abandoned.

Family **CHAETOPHORACEAE**

The thallus consists of a simple or more often branched filament, composed normally of a single series of uninucleate cells, which may all be of equal value, or some may be specialized as supporting or terminal structures and others as potential reproductive structures. The chromatophore in each vegetative cell is band-shaped, or it more or less completely lines the whole cell-wall, and generally contains one to many pyrenoids. Asexual reproduction by means of zoöspores, akinetes or aplanospores.

Sexual reproduction through conjugation of gametes similar in character, though sometimes differing in size.

Synopsis of Tribes and Genera

Tribe I. CHAETOPHOREAE

Plants attached at the base, erect, extensively branched, with more or less differentiation of supporting and reproductive portions (except in *Microthamnion*). All fresh-water plants.

- Plants less than 1 mm. high, not setiferous. I. MICROTHAMNION.
- Plants larger, branches generally pointed or setiferous.
  - Filaments fine, showing little difference in character of stem and branches. II. MYXONEMA.
  - Filaments fine, in tufts involved in dense gelatinous substances. III. CHAETOPHORA.
  - Filaments and main branches larger, bearing dense fascicles of small branchlets. IV. DRAPARNALDIA.

Tribe II. HERPOSTEIREAE

Plants microscopic, creeping on or within other algae or animals, without distinction between basal and apical cells, and without differentiation of supporting and reproductive portions.

- Inhabiting salt water.
  - Plants tending to form an expanded thallus, growing on the surface of bryozoa. V. EPICLADIA.
  - Plants simply branched, endophytic within the membrane of *Elachista*. VI. ENDODERMA.
  - Plants bearing special setiferous cells, epiphytic on Phaeophyceae. VII. BOLBOCOLEON.
- Inhabiting fresh water.
  - Plants composed of flask-shaped cells, bearing setae sheathed at the base. VIII. CHAETOSPHAERIDIUM.
  - Plants composed of globose or cylindrical cells, bearing setae bulbous at the base. IX. HERPOSTEIRON.

The genera of the Chaetophoreae are rather closely related, though *Microthamnion* and *Myxonema*, which are placed together, probably had a separate origin. The latter might be naturally derived from *Ulothrix*, while the former may have developed from a small *Stichococcus*-like ancestor. *Chaetophora* and *Draparnaldia* may easily be conceived of as developing from *Myxonema*.

The genera of the Herposteireae are a somewhat heterogeneous group, and perhaps have originated in different ways from protococcoid ancestors. Only *Epicladia* and *Endoderma* are closely related morphologically. *Herposteiron* seems to approach most nearly to the Coleochaetaceae, for it is not a great step from the

conjugation of the large and small gametes of the former to the oögamous fertilization of the latter.

I. MICROTHAMNION Nägeli; Kütz. Spec. Alg. 352. 1849. Kirchn. Krypt. Flor. Schles. **2**[1]: 70. 1878. Borzi, Nuova. Notarisia, **2**: 390. 1891. Schmidle, Hedwigia, **38**: 165–170. 1899.

Thallus minute, attached by a bulbous basal cell, much branched. Branches throughout of about the same diameter as the main stem. In the formation of a branch, a growth is pushed out at the upper end of a cell and the wall of separation is formed, not at this point, but some distance above in the branch. Cells cylindrical, the cell-wall very thin. Chromatophore a thin sheet, more or less completely covering the cell-wall, without pyrenoids but containing oil-drops.

Asexual reproduction through zoöspores formed in any cell (the basal excepted) to the number of 4 or 8; they are ovoid in shape, biciliate, without eye-spot, and germinate (apparently) directly after adhering to a substratum, without rhizoid formation.

Inhabitants of fresh water. Type *M. Kuetzingianum* Näg. [Etym. *μικρός*, small, and *θαμνίον*, a little bush.]

This genus has frequently been placed in close relation to *Trentepohlia* (*e. g.*, by Wille in Die natürlichen Pflanzenfamilien), because it has been supposed to have special terminal sporangia. In all the forms, however, with which we are familiar, any cell in the plant may produce zoöspores, and with less swelling of the filaments than in most of the Chaetophoreae. We have often seen many of the lower cells of a branch hyaline from the loss of the zoöspores, before they have escaped from the terminal cells. Hence the genus must occupy a position near to *Myxonema*. The remark of Chodat ('**02**) "Borzi pretend avoir vu les zoöspores biciliées (4–6 μ)" is unnecessarily discourteous, as there was every reason to expect that zoöspores would be found in these plants. Equally unjustifiable is his placing this genus in the Pleurococcaceae.

Synopsis of Species

Ramification dense, without distinction between main stem and branches.
1. *M. Kuetzingianum.*

Ramification more open, erect, the main stem distinguishable to the summit.
Terminal cells not narrowed. 2. *M. strictissimum.*
Terminal cells slightly tapering. 2b. *M. strictissimum macrocystis.*

1. MICROTHAMNION KUETZINGIANUM Nägeli; Kütz. Spec. Alg. 352. 1849; Tab. Phyc. **3**: *pl. 1.* 1853. DeToni, Syll. Alg. **1**: 256. 1889. Kirchn. Mik. Pflanz. *pl. 1. f. 10.* 1891. De Wild. Flor. Alg. Belg. 38. *f. 13.* 1896. (?) Schmidle, Hedwigia, **38**: 169. *pl. 7. f. 13–15.* 1899. Chodat, Beitr. Krypt. Flor. Schweiz. **1**[3]: 288. *f. 202, 203.* 1902. (?) Scarcely Wolle, F. W. Alg. *pl. 105. f. 1–4.* 1887.

Mature plants 60–200 μ tall, very densely and irregularly branched from the base, the main trunk soon disappearing in the ramifications; branchlets one- to several-celled, divergent, sometimes curved, not narrowed at the ends; cells cylindrical or sometimes subclavate, 3–4 μ in diameter, 2–4 (rarely 5–8) times as long; chromatophore bright green, covering nearly all the outer cell-wall (*pl. 26, f. 1; pl. 27, f. 2–4*).

EXSIC.: Phyc. Bor. Am. *568.* Greenhouse, Cambridge, Mass., 1899. (F. S. Collins).

Plants solitary or more often forming a thin bushy coating on small dead stems, etc. In watering troughs, in rivulets, and on dripping rocks.

CONNECTICUT: Watertown, May, (561B).

NEW YORK: Morningside Park, March to June (322, 352, 424, 532).

Chodat's description of the chromatophore as covering only two thirds of the circumference of the cell wall, as well as the open character of the branching in his figures do not agree with what is here (and by Schmidle also) considered the typical form of this species.

2. MICROTHAMNION STRICTISSIMUM Rabenh. Alg. Sachs. *829.* 1859; Krypt. Flor. Sachs. **1**: 236 (fig.), 266. 1863; Flor. Eur. Alg. **3**: 375. 1868. Schmidle, Hedwigia, **38**: 169. *pl. 7. f. 4, 5.* 1899.

Microthamnion Kuetzingianum strictissimum Hansg. Prod. Alg. Böhm. **1**: 91. 1886. DeToni, Syll. Alg. **1**: 258. 1889. Chodat, Beitr. Krypt. Flor. Schweiz, **1**[3]: 288. 1902.

Mature plants 300–600 μ tall, erect, branches generally alternate, the main trunks distinguishable even to the summit; branchlets erect or ascending, obtuse and not narrowed at the apex; cells cylindrical, 2.5–4 μ in diameter, 3–12 or even 15–20 times as long; chromatophore thin, pale green, not always encircling the cell (*pl. 26, f. 2–5*).

Forming a furry coating on dead straws and leaves, in stagnant water and in running water of a watering-trough; also in tufts on the sides of a rocky spring.

CONNECTICUT: Plymouth, March (524).

NEW YORK: East Chester, May (392B); Central Park, June (613B).

The opinion expressed by Schmidle that this species is quite distinct from *M. Kuetzingianum* is abundantly confirmed by comparison of American specimens. Most of the specimens on which the above description is based agree quite exactly with Rabenhorst's type material (Alg. Sachs. 829). The length of the cells as here given is greater than that given by Schmidle, but hardly greater then in some of Rabenhorst's plants.

The plants from Central Park are rather shorter and finer, so that we at first identified them as *Microthamnion vexator* Cooke (Grevillea, **11**: 75. 1882; Brit. F. W. Alg. 188. *pl. 73. f. 1.* 1883), but they are marked by a very strict or appressed habit of branching, while Cooke's figures represent a plant with very open branching. We have, therefore, included these plants in *M. strictissimum*, for there is no divergent character of sufficient importance to warrant making a new form. Indeed it is probable that *M. vexator* should not be maintained even as a variety of *M. strictissimum*, for though Cooke states that his plant is very much more slender than the latter species, the diameter he gives (3 μ) is not less than that of many plants of *M. strictissimum.* Furthermore, the measurements of *M. vexator* based on Cooke's original specimens, as given by Nordstedt (Svensk. Vet. Akad. Hand. **22**[8]: 15. 1888), are so similar to those of the type material of *M. strictissimum*, that we fail to see how it is possible to separate the two forms.

MICROTHAMNION STRICTISSIMUM MACROCYSTIS Schmidle, Hedwigia, **38**: 169. *pl. 7. f. 1–3.* 1899

Plants 300–800 μ tall, branching more open; branchlets ascending or spreading, slender, and tapering slightly toward the end; cells 2.5–3 μ (rarely 4 μ below) in diameter, 6–12, or 20 times as long; chromatophore pale and narrow, not encircling the cell, the tips of the apical cells hyaline (*pl. 27, f. 1*).

On dead leaves in a rain-water ditch in the hemlock grove, New York Botanical Garden, May, June (407, 608).

The name given to this variety by Schmidle is hardly appropriate, as the cells are no longer than many in *M. strictissimum*. The plant as here described agrees essentially with Schmidle's diagnosis, though the branching is perhaps less strict.

In the station above noted this form has appeared for a brief period in May and June during two seasons. It is not present in early spring, and the pool becomes dry upon the advent of warm weather.

II. MYXONEMA Fries, Syst. Orb. Veg. 343. *p. p.* 1825; Flor. Scan. 329. 1835

Stigeoclonium Kützing, Linnaea, **17**: 90. 1843; Phyc. Gen. 253. 1843.

Thallus covered with a thin slippery investment of mucus, consisting of a branched filament without great difference in respect to diameter between the main stems and the minor branches. Terminal branchlets pointed or frequently ending in long hyaline setae. Chromatophore a parietal, often laciniate band, zonate in the larger cells, nearly filling the smaller cells, inclosing several pyrenoids.

Asexual reproduction by means of 4-ciliate zoöspores having a red eye-spot, and akinetes which give rise to small 2-ciliate zoöspores, and through a palmella stage.

Sexual reproduction through conjugation of 2-ciliate gametes having a red eye-spot. Both gametes and zoöspores formed only in the vegetative cells of the branchlets.

Inhabitants of fresh water. Type, *M. lubricum* (Dillw.) Fries. [Etym. μύξα, mucus, and νῆμα, a filament.]

The fact that the genus *Myxonema*, as proposed by Fries, was composed of two diverse elements, probably accounts for its early supersession by the more homogeneous genera of Kützing. The first element comprised only the type (that is the first) species, *Conferva lubrica* (syn. *Draparnaldia* Ag.), a well-known branched form. The second element consisted of four unbranched species, *Conferva zonata* (Web. and Mohr), *C. compacta* Roth, *C. oscillatorioides* Agardh, and *C. dissiliens* Dillwyn, of which three are now recognized as species of *Ulothrix*, and the last as a desmid.

Ten years later Fries confirmed the genus, describing the species practically in the same order and adding two more. It is not surprising that such a grouping was made, for in the general appearance of the cells with the girdle-shaped chromatophore and the mucous character of the filaments, these two groups have more in common than many of the diverse elements at that time comprised in the genus *Conferva*. Now these four unbranched species were all placed in other genera before the establishment of Kützing's *Stigeoclonium* and the removal to it of *Myxonema lubricum*, our type. Hence whatever method of determining generic types is followed, that of residues or that of priority of position, since *Myxonema lubricum* was both the first species named under the genus and also the last to remain in it, the conclusion is inevitable that the genus *Myxonema* must stand upon this species. Though it is always an unfortunate necessity that compels the abandonment of a name long used for a large and comparatively homogeneous group like *Stigeoclonium* Kütz., reasons of sentiment cannot weigh in cases of this kind.

It should be noted that Rabenhorst ('47) at first adopted the genus *Myxonema* in practically the same composite sense as used by Fries, and that later, instead of keeping the name for part of the species, he abandoned it entirely for Kützing's genera *Stigeoclonium* and *Ulothrix*.

Fries (Syst. Orb. Veg. 345. 1825) quotes as a synonym of his new genus *Myxonema*, "*Naematrix* Fries, Stirp. Fems.," but we have been unable to find the latter name in the work quoted. Perhaps it was a manuscript name which was finally rejected in the publication of the Stirpium Agri Femsionensis Index, 1825–6.

Other authors refer to *Myxotrix* Fries, Stirp. Fems. 44, as a synonym of *Myxonema*, but the only species is *Myxotrix zonata* (presumably *Ulothrix zonata*); since no description or synonymy is there given, this name needs no further consideration.

Frequently one finds young or anomalous forms of *Myxonema*, which it is almost impossible to identify with any described species. On this account many specimens have been laid aside during the preparation of this work. It is very desirable that such young forms should receive continued attention, so that they may ultimately be associated with their proper species.

Although one may be very sure of the distinctness of species, it is a very difficult matter to construct a good key. It is hoped that the following may be of some assistance, though it is very far from satisfactory.

Synopsis of Species

Forms in which opposite branching predominates.
- Filaments 11–30 μ in diameter, branches often approximate.
  - Lower cells 1–2 times as long as broad, walls thickened, branchlets usually short-pointed. 1. *M. lubricum.*
  - Lower cells 2–5 times as long as broad, walls not thickened, branchlets more attenuate. 1b. *M. lubricum varians.*
  - Lower cells 3–8 times as long as broad, branchlets pointed. 2. *M. amoenum.*
  - Lower cells 4–8 times as long as broad, branchlets setiferous. 3. *M. flagelliferum.*
  - Lower cells scarcely longer than broad, branchlets thorn-like, acute. 4. *M. subuligerum.*
  - Lower cells 2–5 times as long as broad, much inflated. 5. *M. ventricosnm.*
- Filaments 7–10 μ in diameter, branches less crowded, transitional form.
  - Lower cells 1–3 times as long as broad, branchlets tapering or setiferous. 6. *M. tenue.*

Forms in which alternate branching predominates.
- Filaments short, cespitose.
  - Growing in thermal waters; diameter 7.5–12 μ. 7. *M. thermale.*
  - Growing in water of ordinary temperature.
    - Diameter 6–8 μ, branchlets obtuse or short-pointed. 8. *M. nanum.*
    - Diameter 7–9 μ, branchlets erect, attenuate or setiferous. 9. *M. aestivale.*
    - Diameter 11–14 μ, branchlets densely fasciculate, setiferous. 10. *M. glomeratum.*
- Filaments more or less elongated.
  - Diameter 5–7 μ. 11. *M. attenuatum.*
  - Diameter 8–11 μ. 12. *M. stagnatile.*
  - Diameter 12–18 μ. 13. *M. subsecundum.*

1. MYXONEMA LUBRICUM (Dillw.) Fries, Syst. Orb. Veg. 343. 1825; Flora Scan. 329. 1835.

Conferva lubrica Dillw. Brit. Conferv. *pl. 57.* 1 March, 1806. Agardh, Syn. Alg. Scand. 92. 1817. (?) Lyngb. Tent. Hyd. Dan. 150. *pl. 52.* 1819. Not *C. lubrica* Roth. Cat. Bot. 3: 168. 1806 [=*Tetraspora lubrica*].

Draparnaldia tenuis elongata Agardh, Syst. Alg. 57. 1824.

Draparnaldia laxa Bory, Dict. class. d'hist. nat. **5**: 614. 1824.

Draparnaldia lubrica Crouan, Flor. Finist. 128. 1867.

Stigeoclonium lubricum Kütz. Phyc. German. 198. 1845; Spec. Alg. 354. 1849; Tab. Phyc. **3**: *pl. 6. f. 1.* 1853. Rabenh. Krypt. Flor. Sachs. **1**: 267. 1863. Kickx, Flore Crypt. Fland. **2**: 418. 1867. Berthold, Nov. Act. **40**: *pl. 15. f. 9, 11, 12, 14.* 1878.

Stigeoclonium tenue lubricum Rabenh. Flor. Eur. Alg. **3**: 377. 1868. Kirchn. Krypt. Flor. Schles. **2**[1]: 68. 1878. Hansg. Prod. Alg. Böhm. **1**: 66. 1886. Wolle, F. W. Alg. 111. 1887. DeToni, Syll. Alg. **1**: 197. 1889. De Wild. Flor. Alg. Belg. 44. 1896.

Tufts 5 mm. to 3 dm. long, dark green and shining. Filaments much branched; branches single, opposite, or subverticillate, frequently two or more pairs approximate, springing from subglobose cells shorter than those of the rest of the filaments: branchlets very numerous, scattered, opposite, or in the upper part of the plant densely fasciculate, slender, usually only slightly tapering, ending in a short point or sometimes setiferous; lower cells generally somewhat swollen, thick-walled, 14–16.5 μ in diameter, $\frac{2}{3}$–2 (rarely 2–4) times as long, containing a broad girdle-like chromatophore; diameter of branchlets 6–7 μ, the cells equal to or shorter than the diameter (*pl. 28, f. 1, 2*).

EXSIC.: Phyc. Bor. Am. *866*, Malden, Mass., April 29, 1901. (F. S. Collins).

In brooks and watering-troughs, on stones, sticks, etc.

MASSACHUSETTS: Haverhill, April (554); Malden, cemetery, April (551, station same as of P. B. A. *866*).

CONNECTICUT: Watertown, May (564); Litchfield, May (569B).

NEW YORK: New Rochelle, May (585), November (516, 517); West Chester, September (484), November (515); East Chester, May (389); Van Cortlandt Park, September (480); Manhattan, numerous stations, April to October.

NEW JERSEY: Demarest, October (506); Englewood, October (666); Fairview, April (85A, 296); Undercliff, Bergen county, April (85B); Newark, November (514).

The synonymy gives an intimation of the varied treatment this species has received. Even Agardh was quite uncertain as to its

relation to his *Draparnaldia tenuis*, at one time making the latter a synonym under *Conferva lubrica*, and again making *Conferva lubrica* a variety of *D. tenuis*. After a very extended study of both these forms, there is no question in our opinion, of their distinctness, and we believe there is no doubt as to the correctness of the determination of the two as here described. Certainly there is no other American form that can be identified with Dillwyn's *Conferva lubrica*.

Kützing's figure of this species is only fair, and Berthold seems to be the only author who has particularly noted and correctly illustrated the small branch-bearing cells that are so characteristic of this and the rest of the forms of this group, though others have noted them in *Stigeoclonium flagelliferum*, and Kützing has given a hint of their presence in several forms. Miss Tilden ('96) has stated that, to her knowledge, such cells are a characteristic of no other species besides *S. flagelliferum;* possibly this is an indication that the western algal flora is considerably different from that of the east, for here there are at least seven well-marked forms in which these cells are a prominent feature.

Myxonema lubricum may in some sense be considered a standard or point of departure for the comparison of the other forms of this group. Though it reaches a greater length than any of the other members of the group, they are for the most part more developed in some feature. The variety *varians* is smaller but rather more branched; *M. subuligerum* has shorter cells, but more divergent and sharp-pointed branchlets; *M. amoenum* differs chiefly in the long cells of the main branches; *M. flagelliferum* might be considered a form of the last with attenuated, setiferous branchlets; *M. ventricosum* is a form in which the main cells are lengthened and inflated. These do not form an entirely progressive series, but are clearly related to *M. lubricum*. *M. tenue* is a much finer and somewhat simpler form, and might well be placed in the ancestral line of *M. lubricum*. The probable developmental relationship would be better indicated if the alternate branched species were placed first and *M. tenue* made to form a connecting link with the larger forms of the *lubricum* group. The present arrangement is simply more convenient for comparison.

1b. MYXONEMA LUBRICUM **varians** var. nov.

Tufts shorter, 5–15 mm. long; filaments somewhat more slender; branches single or opposite, generally approximate on a moniliform series of 3–10 shorter cells; branchlets slender, needle-shaped; lower cells cylindrical or somewhat swollen, rather thin-walled, 11–14 μ in diameter, 2–5 times as long (*pl. 33, f. 4, 5; pl. 28, f. 3, 4*).

On rocks and sticks, in rapid brooks and in watering-troughs.

MASSACHUSETTS: Medford, in a clay pit, May 7, 1901 (F. S. Collins, *3998*).

CONNECTICUT: Norwich, May (559); Thomaston, May (542).

NEW YORK: Central Park, May (384B), October (663); Flushing, August (456); West Chester, May (388); New Dorp, Staten Island, April, (334); Castleton Corners (330); Clove Lake (331); Concord (336, type).

NEW JERSEY: Undercliff, May (432); Shadyside, April (304B).

We have wavered between considering this form or collection of forms a mere growth stage of *M. lubricum* and a distinct species. The large number of specimens collected indicates that it is sufficiently important to be recognized. It is generally easily distinguished from the typical forms of *M. lubricum* by its smaller size (both in diameter and length of the filaments) and the longer, thin-walled cells. Though at times the branching is comparatively simple, as a rule the tendency is to accumulate more extensive series of branches than are commonly seen in *M. lubricum*. Where the variety has been found with typical forms of the species, it has seemed most distinct. In other cases the relationship has appeared to be so close that it is thought best, at least tentatively, to consider the smaller plant a variety of the larger.

In respect to diameter this form is intermediate between *Myxonema tenue* and *M. lubricum*, but in the matter of branching it is usually rather more developed than either of these; in some cases it approaches *M. amoenum*. Much simpler forms are also found, which must be associated with this variety. In our drawings of *Myxonema lubricum varians* and *M. tenue*, the diameter of the former has been represented as slightly smaller than it should be and that of the latter is slightly too large, in comparison with other species.

2. **Myxonema amoenum** (Kütz.)

Stigeoclonium amoenum Kütz. Phyc. German. 198. 1845; Spec. Alg. 355. 1849; Tab. Phyc. **3**: *pl. 6. f. 2.* 1853. Rabenh. Flor. Eur. Alg. **3**: 378. 1868. Wolle, F. W. Alg. 113. *pl. 98. f. 4.* 1887. DeToni, Syll. Alg. **1**: 202. 1889.

Cespitose, light green, about 5 mm. long. Filaments much branched, branches mostly opposite throughout, frequently two or three pairs approximate, arising from short angular cells; branchlets tapering and pointed but usually not setiferous. Cells of main branches nearly cylindrical, frequently slightly inflated, 3–8 times as long as the diameter, above 2–4 times as long as the diameter, and finally in the branches subequal; chromatophore thin and narrow below; diameter of lower cells 11.5–16 μ, at base of branchlets 6.5–8 μ (*pl. 29*).

Attached to a flag stem, floating in the river. Ipswich, Mass., May, (558A). "Mountain springs and pools, Penn." F. Wolle.

3. MYXONEMA FLAGELLIFERUM (Kütz.) Rabenh. Deutsch. Krypt. Flor. **2**^{2}: 100. 1847

Stigeoclonium flagelliferum Kütz. Phyc. Germ. 198. 1843; Spec. Alg. 355. 1849; Tab. Phyc. **3**: *pl. 10. f. 1.* 1853. Rabenh. Flor. Eur. Alg. **3**: 378. 1868. Wolle, F. W. Alg. 112. *pl. 97. f. 1.* 1887. Scarcely Tilden, Minn. Bot. Stud. **1**: 629. *pl. 31–35.* 1896.

Tufts 5–20 mm. long, bright green; branches mostly in pairs, often 2–4 approximate on short somewhat globose cells; branchlets flagelliform, attenuate into long setae; cells of the lower branches 14–18 μ in diameter, 4–8 times as long, cylindrical or slightly inflated, at the base of the branchlets 9–10 μ.

EXSIC.: Phyc. Bor. Am. *408*, Bridgeport, Conn., Dec. 1895. (I. Holden).

This species seems to differ from *M. amoenum* chiefly in having a slightly larger diameter and setiferous terminal branches.

Miss Tilden, at the end of her elaborate and painstaking study of *Pilinia diluta* Wood and *Stigeoclonium flagelliferum* Kütz., writes as follows:

"To avoid adding to the confusion alreading existing in the genus *Stigeoclonium*, it is thought best to place the plant which

has been undergoing investigation in the above species although it is not entirely in agreement with it. It does agree in one of the main points, that of forming groups of short, branch-bearing cells. * * * As this is a characteristic of no other species, to my knowledge, it seems necessary to connect it with that name."

Possibly the plant treated by this author was an abnormal form of *Stigeoclonium flagelliferum;* it certainly was not typical of the species. The point to be noted is, that because it agreed in *one* of the main points, the author found it necessary to connect it with that name, and thereupon proceeded to rewrite the description of one of the best characterized species in the genus in such a way as to fit her plant, changing some important points so as to transform the character of the description—and all this to avoid adding to the existing confusion!

It might be remarked parenthetically, that in almost every instance where Wolle stretched a description in order to squeeze his specimen into it, his form has to be questioned, and less confusion would have resulted by the addition of several new species.

It is inconceivable that one having any familiarity with Kützing's plates—and lacking such familiarity one ought never to attempt to treat this genus—should have described the branches of *S. flagelliferum* as "rarely opposite," thus removing it from the group of species with which it is really most closely associated.

The fact that *Pilinia diluta* Wood represents a stage in the life history of some specimens of *Stigeoclonium* is most admirably worked out in Miss Tilden's paper. The conclusion, however, that *Pilinia* as a genus is only a form genus to be included in *Stigeoclonium* is wholly unwarranted. It overlooks the true *Pilinia*, *P. rimosa* Kütz., and the other marine forms, *Acroblaste* and *Chaetophora maritima*, that have been associated with it.

4. **Myxonema subuligerum** (Kütz.)

Stigeoclonium subuligerum Kütz. Spec. Alg. 354. 1849; Tab. Phyc. **3**: *pl. 5. f. 1.* 1853.

S. protensum subuligerum Rabenh. Flor. Eur. Alg. **3**: 378. 1868. (?) DeToni, Syll. Alg. **1**: 200. 1889.

More or less tufted, 5 mm. or more in length; filaments very much branched; main branches opposite or approximate, spread-

ing, frequently elongated, beset with numerous, mostly opposite, divaricate branchlets; branchlets thorn-like, tapering from a thick base to an acute point, often attenuate into rather short setae; cells throughout cylindrical, about as long as broad, or a little longer or shorter, filled with the dense chromatophore; diameter of the main branches about 14 μ (12–16 μ), of the branchlets about 8 μ (6–9 μ) at the base (*pl. 30*).

In brooks and rills.

NEW YORK: Bronx Park, June (607, 627); Botanical Garden, May (374, 422), June (629).

NEW JERSEY: Hudson Heights, April (309).

Though our specimens average rather larger than the diameter given by Kützing (11–12.6 μ), yet in general character they seem exactly to correspond with his description and figures. Taking into account the fact that Kützing's description was based on dried specimens, the agreement is certainly as close as could be expected. Rabenhorst seems quite to have misunderstood the nature of this species or of *Stigeoclonium protensum* for the two are conspicuously incompatible; the latter is an alternate-branched form, while this species is extreme in its development of the opposite type of branching.

5. **Myxonema ventricosum** sp. nov.

Cespitose, 5–10 mm. long; filaments much branched, branches mostly opposite, borne on small subglobose cells, often 2–4 pairs approximate, ascending; branchlets alternate, opposite or subfasciculate, short, tapering slightly to a rounded apex, sometimes prolonged into a rather obtuse seta; cells below very strongly inflated, 2–5 times as long as the central diameter, above shorter and less inflated, in upper branches cylindrical, about as long as the diameter or shorter; diameter of lower cells 14–16.5 μ at the dissepiments, 27–30 μ in the center, 45–110 μ long; diameter of branchlets at base 6–8 μ (*pl. 31*).

On stones in the bed of a rapid brook. Cresskill, New Jersey, 1 May 1900 (359).

In the character of the upper branches this species resembles *Myxonema lubricum* and *M. amoenum*. The cells of the main branches, however, are very much more inflated than either of those forms. It is perhaps nearer to *Stigeoclonium insigne* Nägeli (Pflanz-phys. Untersuch. 1: 36. *pl. 1.* 1855), a beautiful species

which appears to have escaped the notice of DeToni, but rather than crowd it unduly into that species, it seems better to establish a new species.

Wolle's figure of *Stigeoclonium nudiusculum* shows considerable similarity to our plant; it is certainly not what it purports to be.

Myxonema ventricosum was abundant at the time noted, but when sought for, less than a month afterward, none could be found. The plant is so marked a form, however, that there can be no doubt of its distinctness.

6. MYXONEMA TENUE (Ag.) Rabenh. Deutsch. Krypt. Flor. **2**^{2}: 100. 1847

Draparnaldia tenuis Agardh, Alg. Dec. 40. 1814; Syst. Alg. 57. 1824; Icon. Alg. Eur. *pl. 38*. 1828–35. Hass. Brit. F. W. Alg. 123. *pl. 11. f. 2*. 1845. Derb. & Sol. Ann. Sci. Nat. Bot. III. **14**: 267. *pl. 33. f. 1–6*. 1850.

Stigeoclonium tenue Kütz. Phyc. Gener. 253. 1843; Phyc. German. 197. 1845; Spec. Alg. 353. 1849; Tab. Phyc. **3**: *pl. 3. f. 1*. 1853. Rabenh. Krypt. Flor. Sachs. **1**: 268. 1863; Flor. Eur. Alg. **3**: 377. 1868. Kirchn. Krypt. Flor. Schles. **2**^{1}: 68. 1878; Mik. Pflanz. 11. *pl. 1. f. 19*. 1891. Hansg. Prod. Alg. Böhm. **1**: 66. 1886. Wolle, F. W. Alg. 111. *pl. 96. f. 11*. 1887. Cooke, Brit. F. W. Alg. 189. *pl. 73. f. 3*. 1883. DeToni, Syll. Alg. **1**: 197. 1889. De Wild. Flor. Alg. Belg. 44. 1896.

Myxothrix tenuis Trevis. Alg. Ten. Udin. 16. 1844.

Tufts 5–10 mm. long, bright green; filaments much branched, slender; main branches solitary or opposite, usually not more than two pairs adjacent; branchlets numerous, scattered or opposite, short, erect, thorn-like, tapering to an acute point or finely setiferous; cells cylindrical or slightly swollen, 7–10 μ (generally 8 μ) in diameter, 1–3 times as long (sometimes longer below); branchlets 5–6 μ in diameter at the base, cells about as long as the diameter (*pl. 32*).

In brooks and watering-troughs.

VERMONT: St. Johnsbury, August (643).

MASSACHUSETTS: Melrose, May 16, 1901 (F. S. Collins, *4007*).

NEW YORK: Botanical Garden, August to October (458, 497), June (612, 631); Manhattan, June (615, 640, 625), September (478).

This species, together with *M. lubricum*, seems to have undergone a gradual course of misinterpretation, until by DeToni it is explicitly described as not setiferous, while the variety *lubricum* is said to be setiferous. As a matter of fact the reverse is nearer the truth. The beautiful figures of Agardh, as well as his original description, clearly represent a form in which the branchlets are often more than subulate; they may be even rather long setiferous. On the other hand the branchlets of *M. lubricum* are more often short-pointed. It is, of course, a matter of some difficulty to determine certainly the true character of an old species like this, but the plants on which our description has been based agree as closely as possible with the above-mentioned original figure and description.

Kützing's figure does not appear to be characteristic. In our judgment it resembles the young forms which are commonly found and which cannot certainly be identified with any particular species. Perhaps this figure has given rise to the incorrect notion of the species that has become prevalent.

The species is variable, the branching less dense and less uniformly opposite than in other members of the *lubricum* group, and it therefore forms a point of transition to the alternate-branched species.

The best specimens of *M. tenue* seem to reproduce *M. lubricum* in miniature, but there is no evidence that the two species intergrade; in fact where both forms have been found growing together they have appeared most distinct.

7. **Myxonema thermale** (A. Braun)

Stigeoclonium thermale A. Braun; Kütz. Spec. Alg. 353. 1849; Tab. Phyc. **3**: *pl. 2. f. 4.* 1853. Rabenh. Flor. Eur. Alg. **3**: 376. 1868. Cooke, Brit. F. W. Alg. 189. *pl. 73. f. 2.* 1883. Wolle, F. W. Alg. . 111. *pl. 96. f. 1.* 1887. DeToni, Syll. Alg. **1**: 201. 1889.

Stigeoclonium Borminanum Anzi, Erb. Critt. Ital. *1034.*

Draparnaldia uniformis Ag. Flora, **10**: 635. 1827; Icon. Alg. Eur. *pl. 37*. 1835. (?)

Bright green, somewhat creeping at the base, branches numerous, branchlets rather remote, alternate or opposite, erect or somewhat divergent, attenuated upward to an acute apex; cells 7.5–12 μ in diameter, 1–2 times as long, in the branchlets 3–5 times as long.

In warm springs and hot water waste from mills, etc.

Wolle's figure seems so well in accord with the species, that there is no good reason for question in regard to it. *Draparnaldia uniformis* has usually been considered a variety of *Stigeoclonium tenue*, but both in respect of general character and habitat, it appears to be more closely allied to this species.

8. **Myxonema nanum** (Dillw.)

Conferva nana Dillw. Brit. Conferv. *pl. 30*. 1803. Web. & Mohr, Grossbrit. Conferv. *pl. 30*. 1805. Lyngb. Tent. Hyd. Dan. 149. *pl. 52. A*. 1819.

Draparnaldia sparsa Hassall, Ann. & Mag. Nat. His. **11**: 428. 1843.

D. nana Hassall, Brit. F. W. Alg. 124. *pl. 10. f. 4*. 1845.

Stigeoclonium nanum Kütz. Spec. Alg. 354. 1849. Cooke, F. W. Alg. 190. *pl. 74. f. 2*. 1883. Wolle, F. W. Alg. 112. *pl. 96. f. 10*. 1887. Saunders, Flora of Neb. **1**: 64. *pl. 18. f. 1*. 1894.

Plants 2–3 mm. high; branches and branchlets alternate, tapering somewhat, obtuse or short-pointed; cells 6–8 μ in diameter, and 1–2 times as long.

EXSIC.: Phyc. Bor. Am. *867*, Iroquois, South Dakota, September, 1897 (De Alton Saunders).

The figures given by Wolle and Saunders are sufficiently like those of Dillwyn and Cooke, so that the identification of their plants can hardly be questioned. At the same time, it appears very probable that this species is only a young state of some other. The specimen from South Dakota particularly has this appearance and the lack of strongly marked characters in the diagnosis points to the same conclusion.

9. **Myxonema aestivale** sp. nov.

Light green, growing in dense tufts 2–5 (rarely 15) mm. long; filaments radiating from a palmelloid base; branches dichotomous or alternate, erect; branchlets few, short, erect, very slender, frequently approximate near the summit, often attenuate into fine setae; cells thin-walled, somewhat swollen, 7–9 μ (rarely 11 μ) in diameter, 2–6 times as long, above about equal to the diameter (*pl. 33, f. 1–3*).

Forming a cespitose covering on the edge of iron fountains and watering troughs.

VERMONT: St. Johnsbury, April (673, 674).

CONNECTICUT: Thomaston, September (493).

NEW YORK: Botanical Garden, June (630), September (479), October (498, 652, 653); Manhattan, July to November (459, 489, 483, 487, 510, 463, 654).

This species appears to be very similar in its general character to *Stigeocloniun radians* Kütz. and *S. fastigatum* Kütz., but from the fact that it never attains the size of these two species, and appears to be fully mature and not a young form, we have felt obliged to consider it an undescribed species. It is distinguished from the forms mentioned, aside from its smaller size, by longer cells, less abundant branches and less developed setae. This is essentially a summer form; we have not found it in New York earlier than June, but it is rather abundant in several stations through the summer and early autumn.

10. **Myxonema glomeratum** sp. nov.

Tufts about 8 mm. long, from a dense palmelloid base; filaments radiating, bearing few, alternate branches below; branches above alternate or rarely opposite, more or less densely penicillate-fasciculate, particularly at the summit, tapering into an acute or long setiferous point; cells of main branches 11–14 μ in diameter, 2–7 times as long, cylindrical or slightly swollen, chromatophore broadly zonate; cells of branchlets 6–8 μ in diameter, 1–2 times as long, chromatophore dense (*pl. 34*).

Attached to twigs in a nearly stagnant pool, and in the iron basin of a fountain.

NEW YORK: East Chester, May (390, 591); Central Park, June (623).

This species is very similar in the character of the terminal branching to *Stigeoclonium fasciculare* Kütz. (not Wolle), but it differs so much from that form in the long cells of the main branches that it must be considered as distinct, at least until further evidence as to Kützing's species is obtained.

Great diversity in the density of the branching may be seen even in a single tuft, and from this circumstance one might suspect this to be an abnormal form of some other species. Because, however, it has maintained in character in the same station, under changed conditions in successive seasons, it has seemed impossible to refer it to any other species.

11. **Myxonema attenuatum** sp. nov.

Tufted, or forming dark green lubricous skeins, 10 mm. to 4 dm. long; dichotomously divided near the base into numerous long, slender filaments, sparsely branched above; branchlets short, spinescent or flagelliform, solitary or 2–3 arising at the same point, less often opposite, tapering into an acute point or into a very finely attenuated seta; cells cylindrical, 5–7 μ in diameter, mostly 2–5 times as long; chromatophore thin and somewhat broken (*pl. 35*).

In running water of watering-troughs.

VERMONT: St. Johnsbury, March to November (642, 646, 667, 670, 685).

CONNECTICUT: Thomaston, February to May (522, 540B, 547).

This species is capable of growing to a greater length than is recorded for any other species in the genus. It forms fine silken tufts on the bottom or sides, and long skeins in the overflow on the outside of iron or wood watering-troughs. Sometimes it stretches in fine cobweb-like strands across a tub just below the surface of the water, and resembles in appearance a fine *Ulothrix*. Usually one does not see the character of the basal branching except in the shorter tufts.

The plant was fully grown in February (although it was not visible in December) and seemed to disappear from the two Connecticut stations where it was observed, before summer. In Vermont it is probable that it was growing from early spring until destroyed by ice in autumn.

12. **Myxonema stagnatile** sp. nov.

Floccose, floating; filaments somewhat elongated, bearing at widely separated intervals, solitary or opposite branchlets, which are short, thorn-like, often curved, tapering to a sharp point or attenuate into a long seta; cells 8–11 μ in diameter, 1–3 times as long (occasionally one or two cells above the point of branching, each a length of 6 times the diameter); branchlets 7–9 μ in diameter at the base (*pl. 36, f. 1, 2*).

Floating in confervoid masses in pools and ponds.

MASSACHUSETTS: Melrose, April, 1901 (553), May, 1902 (676).

NEW YORK: Williamsbridge, April (292).

This form resembles *Stigeoclonium protensum* as represented by Thuret and some others, but most authors describe that species as larger and having long drawn out branches, a characterization which corresponds more closely to Dillwyn's species.

13. **Myxonema subsecundum** (Kütz.)

Conferva subsecunda Kütz. Alg. Dec. *146*. 1836.

Stigeoclonium subsecundum Kütz. Phyc. Gen. 253. 1843; Spec. Alg. 352. 1849; Tab. Phyc. **3**: *pl. 1. f. 2*. 1853. Rabenh. Flor. Eur. Alg. **3**: 376. 1868. Wolle, F. W. Alg. 112. *pl. 99. f. 2*. 1887. (?)

Filaments elongated, about 16 μ (12–18 μ) in diameter; very sparsely branched below, branches never opposite; cells cylindrical, very slightly constricted at the dissepiments, 3–10 times as long as the diameter; some branches elongated with cells of the same character as those of the main filament, others shorter with cells 2–3 times the diameter; branches attenuated toward the apex (*pl. 36 f. 3*).

Pleasantville, New Jersey, May 15, 1891 (F. S. Collins). "Collected by H. W. Ravenel in rice field ditches, South Carolina." F. Wolle.

DOUBTFUL FORMS

STIGEOCLONIUM NUDIUSCULUM Kütz. Tab. Phyc. **3**: 4. *pl. 15. f. 2. pl. 16. f. 1*. 1853. Rabenh. Flor. Eur. Alg. **3**: 380. 1868. Wolle, F. W. Alg. 113. *pl. 98. f. 1, 2*. 1887.

Draparnaldia nudiuscula Kütz. Phyc. Germ. 231. 1845.

The form described and illustrated under this name by Wolle is quite incompatible with the species of Kützing. He seems not to have noticed the essential phrase in the description of Rabenhorst, "ramulis superioribus plerumque ternis fasciculatim aggregatis." Certainly there is no fasciculate branching in Wolle's form: it appears to be more like our *Myxonema ventricosum.*

STIGEOCLONIUM PROTENSUM (Dillw.) Kütz. Phyc. Germ. 198. 1845; Spec. Alg. 355. 1849; Tab. Phyc. **3**: *pl. 18. f. 2.* 1853. Wolle, F. W. Alg. 112. *pl. 101. f. 1–4.* 1887.

Conferva protensa Dillwyn, Brit. Conferv. *pl. 67.* 1806.

Possibly Wolle's figures represent this species, but as no specimens that could be identified with it have been seen, this form must be considered questionable.

STIGEOCLONIUM FASCICULARE Kütz. Bot. Zeit. **5**: 177. 1847; Tab. Phyc. **3**: *pl. 8. f. 1.* 1853. Rabenh. Flor. Eur. Alg. **3**: 380. 1868. Wolle, F. W. Alg. 114. *pl. 99. f. 1.* 1887.

The form illustrated by Wolle is very different from Kützing's species. The phrase in Rabenhorst's description "filis ramisque dichotomis," has been made by Wolle to read "branching mostly *opposite dichotomous*," thus changing entirely the character of the description, to say nothing of bringing together two incompatible features.

Stigeoclonium fasciculare Phyc. Bor. Am. *67* is similar to Wolle's form in its opposite branching and appears to be nearly related to *Myxonema lubricum.*

In the specimen issued under this name by Miss Tilden (Am. Alg. *20*) we can find nothing but *Chaetophora elegans.*

We have seen no American specimens that could properly be considered *Stigeoclonium fasciculare*, though our *Myxonema glomeratum* approaches it in general character.

STIGEOCLONIUM FASTIGATUM Kütz. Spec. Alg. 356. 1849; Tab. Phyc. **3**: *pl. 11. f. 1.* 1853. Wolle, F. W. Alg. 114. *pl. 100. f. 1.* 1887. Saunders, Flora of Neb. **1**: 64. *pl. 18. f. 2.* 1894.

STIGEOCLONIUM RADIANS Kütz. Spec. Alg. 354. 1849; Tab. Phys. **3**: *pl. 7. f. 2.* 1853. Wolle, F. W. Alg, 115. *pl. 102. f. 4.* 1887.

STIGEOCLONIUM LONGIPILUS Kütz. Phyc. Germ. 198. 1845; Tab. Phyc. **3**: *pl. 7. f. 1.* 1853. Wolle, F. W. Alg. 115. *pl. 100. f. 2, 3. pl. 102. f. 1–3.* 1887.

These three species are so similar in character that it is difficult to discover adequate points of distinction. We have seen no American specimens that could well be identified with any of these species, and as Wolle's descriptions are somewhat modified in every case, we feel obliged to question his determinations of these forms. *Stigeoclonium longipilus minus*, as issued in Phyc. Bor. Am., *865*, corresponds to Hansgirg's description, but it is doubtful if a form like this, only 4–6 μ in diameter ought to be considered a variety of a species 11–14 μ in diameter; this may be a young stage of *S. longipilus*.

III. CHAETOPHORA Schrank, Der Naturforscher, **19**: 124–126. 1783; Baier. Flor. **2**: 489–490. 1789

Rivularia Roth, Cat. Bot. **1**: 212–214. 1797.

Myriodactylon Desvaux, Journ. de Bot. **2**: 307. 1809.

Thalli forming globular or elongated colonies, consisting of filaments arising in a dense mass from a palmelloid base and closely held together in an elastic, resistant, gelatinous substance. Filaments repeatedly branched, of nearly equal diameter throughout, the ultimate branchlets more or less fasciculate, often terminating in long hyaline setae. Chromatophore a parietal band inclosing one to several pyrenoids.

Asexual reproduction by means of biciliate zoöspores, formed in the cells of the branchlets. Akinetes may be formed (apparently) in all cells.

Inhabitants of fresh water. Type, *C. globosa* Schrank. [Etym. χαίτη, hair; φορέω, to bear.]

Until 1812 the species which are now placed in this genus generally bore the name *Rivularia* Roth. At that time Agardh, in reviving the old genus *Chaetophora* Schrank, either made no attempt to identify the type species or could not.

The genus *Chaetophora* was founded on two species. Of these, the second *C. lobata*, is plainly to be identified with our *C. incrassata*. The determination of the first or type species, *C. globosa*, is not so simple a matter. This was based on Müller's *Conferva stellaris, filamentis e basi orbiculari parallelis* (Der Naturforscher

7: 189. *pl. 3.* 1775). We believe that any one would naturally connect Müller's figures with one of our globose species of *Chaetophora;* yet it is a curious fact that this plant, or at least one bearing the name *Conferva stellaris* Müller, sixty years later became the type of Kützing's genus *Stigeoclonium.*

Now whether this species was really a *Stigeoclonium* or, what we understand by *Chaetophora*, is, of course, an important question. For if it was the former, then the name *Chaetophora* would have to supersede *Myxonema* and *Stigeoclonium*, while the species we now know as *Chaetophora* would have to be restored to *Rivularia.*

There is every reason, however, to believe that such a confusing readjustment will never be necessary; for a careful study of Müller's paper, supported by a comparison of the treatment of his species by early authors, is sufficient to convince one that the *Conferva stellaris filamentis, etc.*, is really to be identified with one of our species of *Chaetophora.* Indeed by the ingenious process of juggling with names used by some authors, Schrank's type might be identified with *C. pisiformis*, but we do not regard the actual specific identification as sufficiently certain to warrant the displacement of Roth's name.

It should be noted that Roth's type of *Rivularia* was *R. Cornu-Damae* [= *Chaetophora incrassata*], and that the schizophyceous species which form the genus now called *Rivularia* were added later and have no real right to the name. If the modern tendency toward multiplication of genera should reach *Chaetophora*, there would be a necessity for reviving the name *Rivularia* for the forms now grouped under the name *Chaetophora incrassata*, so that another generic name ought to be given to the Schizophyceae now bearing the name *Rivularia.*

Synopsis of Species

Colonies of filaments subglobose or tuberculose.	
Branching lax and spreading, fasciculate at the summit.	1. *C. elegans.*
Branching erect, fasciculate at the summit.	2. *C. pisiformis.*
Branching erect, not fasciculate at the summit.	3. *C. attenuata.*
Colonies of filaments extended, irregularly lobed or laciniate.	4. *C. incrassata.*

1. CHAETOPHORA ELEGANS (Roth) Agardh, Disp. Alg. Suec. 42. 1812; Syst. Alg. 27. 1824. Lyngb. Tent. Hyd. Dan. 192 (excl. syn.) *pl. 65.* 1819. Hassall, Brit. F. W. Alg. 127. *pl. 9. f. 3, 4.* 1845. Kütz. Spec. Alg. 532. 1849; Tab. Phyc. **3**: *pl. 20. f. 1.* 1853. Rabenh. Flor. Eur. Alg. **3**: 384. 1868. Wood, F. W. Alg. 210. *pl. 6. f. 5.* 1873. Cooke, Brit. F. W. Alg. 194. *pl. 78. f. 2.* 1883. Wolle, F. W. Alg. 116. *pl. 103. f. 4–10.* 1887. DeToni, Syll. Alg. 183. 1889.

Rivularia elegans Roth, Neue Beitr. Bot. **1**: 269. 1802.* (Ann. of Bot. **1**: 259. 1805.)

Batrachospermum intricatum Vauch. Hist. Conferv. 117. *pl. 12. f. 2, 3.* 1803. DeCandolle, Flore Franç. **2**: 58. 1815.

Chaetophora longipila Kütz. Phyc. Germ. 261. 1845; Tab. Phyc. **3**: *pl. 17. f. 1.* 1853. Wolle, F. W. Alg. 118. *pl. 103. f. 16, 17.* 1887. (?)

C. cervicornis Kütz. Tab. Phyc. **3**: 5. *pl. 119. f. 2.* 1853.

C. elegans cervicornis Rabenh. Flor. Eur. Alg. **3**: 384. 1868. DeToni, Syll. Alg. **1**: 183. 1889.

C. elegans longipila Hansg. Prod. Alg. Böhm. **1**: 70. 1886. DeToni, Syll. Alg. **1**: 183. 1889.

Colonies globose or more often tuberculose, 1–10 mm. in diameter, light green in color, the gelatinous substance rather soft, frequently confluent; filaments radiating from the center, dichotomously or trichotomously branched, penicillate at the summit; branches lax and somewhat spreading, above sometimes crowded and erect; terminal branchlets short pointed or setiferous; cells of main branches about 8 μ (6–11 μ) in diameter, 3–10 times as long; terminal cells 5–7 μ in diameter (*pl. 37*).

Attached to leaves, sticks and stones, in brooks and stagnant waters.

NEW YORK: Van Cortlandt Park, April–June (344, 602, 636); Botanical Garden, April (81, 274, 354), May (387), June (441, 442); East Chester, May (392).

NEW JERSEY: Hudson Heights, April (302); Grantwood, March–May (4, 13, 367, 440); Greenwood Lake, September (465).

WASHINGTON: Whidley Island, July, 1901 (N. L. Gardner).

There is to be found in this species every degree of variation, from tiny globose specimens up to large tuberculose and con-

* Citation from Roth, Cat. Bot. **3**: 337. 1806.

fluent forms. These large forms have probably been generally referred to *Chaetophora tuberculosa*, but extended observations in field and laboratory have convinced us that they are merely growth forms of *C. elegans*.

The presence or absence of terminal setae should not be made a character for separation of varieties in this species, for plants which possess them early in their growth, lose them later.

A suspicion was expressed by Wolle, that *C. elegans*, *C. pisiformis* and *C. tuberculosa* might be stages in the growth of one plant, because he found it difficult at times to separate them. One is inclined to question whether Wolle understood the true character of the species, particularly *C. pisiformis*. The separation of the species is not a matter of cell measurements, for these are subject to the greatest variation. Practically the only distinction between *C. elegans* and *C. pisiformis* as described by Roth, that holds good generally, is in the much more open and loose branching of the former. The issues of the two species in American exsiccatae are badly confused.

2. CHAETOPHORA PISIFORMIS (Roth) Agardh, Disp. Alg. Suec. 43. 1812; Syst. Alg. 27. 1821. Grev. Scot. Crypt. Flor. **6**: Synop. 40. *ibid.* **3**: *pl. 150.* 1825 (as *C. elegans*). Kütz. Spec. Alg. 532. 1849; Tab. Phyc. **3**: *pl. 18. f. 3.* 1853. Harvey, Ner. Bor. Am. **3**: 70. 1857. Rabenh. Flor. Eur. Alg. **3**: 383. 1868. (?) Cooke, Brit. F. W. Alg. 193. *pl. 78. f. 1.* 1883. (?) Wolle, F. W. Alg. 116. *pl. 103. f. 1–3, 12–15.* 1887. Kirchn. Mik. Pflanz. 11. *pl. 2. f. 20.* 1891. Saunders, Flora of Neb. *pl. 13. f. 5.* 1894. (?)

Rivularia pisiformis Roth, Neue Beitr. Bot. **1**: 272. 1802.* (Ann. of Bot. **1**: 261. 1805.)

Colonies globose or tuberculose, 2–5 mm. in diameter, usually dark green, rarely confluent, the gelatinous substance dense and resistant; filaments densely radiating from the center, strict, dichotomously or less frequently trichotomously branched, branches erect or appressed throughout; terminal branchlets slender, acute or sometimes setiferous; cells of main branches about 6–7 μ (5.5–8 μ) in diameter, 3–6 times as long; terminal cells 4–6 μ in diameter (*pl. 38, f. 1*).

* Citation from Cat. Bot. **3**: 338. 1806.

In brooks, chiefly attached to pebbles and rocks.

MASSACHUSETTS: Middlesex Fells, July (449).

NEW YORK: Bronx Park, May (372); Van Cortlandt Park, May (603).

NEW JERSEY: Hudson Heights, May (434); Demarest, October (507).

Though sometimes appearing to be very closely related to *C. elegans*, nevertheless, in general this species is very distinct from that form. It usually has a darker green color, and firmer more resistant gelatinous substance; in fact it is often a difficult matter to separate or crush the closely packed filaments. Though size is a very variable quantity, in general the filaments of *C. pisiformis* are more slender than those of *C. elegans*, the branches are always erect, and the terminal branchlets usually less numerous. This species appears to be less inclined to grow in quiet waters; we have nearly always found it in a strong current.

3. **Chaetophora attenuata** sp. nov.

Colonies globose or slightly verrucose, solitary, 2–5 mm. in diameter, bright green, involved in dense and very resistant gelatinous substance; filaments dichotomously or trichotomously branched from the base, always erect and subparallel, not fasciculate at summit; terminal branchlets finely pointed or setiferous; cells of the main filament 5–5.5 μ in diameter, 5–10 times as long; branch-bearing cells broad and often bifurcated at the top (*pl. 39*).

On rocks and pebbles at the edge of ponds.

CONNECTICUT: Plymouth, reservoir, September (491, type).

NEW JERSEY: Greenwood Lake, September (466).

This species, like *C. pisiformis*, possesses a more resistant gelatinous investment, and a stricter habit of branching than *C. elegans*, but its filaments are much finer and more attenuated than those of either of the other species. It is characterized by great regularity in its branching above, and by abundant rhizoid development, rhizoids being pushed out even below the palmelloid basal cells. This appears to be a summer form, for all traces of it disappear before the end of October, and none appeared in the spring up to the middle of May.

It is a curious fact that *Chaetophora pisiformis* and *C. attenuata* are at times infested by rotifers, while *C. elegans* seems never to be

so troubled; possibly the peculiar consistence of the gelatinous investment makes the two former species better fitted for sheltering animal inhabitants. Furthermore in both stations *C. attenuata* harbored the same species of rotifer, while a different species is found in *C. pisiformis.*

4. **Chaetophora incrassata** (Hudson).

Ulva incrassata Hudson, Flor. Ang. 572. 1778 [Ed. 2]; Eng. Bot. *pl. 967.* 1802.

Chaetophora lobata Schrank. Der Naturf. **19**: 126. 1783; Baier. Flor. **2**: 491. 1789.

Rivularia Cornu-Damae Roth, Cat. Bot. **1**: 212. *pl. 6. f. 2.* 1797; Ann. of Bot. **1**: 256. 1805.

Rivularia endiviaefolia Roth, Römer's Archiv f. Bot. **1**[3]: 51. 1798; Cat. Bot. **2**: 249. 1800; Ann. of Bot. **1**: 257. 1805.

Tremella palmata Hedwig, Com. Trem. Nost. 70. *f. 4–7.* 1798.

Conferva incrassata Bosc, Bull. Sci. Soc. Phil. **2**: 145–6. *pl. 11. f. 2. A–C.* 1800.

Batrachospermum fasciculatum Vauch. Hist. Conferv. 116. *pl. 13. f. 1, 2.* 1803.

Myriodactylon incrassatum Desvaux, Journ. de Bot. **2**: 307. 1809.

Chaetophora endiviviaefolia Agardh, Disp. Alg. Suec. 42. 1812. Lyngb. Tent. Hyd. Dan. 191. *pl. 65.* 1819. Hassall, Brit. F. W. Alg. 125. *pl. 9. f. 1, 2.* 1845. Kütz. Spec. Alg. 532. 1849; Tab. Phyc. **3**: *pl. 21.* 1853. Harvey, Ner. Bor. Am. **3**: 69. 1853. Rabenh. Krypt. Flor. Sachs. **1**: 272. 1863. Wood, Hist. F. W. Alg. 210. 1873. Cooke, Brit. F. W. Alg. 194. *pl. 78. f. 2.* 1883. Wolle, F. W. Alg. 117. *pl. 104.* 1887.

Rivularia incrassata Purton, Midl. Flor. **3**: 179. 1817. [*fide* Cooke.]

Chaetophora Cornu-Damae Agardh, Syst. Alg. 29. 1824. De-Toni, Syll. Alg. **1**: 187. 1889. Saunders, Flora of Neb. **1**: 64. *pl. 17. f. 1.* 1894.

Chaetophora clavata Hornem. Flor. Dan. *pl. 1728. f. 2.* 1831.

Batrachospermum Americanum Schweinitz, MS.

Chaetophora Schweinitzii Bailey, MS.

Colony irregularly extended and lobed or laciniate, 2 mm. to 1 dm. long, consisting of elongated filaments held together by mucus in sheaf-like fascicles; branches alternate or secund, bearing densely crowded terminal fascicles of branchlets which are usually long-setiferous; cells of filaments 8–16 μ in diameter, 2–6 times as long, cylindrical or inflated; terminal branchlets often torulose and curved, 6–11 μ in diameter, cells 1–2 times as long (*pl. 38, f. 2, 3*).

EXSIC.: Phyc. Bor. Am. *68*. Middlesex Fells, Mass., May, 1890 (F. S. Collins). Hauck & Richt, *387*. Middlesex Fells, Mass., April, 1890 (F. S. Collins). Wittr. & Nordst. *510*. Bethlehem, Pa., 1882 (F. Wolle). Tild. Am. Alg. *10*. Hennepin county, Minn., 1894; *267*. King county, Washington, July, 1897; *268*. Chester county, South Carolina, April, 1896 (H. A. Green).

On stones, sticks and leaves in brooks.

VERMONT: Alburg, June (682).

MASSACHUSETTS: Cambridge, 24 May 1891 (L. M. Underwood).

CONNECTICUT: New Haven, May, 1885 (W. A. Setchell).

NEW YORK: Van Cortlandt Park, April to June (98, 345, 346, 407, 601, 636).

NEW JERSEY: Grantwood, April, May (94, 122, 282, 366, 577).

SOUTH DAKOTA: June 28, 1897 (D. Griffiths).

MONTANA: Great Falls, August, 1885 (F. W. Anderson).

The reference by Hudson to the excellent figures of Vaillant (Botanicon Parisiense, 56. *pl. 10. f. 3*. 1727) and Dillenius (Hist. Musc. 51. *pl. 10. f. 10*. 1741) leaves no doubt as to the identity of his *Ulva incrassata* with the plant that has been known as *Chaetophora endiviaefolia* or *C. Cornu-Damae;* hence the necessity for reviving this ancient name which antedates Roth by nearly twenty years.

The two manuscript names above quoted are here inserted because they have been erroneously referred to *Draparnaldia opposita*. (See discussion under that species.)

The numerous varieties of this species that have been proposed chiefly by Kützing and Rabenhorst appear to be for the most part at least, mere growth forms, and therefore they are not enumerated here.

This species is so very different in form from the globose species of *Chaetophora* that one unfamiliar with it is likely to think of it as an abnormally fasciated *Draparnaldia.*

DOUBTFUL FORMS

CHAETOPHORA TUBERCULOSA (Roth) Agardh, Syn. Alg. Scand. 129. 1817. Wolle, F. W. Alg. 116. *pl. 103. f. 11.* 1887.

Rivularia tuberculosa Roth, Neue Beitr. Bot. **1**: 285. 1802 (ref. from Cat. Bot. **3**: 341. 1806).

There has been some diversity in the interpretation of this species. Roth's description, notably the clause, "Ramis ramulisque approximatis patulis sparsis," indicates a plant differing from the erect-branched form illustrated by Kützing (Tab. Phyc. **3**: *pl. 19. f. 1*) and Hansgirg (Prod. Alg. Böhm. **1**: 71. *f. 30.* 1886). These erect-branched forms correspond with our idea of what *C. pisiformis* should be.

Kützing's earlier figure (Phyc. Gen. *pl. 10. f. 2*) and European exsiccatae (Kütz. Alg. Dec. *92.* Rabenh. Alg. Eur. *1077.* Hauck & Richter, *384.* Wittr. & Nordst. *610b*) seem to harmonize better with Roth's description, but can hardly be separated from tuberculose forms of *C. elegans* common with us.

We should hardly wish to do away entirely with *C. tuberculosa* on this evidence, but we can obtain no assurance of its occurrence in this country, and possibly all specimens may be referred to *C. elegans* and *C. pisiformis.*

CHAETOPHORA MONILIFERA Kütz. Spec. Alg. 896. 1849; Tab. Phyc. **3**: *pl. 20. f. 2.* 1853. Rabenh. Flor. Eur. Alg. **3**: 384. 1868. Wolle, F. W. Alg. 118. *pl. 103. f. 18, 19.* 1887.

The figure furnished by Wolle evidently represents only a zoösporiferous state of one of our ordinary species. The specimen issued by Miss Tilden (Am. Alg. *9*) is of no greater value; it does not show the large thick-walled cells to be seen in Rabenhorst's specimen of *C. monilifera.*

The suggestion of Schmidle (Hedwigia **36**: 9–12. 1897), that this species, as well as *C. pachyderma* Wittr., is only a form of *C. elegans* in which the cells have largely developed into akinetes, appears to contain much of truth. If, however, we accept the view that these are only developmental forms, their names should

not be given varietal rank as was done in the case of *C. elegans pachyderma* (Wittr.) Schmidle, *l. c.*

CHAETOPHORA CALCAREA Tilden, Am. Alg. *11.* 1894; Minn. Bot. Stud. **1**: 229. 1895; Bot. Gaz. **23**: 102. *pl. 8, 9. f. 6, 7.* 1897.

There is no character, besides that of secreting lime, furnished in the description of this species that particularly distinguishes this plant from species like *C. elegans* and *C. pisiformis*, and that character, judging from the frequence of its occurrence in different forms, can hardly, in our opinion, be considered a point of strong specific importance.

IV. DRAPARNALDIA Bory, Ann. Mus. Hist. Nat. **12**: 399 ff. 1808

Charospermum Link, Epist. de Alg. 5. 1820.

Thallus covered with a soft, gelatinous investment, attached to the substratum by rhizoids developed from the lower cells and often at points of branching; main filament and primary branches large, bearing, as well as the smaller branches, numerous crowded fascicles of small branchlets which often terminate in a long hyaline seta. Chromatophore, in the cells of the larger branches, a parietal band, sometimes perforated or reticular, containing numerous pyrenoids; in the small cells of the branchlets, a layer covering the inner surface of the cell-wall, containing few pyrenoids.

Asexual reproduction by means of 4-ciliate zoöspores furnished with a red eye-spot, which germinate immediately, and by means of akinetes; both are formed only in the smaller cells.

All inhabitants of fresh water. Type species *Draparnaldia mutabilis* Bory (= *D. glomerata*). [Named in honor of the French botanist, J. P. R. Draparnaud.*]

Synopsis of Species

Rachis clearly traceable to or beyond the summit of the fascicles of branchlets.
- Fascicles mostly erect, lanceolate, elongated at the apex. 1. *D. plumosa.*
- Fascicles ascending or spreading, broadly ovate, acuminate. 2. *D. acuta.*

Rachis soon lost in the ramification of the orbicular, spreading fascicles.
- Cells of main branches much inflated, chromatophore narrow. 3. *D. glomerata.*
- Cells of main branches cylindrical, chromatophore broad. 4. *D. platyzonata.*

* The name of this genus has been written *Draparnaudia* by DeToni and some other recent authors. As the personal name, however, was sometimes written Draparnauld, it has been thought best to adhere to Bory's spelling, until good reason is shown for the change.

1. DRAPARNALDIA PLUMOSA (Vauch.) Agardh, Disp. Alg. Suec. 42. 1812; Alg. Dec. 38. 1814; Syst. Alg. 58. 1824. Lyngb. Tent. Hyd. Dan. 189. 1819. Hassall, Brit. F. W. Alg. 121. *pl. 12. f. 1.* 1845. (?) Kütz. Spec. Alg. 357. 1849; Tab. Phyc. **3**: *pl. 14. f. 1.* 1853. Rabenh. Flor. Eur. Alg. **3**: 382. 1868. Harvey, Ner. Bor. Am. **3**: 72. 1857. Wood, Hist. F. W. Alg. 208. 1873. Kirchn. Krypt. Flor. Schles. **2**[1]: 67. 1878; Mik. Pflanz. 11. *pl. 1. f. 18.* 1891. Cooke, Brit. F. W. Alg. 193. *pl. 75. f. 1, 2.* 1883. Wolle, F. W. Alg. 109. *pl. 94.* 1887. DeToni, Syll. Alg. **1**: 191. 1889. Saunders, Flora of Neb. **1**: 65. *pl. 19. f. 1.* 1894.

Conferva mutabilis Roth., Cat. Bot. **1**: 197. 1797. (?) Dillw. Brit. Conferv. *pl. 12.* 1802. (?)

Batrachospermum plumosum Vauch. Hist. Conferv. 113. *pl. 11. f. 2.* 1803. DeCand. Flor. Franç. **2**: 59. 1815.

Draparnaldia hypnosa Bory, Ann. Mus. Hist. Nat. **12**: 405. *pl. 35. f. 2.* 1808.

Conferva lubrica Eng. Bot. *pl. 2087.* 1809. Not Dillwyn.

Tufts 1–15 cm. long; branches spreading or ascending, solitary or opposite, the fascicles of branchlets single, opposite or whorled, generally crowded, erect or ascending, lanceolate to ovate-acuminate in outline, their branchlets erect or ascending, the rachis usually much extended at the apex, or at least easily distinguishable from other branchlets; ultimate branchlets subulate, or setiferous; cells of larger branches generally nearly cylindrical, somewhat constricted at the joints, 45–70 μ in diameter, 1–3 times as long, terminal branchlets 6–10 μ in diameter; chlorophyll band $\frac{1}{4}$–$\frac{1}{3}$ as wide as the length of the cell, proportionally broader in the small branches (*pl. 40, f. 1. 2*).

EXSIC.: Tild. Am. Alg. *12*, Minneapolis, Minn., August 1894, Chester, S. C., February, 1896 (H. A. Green). Phyc. Bor. Am. *21*, Bridgeport, Conn., February, 1892 (I. Holden).

Attached to sticks and stones in running water.

VERMONT: St. Johnsbury, August (644); North Hero, June (680).

MASSACHUSETTS: Haverhill, April (555).

CONNECTICUT: Derby, April (539).

NEW YORK: Central Park, April (317, 319), May (383, 595); Syracuse, June, 1884 (L. M. Underwood).

NEW JERSEY: Hudson Heights, April (304); Demarest, November (218); Englewood, May (360).

PENNSYLVANIA: Chester county, 1890 (H. M. Richards).

INDIANA: Greencastle, October, 1893 (L. M. Underwood).

MONTANA: Great Falls, September, 1885 (F. W. Anderson).

This species usually has closely set, plumose fascicles of densely crowded branchlets. More slender or less branched forms are often called *D. plumosa pulchella* Rabenh., but there is some reason to believe that Kützing's *D. pulchella* may be a more distinct form.

Some of the material above quoted from Haverhill, Mass., seems to correspond to Kützing's description of *D. pulchella* in having longer, more ventricose cells. Without further collection, however, we cannot regard it as more than a young stage of *D. plumosa*.

2. DRAPARNALDIA ACUTA (Ag.) Kütz. Phyc. Germ. 230. 1845; Spec. Alg. 356. 1849; Tab. Phyc. **3**: *pl. 13. f. 2.* 1853

D. glomerata acuta Agardh, Syst. Alg. 59. 1824. Rabenh. Flor. Eur. Alg. **3**: 382. 1868. DeToni, Syll. Alg. **1**: 192. 1889. DeWild. Flor. Alg. Belg. 43. 1896.

Tufts 1–8 cm. long; branches ascending or spreading, solitary or opposite, somewhat moniliform; the fascicles of branchlets single, opposite or whorled, generally somewhat crowded, ascending or spreading, broadly ovate to lance-ovate and acuminate in outline; branchlets in the fascicle ascending, the rachis usually extended at the apex; ultimate branchlets subulate or setiferous, often curved; cells of larger branches somewhat inflated, or above nearly cylindrical, 50–90 or more, rarely 110 μ in diameter, 1–2 times as long, chlorophyll band half as wide as the cell-length or narrower; diameter of terminal branchlets 6–10 μ.

EXSIC.: Tild. Am. Alg. *12 C.* (as *D. plumosa*), Forest Grove, Ore., February, 1896 (F. E. Lloyd.) (?)

In brooks, rills, and semi-stagnant waters.

CONNECTICUT: Thomaston, May (541, 546, 565, 566).

NEW YORK: Bronx Park, May (370, 408); East Chester, May (391), November (518).

NEW JERSEY: Hudson Heights, May (433); Cresskill, May (358); Undercliff, May (572).

This form has usually been considered a variety of *D. glomerata*, but it appears to be equally or more closely related to *D. plumosa*. It frequently exhibits, to be sure, the spreading habit of branching, the broad fascicles of branchlets, and the inflated

lower cells, which are characteristic of *D. glomerata;* but even in these points, especially toward the end of the branches, it often resembles more closely *D. plumosa*, while it invariably shows, in common with the latter, a very distinct, long rachis in the fascicles of branchlets. This last character is of greater phylogenetic importance than the others. It is very easy to derive the simpler forms of *D. plumosa* from one of the larger *Myxonema* species, and then through such an intermediate form as *D. acuta*, to arrive at *D. glomerata.*

Draparnaldia plumosa and *D. glomerata* as here restricted are very readily distinguished. When *D. acuta* is made a variety of the latter, the species immediately become confused and separation is at times difficult. The present disposition contributes much to clearness. Repeated observation at the same station has convinced us that *D. acuta* is, in spite of its variability, a reasonably distinct form. If, however, it is to be reduced from specific rank, it should undoubtedly, in our judgment, be made a variety of *D. plumosa* rather than of *D. glomerata.*

3. DRAPARNALDIA GLOMERATA (Vauch.) Agardh, Disp. Alg. Suec. 41. 1812; Alg. Dec. 37. 1814; Syst. Alg. 58. 1824. Lyngb. Tent. Hyd. Dan. 189. *pl. 64.* 1819. Hassall, Brit. F. W. Alg. 120. *pl. 13. f. 1.* 1845. Roemer, Die Alg. Deutsch. *pl. 2. f. 25.* 1845. Kütz. Spec. Alg. 356. 1849; Tab. Phyc. **3**: *pl. 12.* 1853. Harvey, Ner. Bor. Am. **3**: 72. 1857. Rabenh. Flor. Eur. Alg. **3**: 381. 1868. Wood, Hist. F. W. Alg. 207. 1873. Cooke, Brit. F. W. Alg. 191. *pl. 76. f. 1, 2.* 1883. Wolle, F. W. Alg. 108. *pl. 92.* 1887. Saunders, Flora of Neb. **1**: 65. *pl. 19. f. 2.* 1894.

Batrachospermum simplex DeCand. Bull. Sci. Soc. Phil. **3**: 21. *p. p.* 1802.*

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* DeCandolle quotes as synonyms for his *Batrachospermum simplex*, *Conferva gelatinosa* Girod, Rech. Chim. et Mic. 33. *pl. 5.* 1802, and Vaucher's *Conferva inédite*, Bull. Sci. Soc. Phil. **2**: *pl. 13. f. 4* 1802. The former is *Batrachospermum*, the latter is undoubtedly *Draparnaldia glomerata*, but a specific name founded, in this way, on two diverse elements without sufficient description to be recognizable apart from the synonyms can hardly displace such a well-grounded name as *Draparnaldia glomerata*. It is noticeable that under the latter species, Vaucher makes no reference to his earlier figure.

Batrachospermum glomeratum Vauch. Hist. Conferv. 114. *pl. 12. f. 1.* 1803. DeCand. Flor. Franç. **2**: 59. 1815.

Conferva Chara Roth, Cat. Bot. **3**: 285. 1806.

Conferva mutabilis Eng. Bot. *pl. 1740.* 1807.

Draparnaldia mutabilis Bory, Ann. Mus. Hist. Nat. **12**: 402. *pl. 35. f. 1 b. d.* 1808.

Generally densely tufted, 1–8 cm. long; filaments repeatedly branched, branches spreading or horizontal, solitary or opposite, moniliform, bearing very numerous scattered, opposite, or whorled fascicles of branchlets, fascicles mostly set at right angles to the branch and often sessile, broadly orbicular to elliptical in outline, their branchlets spreading, the rachis of the fascicle disappearing in the ramification or at least not more prominent at the summit than other branchlets, ultimate branchlets densely crowded, subulate, often setiferous; cells of larger branches strongly inflated, 50–90 or sometimes 125 μ in diameter, their length about equal to (½–2 times) the diameter; chlorophyll band rather narrow or half as broad as the diameter, proportionately broader or even filling the cell in the smaller branches; diameter of terminal branchlets 6–9 μ (*pl. 40, f. 3, 4*).

EXSIC.: Phyc. Bor. Am. *20*, Bridgeport, Conn. (I. Holden). Tild. Am. Alg. *13*, St. Paul, Minn., September 1894.

Attached to grass, sticks, stones and earth, in active or quite waters.

VERMONT: St. Johnsbury, April (671), July (684), October (649).

MASSACHUSETTS: Melrose, April (552); Rowley, May (556); Worcester, 1887 (G. E. Stone).

CONNECTICUT: Thomaston, May (544, 545).

NEW YORK: Bronx Park, April (14, 80, 270, 338, 339); Van Cortlandt Park, April (79, 342).

NEW JERSEY: Grantwood, Bergen county, March (4, 62), April (91), May (364); Hudson Heights, March (70), April (303).

This species is very well distinguished from *D. plumosa* and *D. acuta* by its broadly rounded fascicles of branchlets, in which the rachis is quickly lost in the branching.

The forms known as *D. glomerata distans* (Kütz.) Hansg., and *D. glomerata remota* Rabenh. appear to be no more than growth stages of the species. The description of *D. glomerata maxima* Wood, Hist. F. W. Alg., contains no feature that dis-

tinguishes the form from the species as above interpreted, the expression "fasciculi ovate or broadly lanceolate" indicates an identification with *D. acuta*. The large diameter (100 μ) is not inconsistent with many of our specimens of both species, though it is greater than that reported by European authors.

4. **Draparnaldia platyzonata** sp. nov.

Filaments 1–7 cm. long, loosely tufted or solitary; branches mostly opposite or whorled and horizontal; fascicles of branchlets set strictly perpendicular to the branch, prominently stalked, broadly orbicular in outline, the branchlets somewhat symmetrically radiating from the summits of the branches of the rachis, sometimes densely crowded, subfusiform, acuminate or setiferous; cells of larger branches cylindrical, sometimes slightly constricted at the joints, 50–90 μ in diameter, in length equal to the diameter, or frequently shorter, chromatophore very wide, always nearly covering the length of the cell and often strongly reticular; diameter of terminal branchlets 6–11 μ (*pl. 41*).

On rocks or sticks, in brooks draining swamps.

NEW JERSEY: Grantwood, April, 1899 (89), April, 1900 (281), May, 1900 (363, type).

VERMONT: Fifield bog, Wallingford, 2 July, 1901 (641).

This species in certain stages recalls the figure of *D. plumosa opposita* Lyngbye, Tent. Hyd. Dan. *pl. 65A*, and resembles the specimens of *D. glomerata biformis* Wittrock and Nordstedt, Alg. Exsic. *513*. It lacks, however, what seem to be essential characters of these two forms, namely, the two longitudinal lines supplying the place of a chlorophyll band in the former, and the double character of the filament which gives the name to the latter. Our form is always easily recognizable by its short cylindrical cells with their broad chromatophore, and by the horizontally set, rosette-like, stout-stalked fascicles of branchlets. Though the chromatophore of *D. glomerata* and *D. plumosa* is sometimes described as a reticular band, it might better be called perforate, while that of *D. platyzonata* attains the maximum of a truly reticular structure. This species is more distinct from *D. glomerata* than the members of the *D. plumosa-acuta-glomerata* series are from one another. This view has been confirmed by repeated collections from the type station and by cultures of that material.

During the first week of April, 1901, a visit to the station was made to get material for distribution, but owing to the lateness of the season no *Draparnaldia* had appeared. Before a second visit in May, the encroachments of civilization had so disturbed the brook that no vegetation remained, and it is to be feared that the station is permanently lost.

It was, therefore, particularly pleasing to stumble upon this species during a field meeting of the Vermont Botanical Club in July. The reason for finding this species still vigorous after an extremely hot period, is probably that, in the Vermont bog, it was growing at an altitude of two to three thousand feet.

DOUBTFUL OR LITTLE KNOWN SPECIES

DRAPARNALDIA BILLINGSII Wood, Proc. Am. Phil. Soc. **11**: 143. 1869; Hist. F. W. Alg. 208. *pl. 14. f. 6.* 1873. DeToni, Syll. Alg. **1**: 191. 1889.

There is nothing in Wood's description which marks this species as especially different from the common forms. Possibly it is to be identified with *D. acuta.* A fragmentary specimen bearing the name was seen in the Wolle herbarium. Chodat disposes of this species and *D. cruciata* Hicks as forms of *D. plumosa* without giving evidence of more knowledge of their character than may be gained from the unsatisfactory published descriptions.

DRAPARNALDIA OPPOSITA (Lyngb.) Agardh, Syst. Alg. 59. 1824. Kütz. Spec. Alg. 357. 1849 (*sub Species inquirendae*). Harvey, Ner. Bor. Am. **3**: 71. 1857. DeToni, Syll. Alg. **1**: 194. 1889.

D. plumosa opposita Lyngbye, Tent. Hyd. Dan. 190. *pl. 65A.* 1819.

It is very doubtful whether the form reported by Harvey was correctly named; his description reads very much as though he had a form of *D. plumosa.* Both the description* and figure given by Lyngbye indicate a form very similar to our *D. platyzonata.*

The specimen issued by Miss Tilden as *D. opposita* (Am. Alg. *12*) was doubtless identified by the description of Harvey or of

* "Ramis inferioribus subverticillatis; penicillis brevibus, patentibus, oppositis; articulis diametro subaequalibus, lineis linis longitudinalibus notatis."

DeToni; it is inconceivable that this slender, erect-branched form should have been so identified by any one familiar with Lyngbye's work.

Agardh quotes in the synonymy of this species, *Batrachospermum Americanum* Schweinitz. This was in all probability merely a manuscript name, but a specimen bearing this name in Schweinitz's hand in the Torrey herbarium is not *Draparnaldia* but *Chaetophora incrassata;* it was so recognized by Bailey, who called it *Chaetophora Schweinitzii* (*cf.* Kütz. Tab. Phyc. **3**: 6. 1853).

DRAPARNALDIA SPINOSA Kütz. Phyc. Germ. 230. 1845; Spec. Alg. 356. 1849; Tab. Phyc. **3**: *pl. 13. f. 1.* 1853. Wolle, Bull. Torrey Club, **8**: 40. 1881; F. W. Alg. 109. *pl. 93. f. 1–8.* 1887.

Wolle's figures appear to represent a plant different from any known to us. Whether his specimens were correctly determined can probably be decided only by a visit to his station, Glen Onoko, Pa. No specimens bearing this name were seen in the Wolle herbarium.

DRAPARNALDIA RAVENELII Wolle, F. W. Alg. 110. *pl. 95.* 1887. DeToni, Syll. Alg. **1**: 193. 1889.

Batrachospermum vagum Ravenelii Wolle, Bull. Torrey Club, **9**: 29. 1882.

This species seems to possess strongly marked characters in the large diameter (150–170 μ) of the filaments and the crowded sessile fascicles of branchlets. We have found no report to show that it has been collected since the type specimens were obtained by H. W. Ravenel in South Carolina. It is strange, but rather in keeping with Mr. Wolle's methods, that in describing this species as *Draparnaldia,* no reference was made to the earlier disposition of it as *Batrachospermum.*

V. EPICLADIA Reinke, Alg. West. Ostsee, 86. 1889; Atlas Deutsch. Meeresalg. 31. 1889*

Thallus microscopic, creeping on the surface of its bryozoan host, irregularly branched on all sides, often appearing to be composed of a small central plate of cells extended into a fringe of

* This genus was announced without diagnosis in Ber. Deutsch. bot. Gesell. **6**: 241. 1888, and De Toni, Syll. Alg. **1**: 151. 1889.

branched filaments. Chromatophore a homogeneous parietal layer inclosing a pyrenoid.

Reproduction by means of zoöspores (gametes?) of which many be formed in a cell and escape through a round hole in the cell-well.

Type (and only species) *E. flustrae* Reinke. Inhabitant of salt water. [Etym. ἐπί, upon, and κλάδος, branch.]

This genus is closely related to *Endoderma*, from which it differs in its non-endophytic habit and in its greater tendency toward the formation of an expanded thallus. Here the plate of cells is central and in some sense primary, while in *Endoderma* it is only accidental, that is, resulting from the coalescence of vigorously growing filaments. *Epicladia* thus seems to furnish a point of connection with the genus *Monostroma* in the Ulvaceae.

1. EPICLADIA FLUSTRAE Reinke, *l. c.*

Cells of the central plate irregularly polygonal in outline, 7–12 μ in diameter [12–20 μ, Reinke], those of the free filaments short-cylindrical or irregular, 5–10 μ in diameter (*pl. 42, f. 2*).

EXSIC.: Phyc. Bor. Am, *160*, Spectacle Island, Penobscot Bay, Maine, July, 1893 (F. S. Collins).

Growing on *Flustra*, *Sertularia*, and other bryozoa, often among the masses of *Fucus* between tide marks.

NEW HAMPSHIRE: Hampton, July, 1884 (F. S. Collins).

MASSACHUSETTS: Nahant, July (451); April, 1892 (F. S. Collins).

NEW YORK: Pelham Bay, May (408, 582).

We have been unable to find this plant in New York waters in summer and autumn.

VI. ENDODERMA Lagerheim, Öfvers. Vet. Akad. Förhand. **1883**[2]: 74, 75. 1883. Huber, Ann. Sci. Nat. Bot. VII. **16**: 313–326. *pl. 14, 15.* 1892.

Entocladia Reinke, Bot. Zeitung, **37**: 476–478. *pl. 6.* 1879. Not *Endocladia* J. Ag. Linnaea, **15**: 449. 1841.

Reinkia Borzi. Notarisia, **3**: 448. 1888 [*nomen nudum*].

Periplegmatium Hansg. Flora, **72**: 58, 59. 1889. Not Kütz. Phyc. Gen. 273. *pl. 7. f. 3.* 1845.

Thallus microscopic, growing within the membrane of other algae, irregularly branched. Cell-division is mostly confined to the pointed end cells. Chromatophore a sheet covering most of the cell-wall, inclosing a pyrenoid.

Four to eight zoöspores may be formed in any cell and escape by a round hole through the cell-wall and host plant; they lack a red eye-spot, the number of cilia and manner of germination is unknown.

Inhabitants of salt water, for the most part. Type, *E. viridis* (Reinke) Lagerh. [Etym. ἔνδον, within, and δέρμα, cuticle.]

Hansgirg ('**89**), believing that the type species *Endoderma viridis* was identical with *Periplegmatium ceramii* Kütz., transferred the several species of *Endoderma* to *Periplegmatium*. Kützing's type, besides having, so far as can be judged from his published figures, a different type of branching from that seen in *Endoderma viridis*, is described as epiphytic on Florideae while *Endoderma* is endophytic.

Hansgirg's attempt does not seem to have been taken very seriously, and reliance has been placed in the judgment of Professor Wille ('**90**) that *Endoderma* is to be retained.

1. ENDODERMA WITTROCKII (Wille) Lagerheim, Öfvers. Vet. Akad. Förhand. **1883**[2]: 75. 1883. DeToni, Syll. Alg. **1**: 209. 1889. Wille; Engler & Prantl, Nat. Pflanzenfam. **1**[2]: 94. *f. 57.* 1890.

Entocladia Wittrockii Wille, Förhand. Vidensk. Selskab. Christ. **1880**[4]: 1–4. *pl.* 1880; Jahrb. wiss. Bot. **18**: 435–437. *pl. 16. f. 12–14.* 1887. Hauck; Rabenh. Krypt. Flor. Deutsch. **2**: 463. *f. 199.* 1885. Collins, Bull. Torrey Club, **18**: 340. 1891.

Periplegmatium Wittrockii Hansg. Flora, **72**: 59. 1889; Phys. und Phyc. Untersuch. 240. 1893. Möbius, Notarisia, **6**: 1291. 1891.

Plant a simple or irregularly branched filament, tapering at the ends, sometimes forming a small single-layered plate by reason of the partial coalescence of the branches; cells 5–10 μ in diameter, and 7–12 μ long (*pl. 42, f. 1*).

EXSIC.: Phyc. Bor. Am. *265*, Nahant, Mass. June, 1893 (F. S. Collins). Endophytic between the layers of the cell-wall of *Elachista fucicola.*

MASSACHUSETTS: Nahant, July (452).

CONNECTICUT: Madison, July, August (453).

VII. BOLBOCOLEON Pringsheim, Phys. Abhand. Königl. Akad. Wiss. **1862**: 8. *pl. 1.* 1863. Huber, Ann. Sci. Nat. Bot. VII. **16**: 308–311. *pl. 13. f. 8–12.* 1892.

Thallus microscopic, epiphytic, consisting of a more or less branched creeping filament of irregularly shaped cells on which are borne smaller bulb-shaped cells (representing branchlets), the latter produced at the summit into a tube from which grows a long flagelliform hair. Chromatophore, in the larger cells, a parietal sieve-like layer containing 5–10 pyrenoids; in the smaller piliferous cells, an irregularly toothed plate with two pyrenoids.

Asexual (?) reproduction by means of biciliate zoöspores, produced in large numbers in the vegetative cells.

Type (and only species) *B. piliferum* Pringsh. Inhabitant of salt water. [Etym. *βολβός*, a bulb, and *κολεόν*, sheath.]

1. BOLBOCOLEON PILIFERUM Pringsheim, *l. c.* Farlow, Marine Algae, 57. 1881. Hauck; Rabenh. Krypt. Flor. Deutsch. **2**: 465. *f. 201.* 1885. Reinbold, Schrift. Naturw. Ver. Schles.-Holst. **8**: 138. 1889. DeToni, Syll. Alg. **1**: 211. 1889. Huber, *l. c.* Wille; Engler & Prantl, Nat. Pflanzenfam. **1**^{2}: 96. *f. 60.* 1890.

Vegetative cells 12–16 μ thick, subcylindrical and 2–3 times as long as the diameter, or somewhat conical.

Epiphytic among the cortical cells of *Leathesia tuberiformis*, *Chordaria divaricata*, etc., in summer.

NEWFOUNDLAND: Grand Bay, near channel, on *Castagnea virescens*, 1 August 1901 (M. A. Howe).

MAINE: Cape Rosier, on *Ralfsia Borneti*, July, 1900 (F. S. Collins).

MASSACHUSETTS: Swampscott, on *Ralfsia Borneti*, 2 April 1891 (F. S. Collins); Nahant, on *Castagnea virescens*, 12 July 1884 (F. S. Collins); "Woods Holl, Gloucester" (W. G. Farlow).

RHODE ISLAND: Newport, on *Castagnea virescens*, 18 June 1883 (F. S. Collins).

CALIFORNIA: San Pedro Bay, on *Nemalion Andersonii*, November, 1898 (Miss S. P. Monks).

There is no apparent reason why this species should not be found in Long Island Sound and New York Bay, but careful search in these places has been fruitless.

VIII. CHAETOSPHAERIDIUM Klebahn, Jahrb. wiss. Bot. **24**: 276. 1892; **25**: 306. 1893*

Thallus microscopic, epiphytic on filamentous algae; cells joined in a short filament by means of empty cylindrical utricles, or in a loose aggregation held together by a gelatinous investment. Cells flask-shaped, composed of a globose basal portion produced into a narrow cylindrical or conical summit which forms a basal sheath for a very long and delicate, flagelliform, persistent seta. Chromatophore a parietal layer, carrying a pyrenoid. Division of the cells horizontal, the lower of the daughter-cells migrating to the side.

Reproduction by means of zoöspores, formed to the number of 4 or more (?) in any cell.

Inhabitants of fresh water. Type *C. Pringsheimii* Klebahn. [Etym. χαίτη, hair, and σφαιρίδιον, a little sphere.]

I. CHAETOSPHAERIDIUM PRINGSHEIMII Klebahn, Jahrb. wiss. Bot. **24**: 276. *pl. 4.* 1892; **25**: 307. *pl. 14. f. 11.* 1893. Moebius, Flora, **75**: 433. 1892. De Wild. Flor. Buitenz. **3**: 60. 1900. *Aphanochaete globosa* Moebius, Biol. Centralb. **12**: 105. *f. 8.* 1892.

Thallus composed of 3–18 cells loosely joined into filaments, or with the connecting utricles well developed; cells at the base globose, 9–12 μ in diameter; sheath 1.5–2 μ in diameter, 10–12 μ long (13–18 μ, Klebahn); seta flagelliform, often 200–300 μ long (*pl. 42, f. 3, 4*).

Creeping on *Oedogonium*, Greenwood Lake, New Jersey, September (467).

In the general character of the cells our specimens agree very closely with Klebahn's description. The utricles, mentioned by this author as a prominent character are hardly distinguishable, so that possibly our specimens should be considered his forma *conferta*. In one case only there appeared to be an investment of mucus (shown in our figure). The divergences from *C. Pringsheimii* do not seem sufficient to warrant establishing a new species.

2. CHAETOSPHAERIDIUM GLOBOSUM (Nordst.) Klebahn, Jahrb. wiss. Bot. **25**: 306. *pl. 14. f. 5–10.* 1893; Bot. Centralb. **56**: 323–326. 1893.

Herposteiron globosa Nordst. Alg. ex Ins. Sandvic. 23. *pl. 2. f. 22, 23.* 1878.

* Reported in advanced of publication, Ber. Deutsch. bot. Gesell. **9**: (7). 1891.

Aphanochaete globosa Wolle, F. W. Alg. 119. *pl. 105. f. 5.* 1887. Nordst. Svensk. Vet. Akad. Hand. **22**[8]: 15. 1888. Hansg. Flora, **71**: 216. 1888. DeToni, Syll. Alg. **1**: 180. 1889. Saunders, Flora of Neb. **1**: 63. *pl. 17. f. 2.* 1894.

Not *Nordstedtia globosa* Borzi, Nuova Notarisia, **3**: 50. 1892.

Cells 14–16 μ in diameter (12–18 μ Klebahn), loosely associated, inclosed in a subglobose gelatinous mass 1 mm. or more in diameter.

"MASSACHUSETTS: Lake Quinsigamond" (G. E. Stone).

"NEW JERSEY: Hammonton" (F. Wolle).

"NEBRASKA: Cherry county" (De Alton Saunders).

We have seen no specimen of this species, but the descriptions of Wolle and Saunders leave little room for doubt that they actually collected it.

The genus *Nordstedtia* Borzi was supposedly founded on *Aphanochaete globosa* (Nordst.) Wolle, but Dr. Klebahn found by comparison of original specimens of Nordstedt's species with drawings of *Nordstedtia* furnished by Borzi, that the latter represented an entirely different plant.

IX. HERPOSTEIRON Nägeli; Kütz. Spec. Alg. 424. 1849

Aphanochaete A. Braun, Betracht. über Erschein. Verjung. 196. 1851. Huber, Ann. Sci. Nat. Bot. VII. **16**: 278–290. 1892.

Thallus microscopic, composed of simple or irregularly branched, creeping filaments. Cells bearing on the dorsal or exposed surface one or more elongated, hyaline, inarticulate bristles, which are inflated or bulb-like at the base but not sheathed. Chromatophore covering the cell-wall more or less completely, inclosing one or more pyrenoids.

Asexual reproduction by means of 4-ciliate zoöspores generally furnished with a red eye-spot, 1–4 produced in a cell.

Sexual reproduction by conjugation of a large female, and much smaller male gamete, both 4-ciliate.

Inhabitants of fresh water. Type, *H. confervicola* Näg. [Etym. ἕρπω, to creep, and στεῖρος, rigid.]

The researches of Huber and Klebahn leave no room for doubt that the two types, *Herposteiron confervicola* Näg. and *Aphanochaete repens* A. Braun, are the same plant. These two investigators, however, reject the earlier name proposed by Nägeli,

on the ground that his description is incomplete and even inaccurate in certain respects. The identification of his plant with that later described by Braun as *Aphanochaete repens* rests upon authentic drawings by Nägeli, but as these were not published with the description, the evidence furnished by them on a matter of priority is not admitted by Klebahn and Huber. From an American point of view, these original drawings, even though unpublished, furnish as valid evidence in regard to the character of Nägeli's species as would be furnished by specimens from his herbarium.

Furthermore, on the very ground upon which it is alleged that Nägeli's genus should be abandoned, there is even more reason for rejecting *Aphanochaete* A. Braun. For in two important points, namely, the description of the bristles as articulate and the zoöspores as biciliate, Braun's characterization is faulty. These inaccuracies gave rise to the confusing and untenable arrangement by Hansgirg ('**88**, '**93**) (which was unfortunately adopted by DeToni and by Wille in Engler & Prantl) of the two genera, *Herposteiron* (Näg.) Hansg. (*Aphanochaete* A. Br. *non* Berthold) and *Aphanochaete* (Berthold) Hansg. *non* A. Br.

The identity of the types of these two so-called genera is sufficiently evident by a comparison of Nägeli's drawings, published by Huber, and Berthold's well-known figures.

There is, then, no good reason why the name *Herposteiron confervicola* Näg. should not be retained.

1. HERPOSTEIRON CONFERVICOLA Nägeli; Kütz. Spec. Alg. 424. 1849. Hansg. Flora, **71**: 216. 1888; Phys. und Phyc. Untersuch. 243. 1889. Kirchn. Mik. Pflanz. 11. *pl. 2. f. 23.* 1891. Huber, Ann. Sci. Nat. Bot. VII. **16**: 286. *pl. 9. f. 6, 7.* 1892 [fig. "aprés Nägeli"]. Saunders, Flora of Neb. **1**: 63. *pl. 22. f. 1.* 1894. Möbius, Abhand. Senckenb. Nat. Gesell. **18**: 322. *pl. 2. f. 1.* 1894.

Aphanochaete repens A. Br. Betracht. ü. Erschein. Verjung. 196. 1851. Rabenh. Flor. Eur. Alg. **3**: 391. *f. 114.* 1868. Wood, Hist. F. W. Alg. 212. *pl. 14. f. 5.* 1873. Berthold, Nov. Act. Acad. Leop. Car. **40**: 214. *pl. 18. f. 2–5.* 1878. Kirchn. Krypt. Flor. Schles. **2**[1]: 71. 1878. Cooke, Brit. F. W. Alg. 197. *pl. 80.*

f. 3. 1883. Wolle, F. W. Alg. 119. *pl. 105. f. 8.* 1887. Wille; Eng. & Prantl, Nat. Pflanz. 1^2: 95. *f. 58.* 1890. Klebahn, Jahrb. wiss. Bot. **25**: 294. *pl. 14. f. 1–4.* 1893. Huber, Bull. Soc. Bot. France, **41**: XCIV–CIII. *pl. 7.* 1894. Klebs, Fortpflanz. Alg. und Pilz. 404. *pl. 3. f. 19–22.* 1896. Chodat, Beitr. Krypt. Flor. Schweiz, 1^3: 324–329. *f. 240–243.* 1902.

Aphanochaete confervicola Rabenh. Flor. Eur. Alg. **3**: 391. 1868.

Herposteiron repens Wittr. Bih. Svensk. Vet. Akad. Hand. 1^1: 27. 1872.

Herposteiron Braunii Huber, ex Näg. MS. Ann. Sci. Nat. Bot. *l. c.* De Wild. Flor. Alg. Belg. 38. 1896.

Cells subglobose to nearly cylindrical; setae usually solitary, 3–4 μ thick at the base, very slender above, often 160 μ long, frequently absent or disappearing early (*pl. 42, f. 5–7*).

Exsic.: Tild. Am. Alg. *133*, St. Paul, Minn., May, 1896. Phyc. Bor. Am. *762*, Wright's Pond, Middlesex Fells, Mass., 19 August 1900 (F. S. Collins).

Epiphytic on various confervae, especially *Oedogonium*, usually in quiet waters.

VERMONT: St. Johnsbury, July (688), October (648, 650), November (668).

MASSACHUSETTS: Middlesex Fells, Wright's Pond, 11 July 1900 (448); Peabody, 24 September 1890 (F. S. Collins).

NEW YORK: Van Cortlandt Park, May (424).

NEW JERSEY: Greenwood Lake, Setember (467).

DOUBTFUL FORM

APHANOCHAETE VERMICULOIDES Wolle, F. W. Alg. 119. *pl. 105. f. 9, 10.* 1887. De Toni, Syll. Alg. **1**: 180. 1889.

Exsic.: Phyc. Bor. Am. *161*, Norwich, Conn. (W. A. Setchell).

Wolle's description and figures of this species do not show its right to be placed in this genus. No specimen could be found in his herbarium, nor does the exsiccata quoted shed light on the character of the form.

SUMMARY

1. In the Ulothricaceae twenty-seven species and two formae are recognized; of these, three species and one forma are new to

science, one variety is raised to specific rank, and five species are definitely reported in America for the first time. Fourteen species and varieties previously recorded have been considered doubtful, either in respect to their occurrence in this country or their validity in general. Numerous other varieties listed by Wolle, but without record of actual occurrence here have been ignored.

2. In the Chaetophoraceae twenty-nine species and two varieties are recognized: of these, seven species and one variety are described as new, and, in addition, four species and one variety are reported from America for the first time. Fourteen species have been placed on the list of little known or doubtful forms.

3. While records of extended distribution have not been obtained, certain regions, particularly the vicinity of New York city, the palisade region of New Jersey, and, to a lesser degree, portions of New England, regarding which previous records are very meager, have been rather thoroughly explored.

4. In several genera important additions have been made to the knowledge of reproductive processes.

5. A careful study of generic and specific foundations has been made, and in this regard, these plants have been placed upon a firmer and more satisfactory taxonomic basis. It is believed that the discussion of so many forms as doubtful has in a measure cleared the way for a more complete knowledge of these algae.

6. Two genera, namely *Stichococcus* and *Microthamnion*, have been placed in a position more in accordance with their true affinities than they have held with recent authors.

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Description of Plates

The outlines of the drawings were made by means of a Leitz camera lucida and the details filled in by careful reference to the specimens. Three combinations were used, namely, Leitz ocular 3 with objective $\frac{1}{12}$ oil immerson, ocular 3 with objective 7, and ocular 1 with objective 7, and the drawings thus made reduced one half in reproduction, so that the actual magnifications of the figures are 575, 350 and 255 diameters. Most of the drawings were made from preparations made by the Flemming-chromic-alum method. For convenience in identifying the material from which the drawings were made, numbers of collections corresponding to those in the text, and the pages on which the descriptions appear are appended.

PLATE 20 (magnification 575 : 1)

1. *Ulothrix zonata.* Lower rhizoid-like portion of a filament (381), p. 148.

2. Upper portion of the same filament. This specimen corresponds to *U. attentuata* Kütz., but many filaments of the same material have lower cells differing little in diameter from the upper cells, showing that this is an accidental variation.

3. A young filament with longer cells (594).

4. Formation of zoöspores, and evacuated cells; a motile zoöspore (594).

5, 6. *Ulothrix tenuissima.* Portions of two filaments (535); distinguished from small forms of *U. zonata* chiefly by the shortness of the cells, p. 149.

7–9. *Ulothrix flacca.* Apical, middle, and rhizoidal portions of the same filament (533), p. 155.

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1, 2. *Ulothrix implexa.* Vegetative filaments (570 A), p. 154.

3, 4. *Ulothrix tenerrima.* Two filaments showing different condition of the chromatophores (645), p. 151.

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10. *Stichococcus subtilis.* Cells evacuated by zoöspores (321), p. 163.

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14, 15. *Stichococcus flaccidus.* Zoösporiferous filaments and motile zoöspores (618), p. 164.

16, 17. Vegetative filaments showing varying proportions of the cells (536, 315).

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2, 3. *Stichococcus bacillaris* forma *confervoidea* (550, 534), p. 160.

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2. *Microspora crassior*. (620), p. 169.

3, 4. *Microspora Loefgrenii*. (351, 447 B), p. 171.

5. *Microspora Wittrockii*. (348), p. 172.

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7. One of the H units of the cell-wall.

PLATE 24 (575 : 1)

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2. A typical filament in active growth, with somewhat reduced chromatophore (409).

3. A filament containing zoöspores (599).

4. Akinetes and two dead cells (283 A).

5. *Microspora Willeana*. A vegetative filament, with dead cells at top and bottom (609), p. 175.

6. An aplanospore or dead zoöspore, a dead cell, and an akinete (609).

7. End of a filament of akinetes (609).

8, 9. *Microspora tumidula*. Vegetative filaments (600, 679), p. 177.

10. The structure of the cell-walls brought out by prolonged preservation in pyroligneous-formol solution (283 C).

11. Formation of akinetes (573 A).

12. *Microspora stagnorum*. Vegetative filament and zoöspore formation (495) p. 176.

13. A vegetative filament with long cells (66).

14. *Microscopa quadrata*. End of a filament from material which formed a furry coating on sticks in an aquarium (669), p. 178.

15. Filament from a confervoid mass (423).

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1, 2. *Tribonema bombycinum*. Varying forms of vegetative cells (430, 421), p. 184.

3. Cells pulling apart for dispersal of zoöspores (128). [This single figure was originally drawn from living material with ocular 3 and objective 7, and later was enlarged to the scale of the rest of the plate.]

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7. Male gametes forming in one cell (420).

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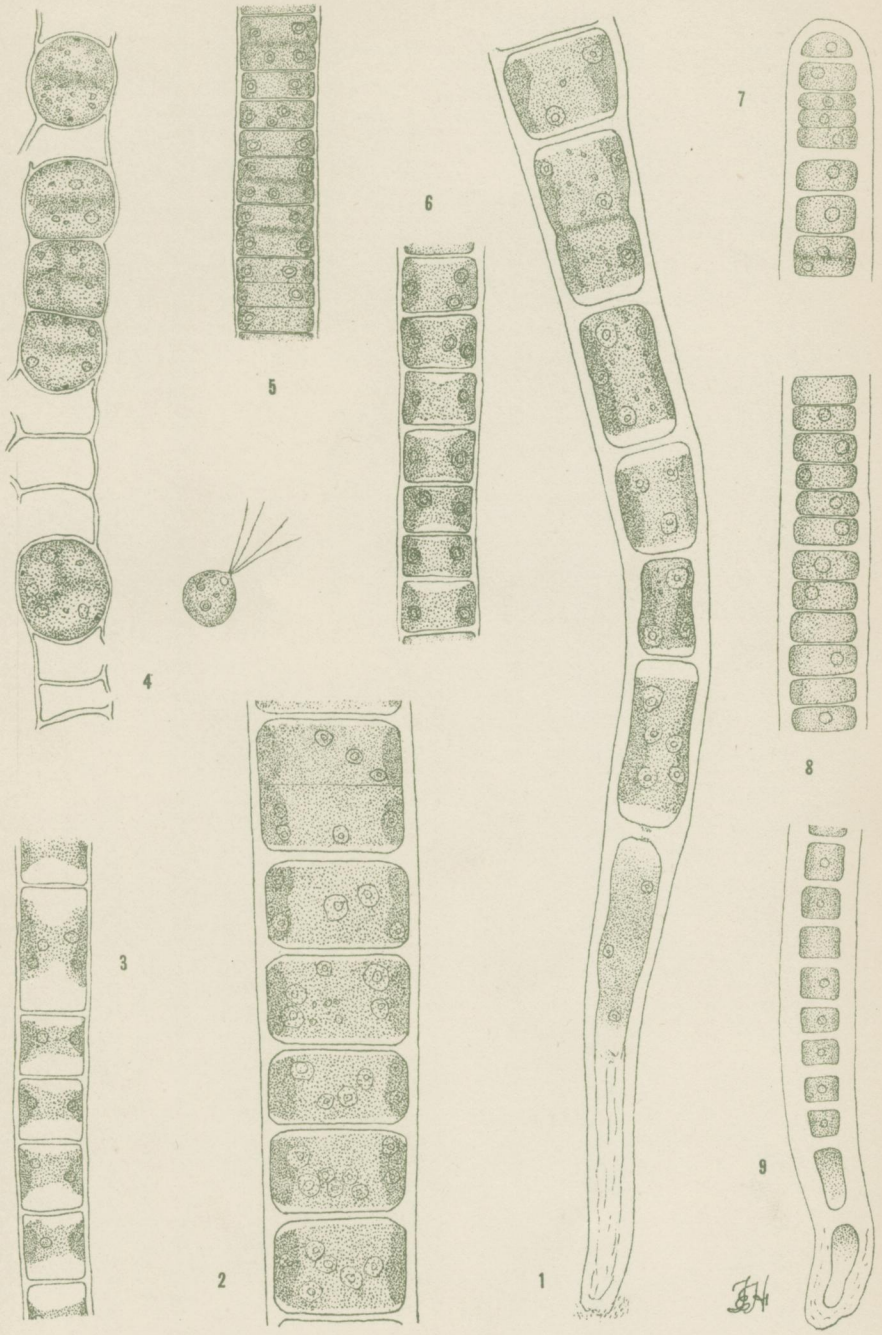
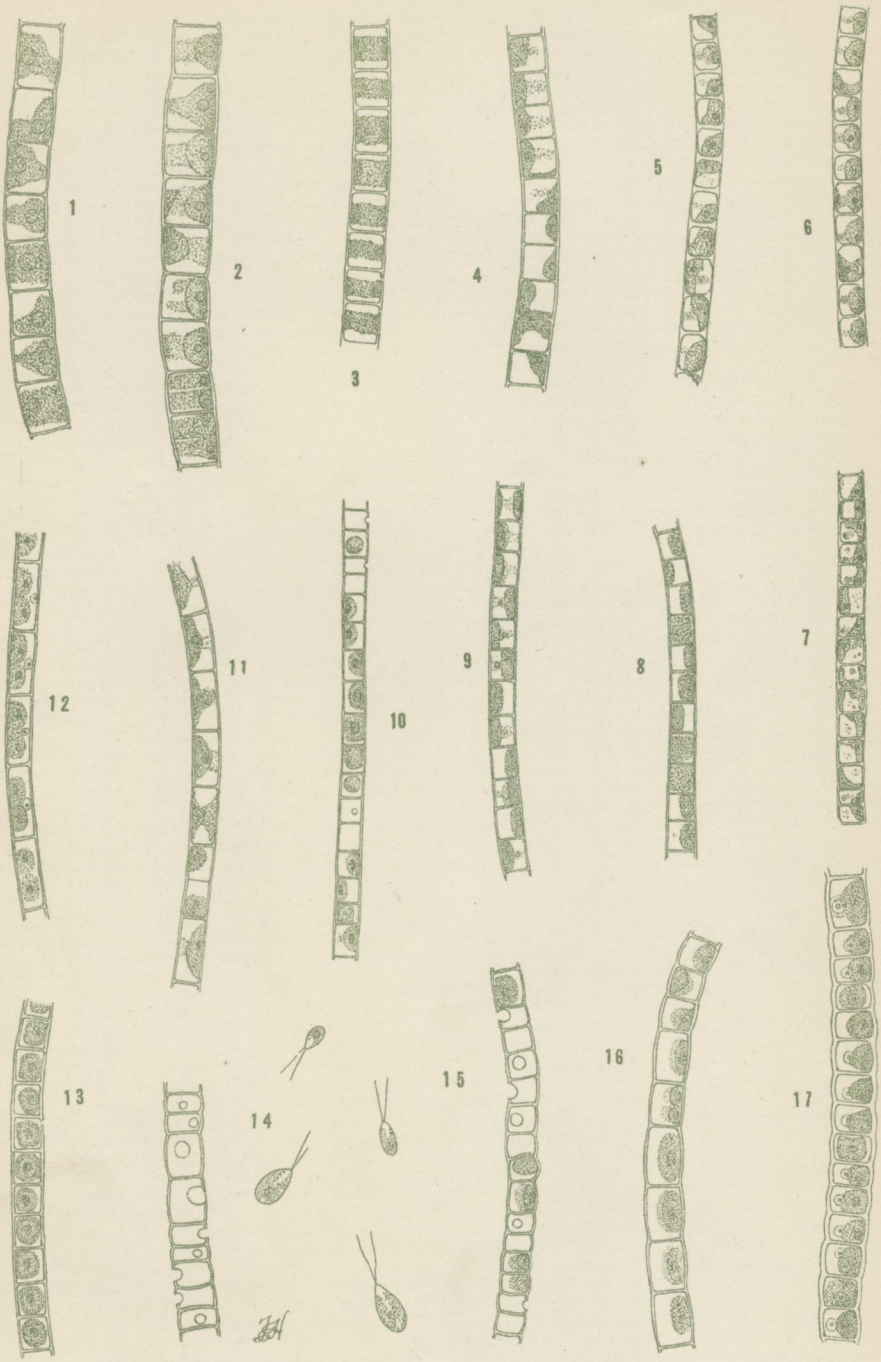
Names of species and genera which are only casually mentioned and those considered doubtful in respect to their occurrence in this country or their validity are printed in Roman type; accepted and described species and genera are in SMALL CAPITALS, and synonyms in *italics*. The page on which the technical treatment appears is printed in **full-face**.



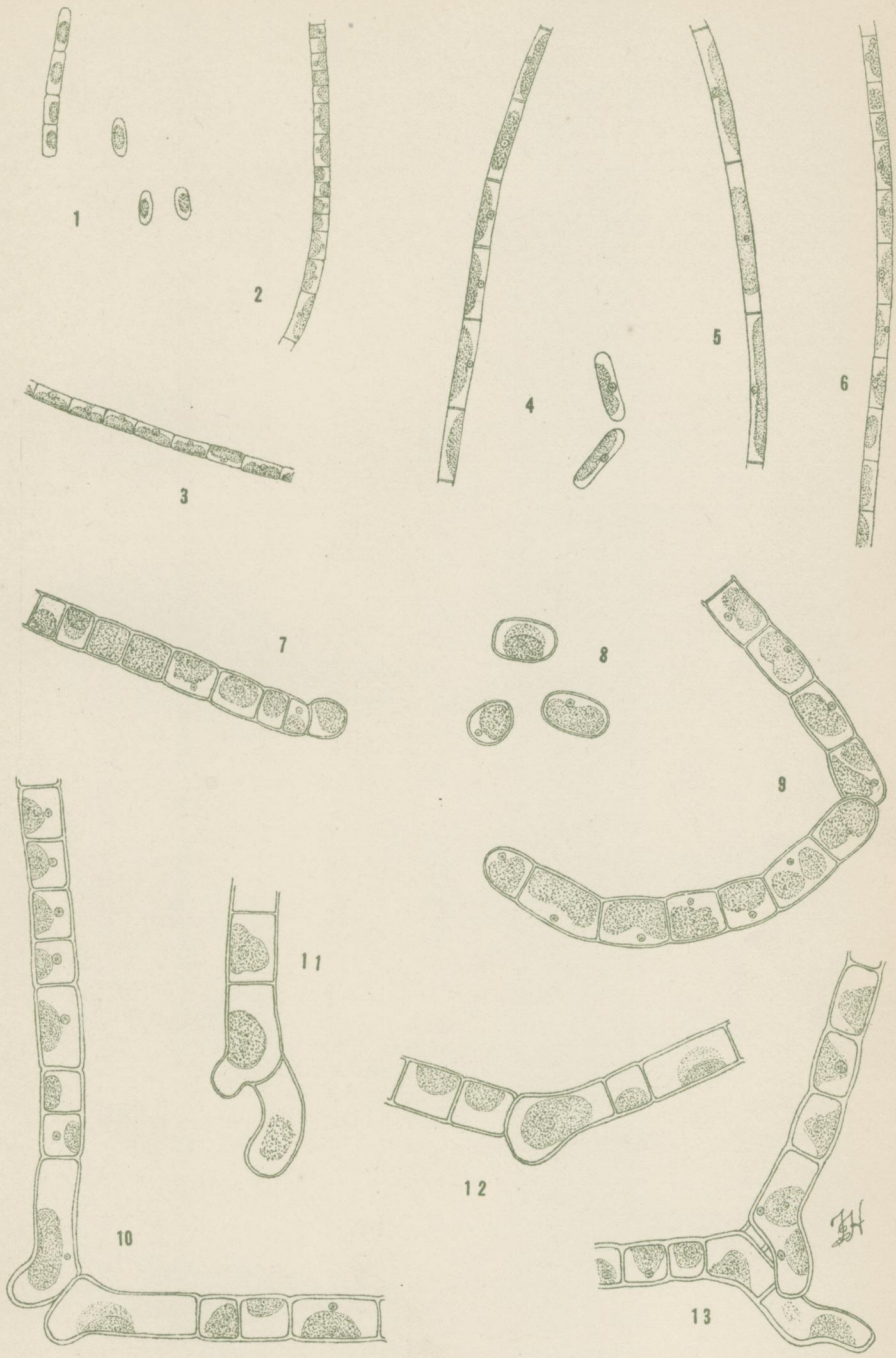
1-4. ULOTHRIX ZONATA. 5,6. U. TENUISSIMA. 7-9. U. FLACCA

HELIOTYPE CO., BOSTON.



1,2. ULOTHRIX IMPLEXA. 3,4. U. TENERRIMA. 5-7. U. VARIABILIS.
8,9. STICHOCCUS MARINUS. 10-13. S. SUBTILIS. 14-17. S. FLACCIDUS.

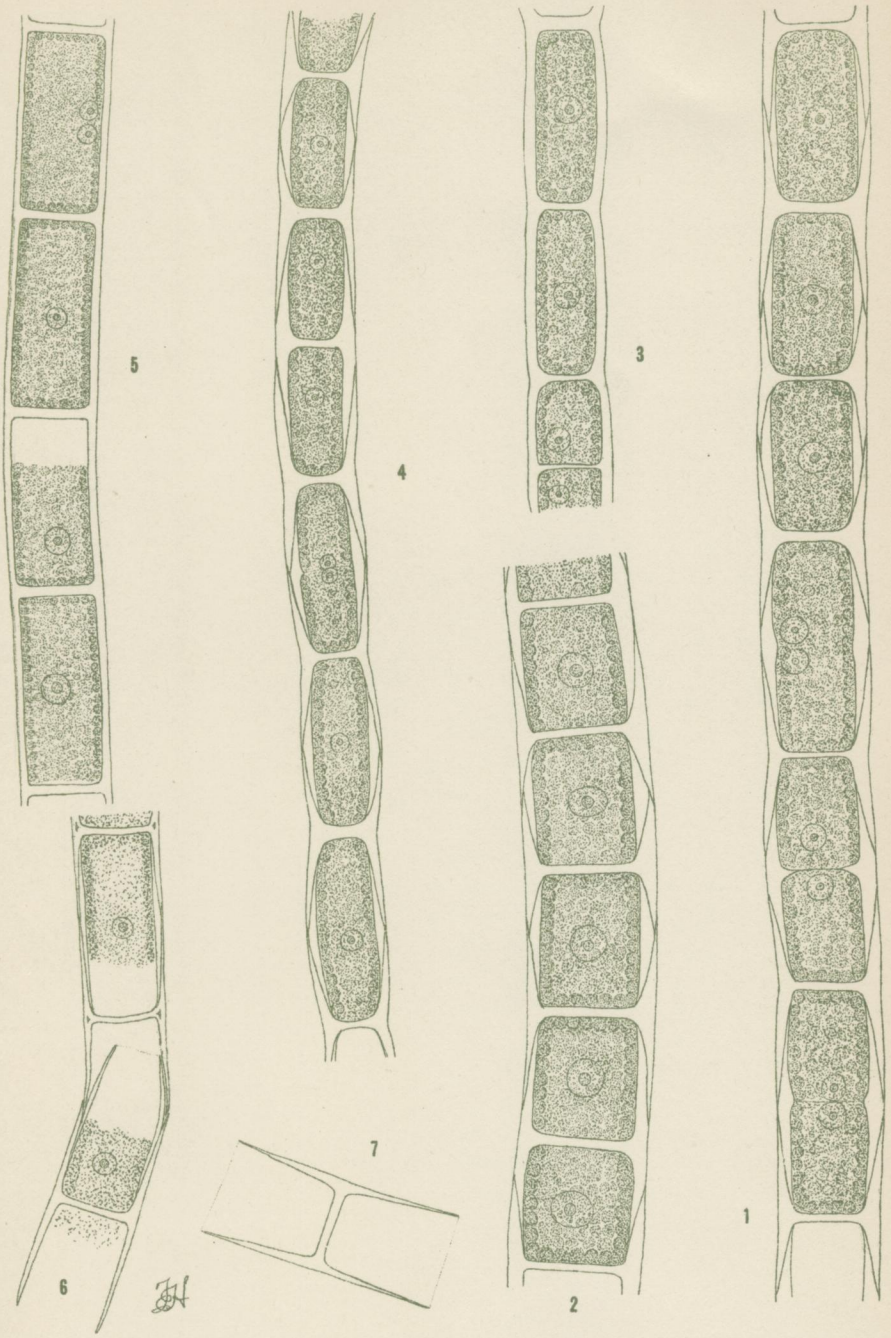
HELIOTYPE CO., BOSTON.



1-3. STICHOCOCCUS BACILLARIS. 4-6. S. SCOPULINUS. 7-9. S. FLUITANS.

10-13. S. RIVULARIS

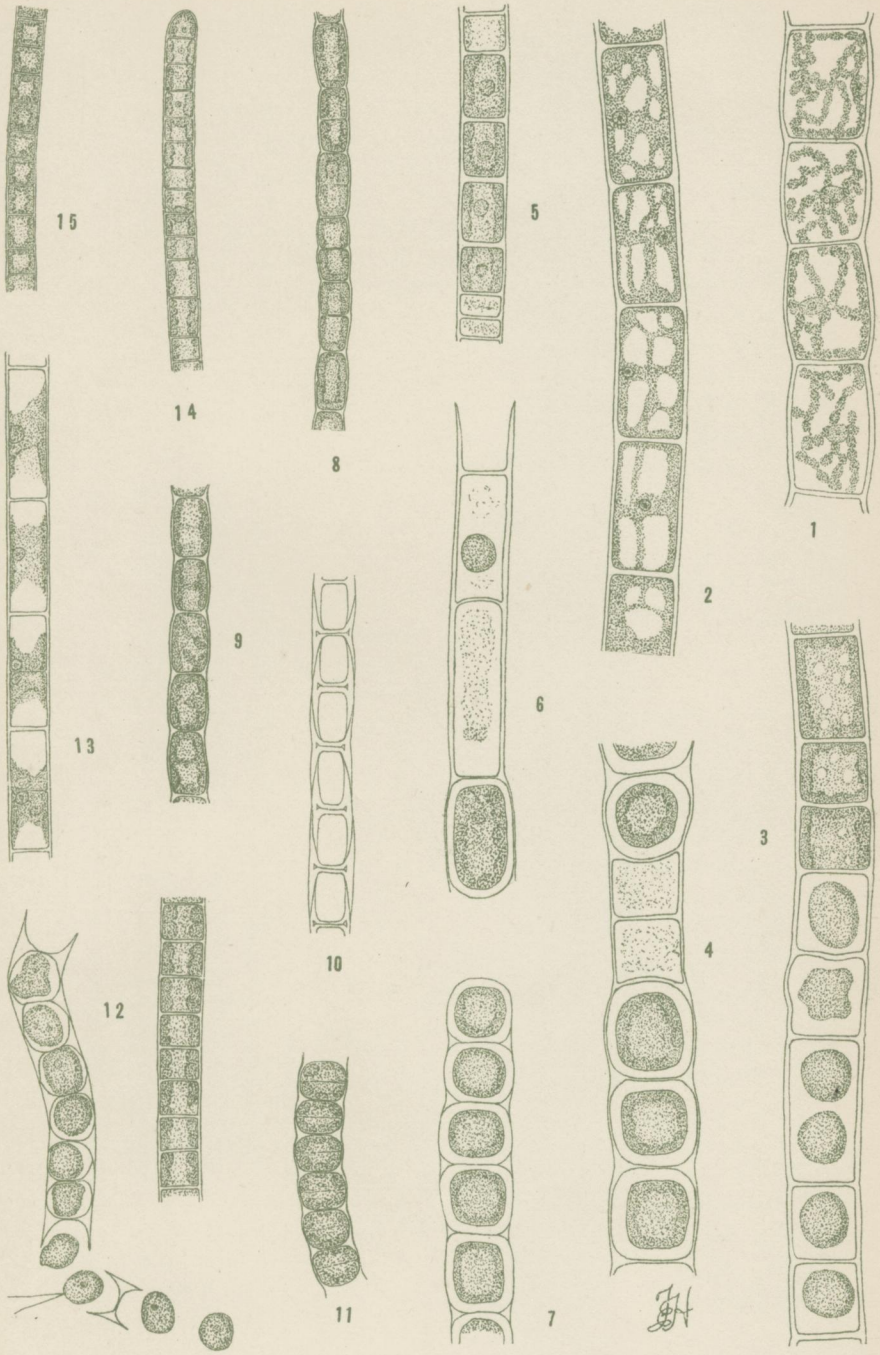
HELIOTYPE CO., BOSTON.



1. MICROSPORA AMOENA. 2. M. CRASSIOR 3-4. M. LOEFGRENII.

5-7. M. WITTROCKII

HELIOTYPE CO., BOSTON.



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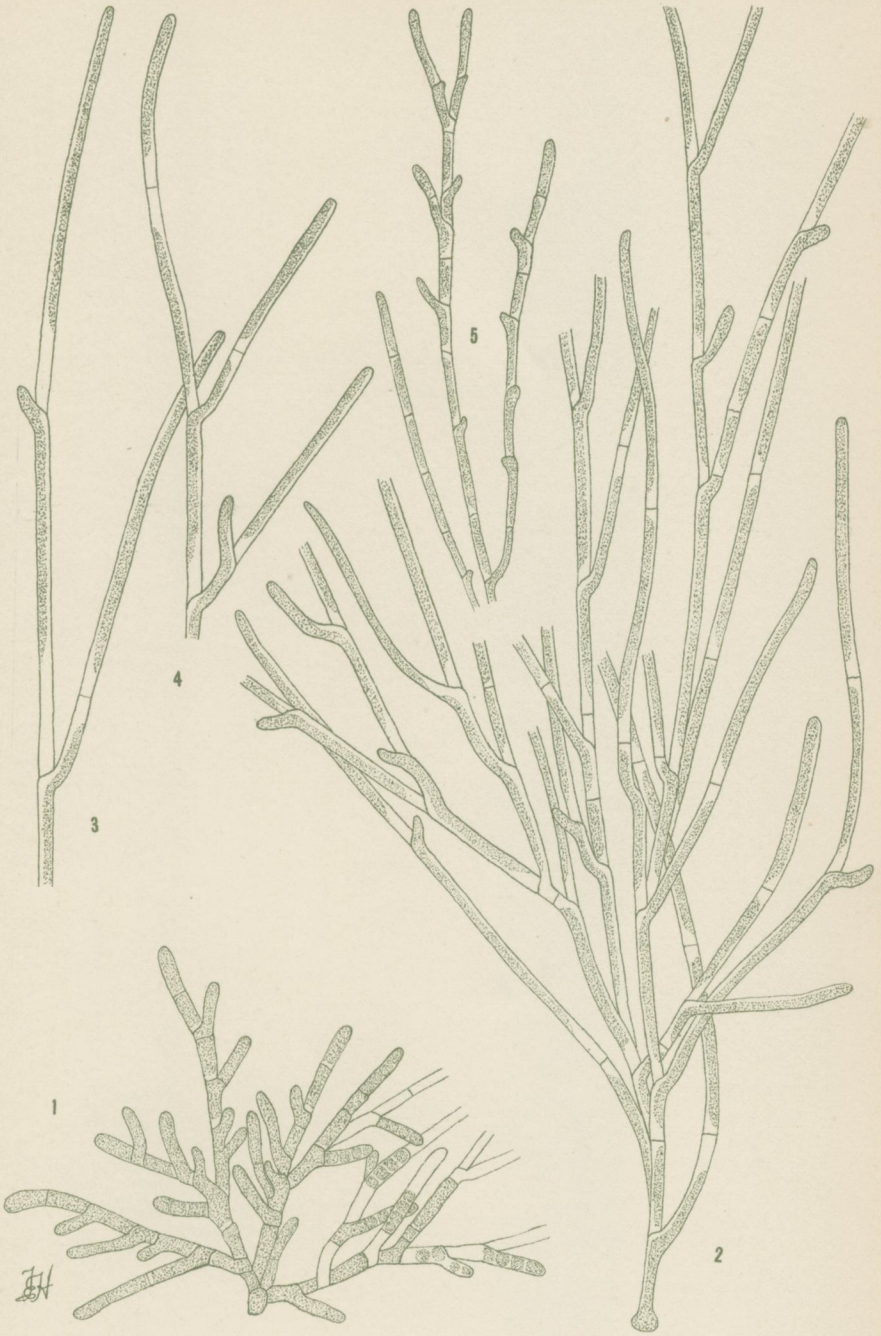
HELIOTYPE CO., BOSTON.

1-6. TRIBONEMA BOMBYCINUM. 7,8. T. MINUS. 9-11. T. UTRICULOSUM

HELIOTYPE CO., BOSTON.



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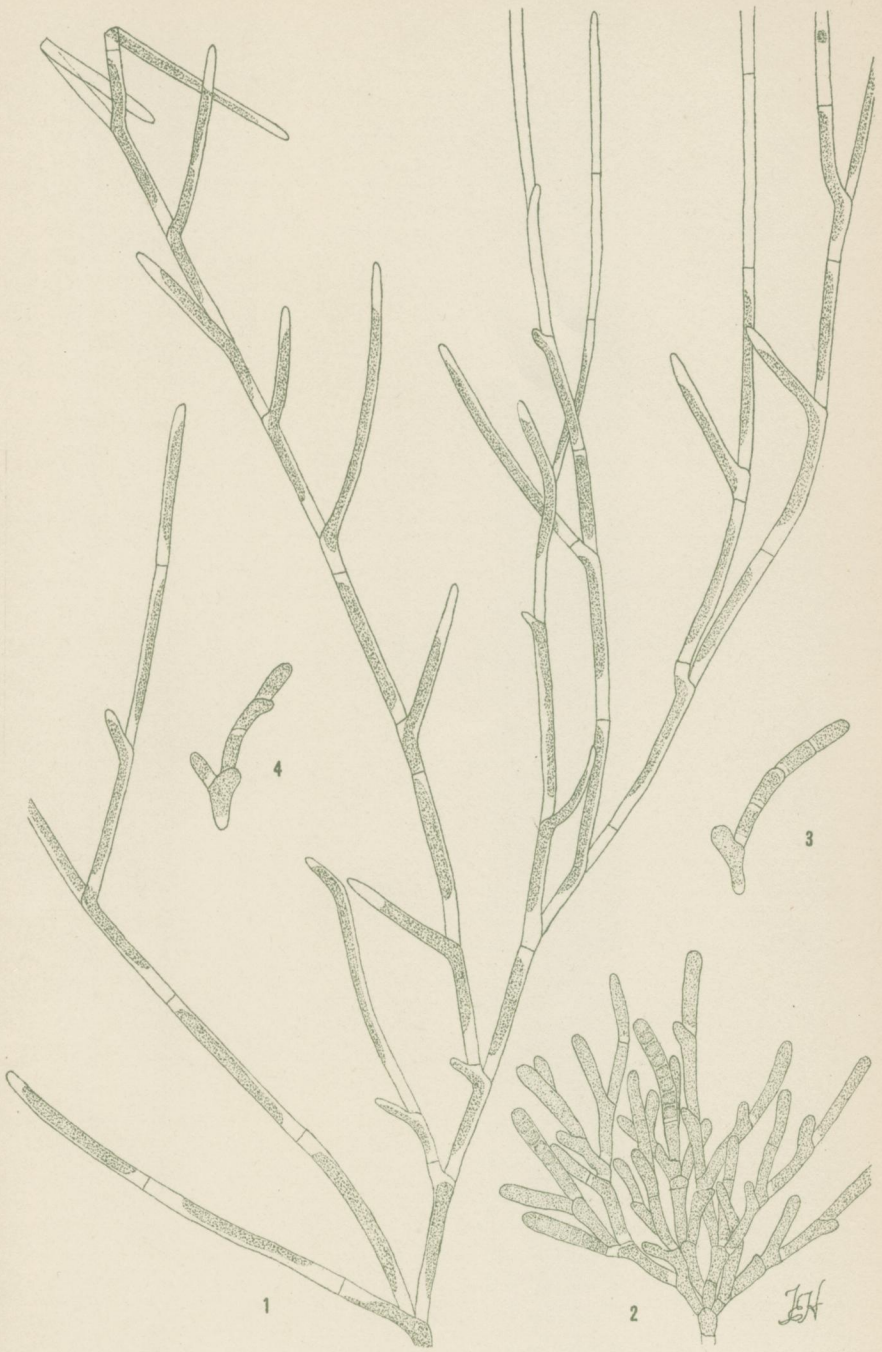
HELIOTYPE CO., BOSTON.



1. MICROTHAMNION STRICTISSIMUM MACROCYSTIS.

2-4. M. KUETZINGIANUM

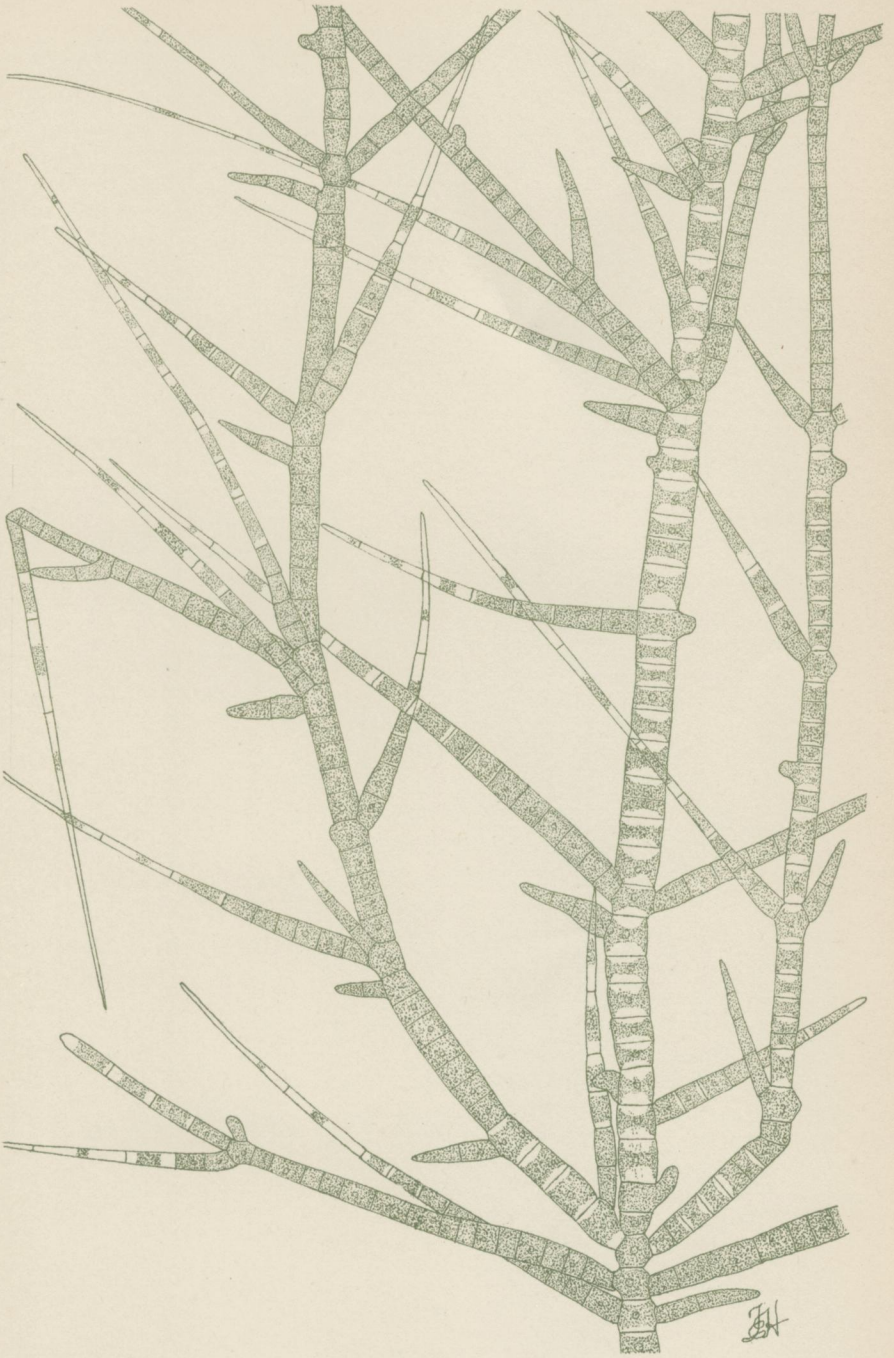
HELIOTYPE CO., BOSTON.

MYXONEMA LUBRICUM

HELIOTYPE CO., BOSTON.

MYXONEMA AMOENUM

HELIOTYPE CO., BOSTON.



MYXONEMA SUBULIGERUM

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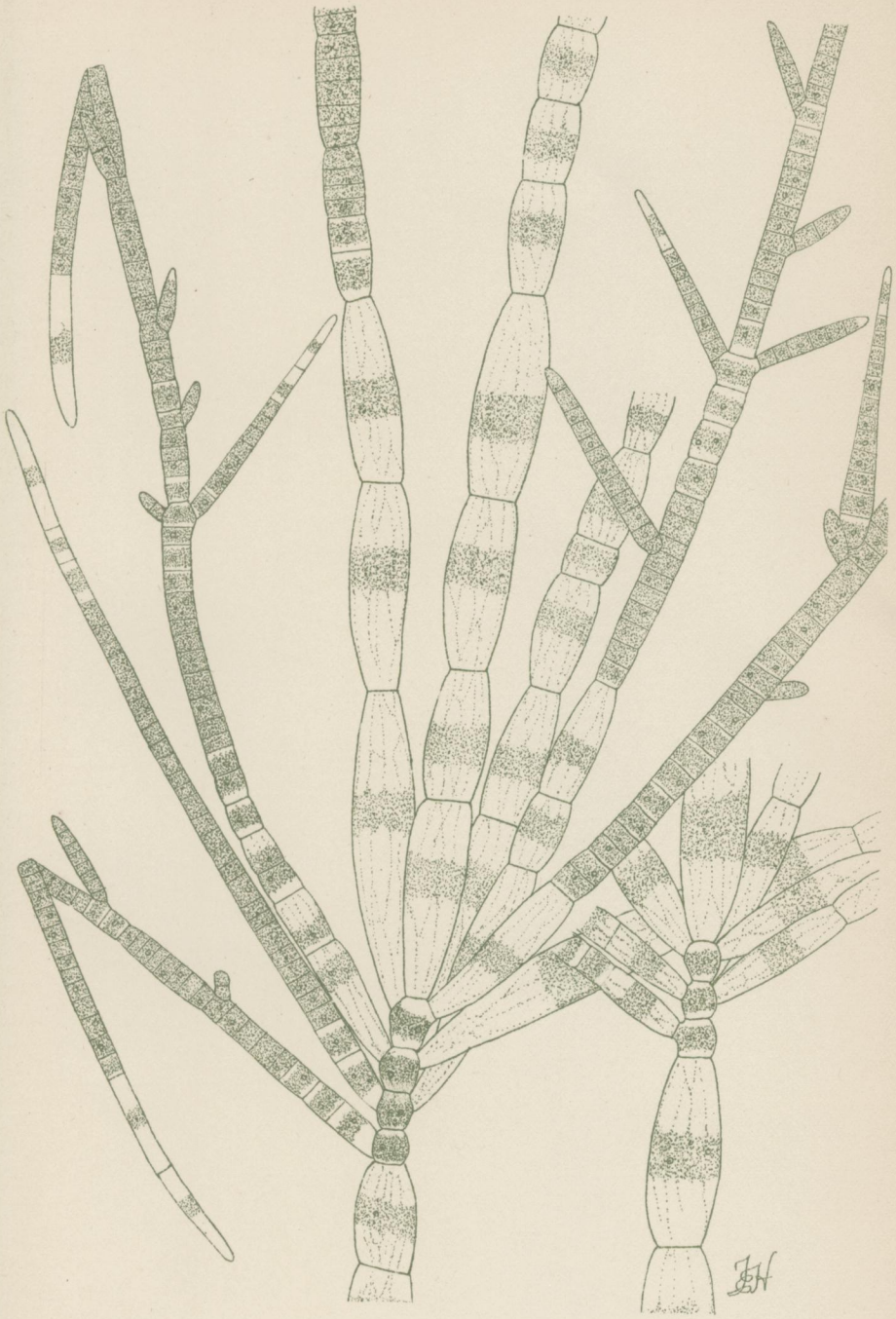

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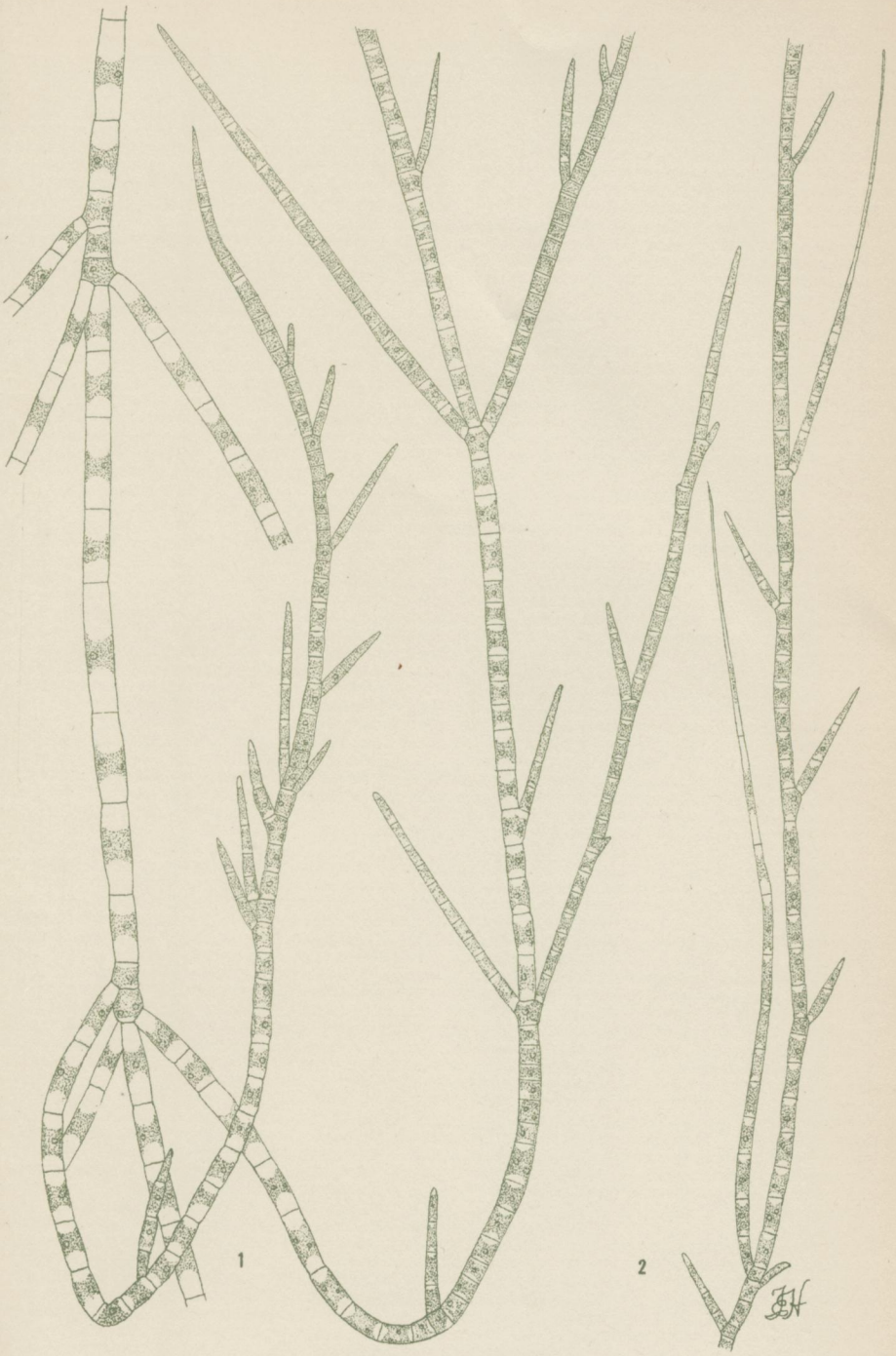

MYXONEMA TENUE

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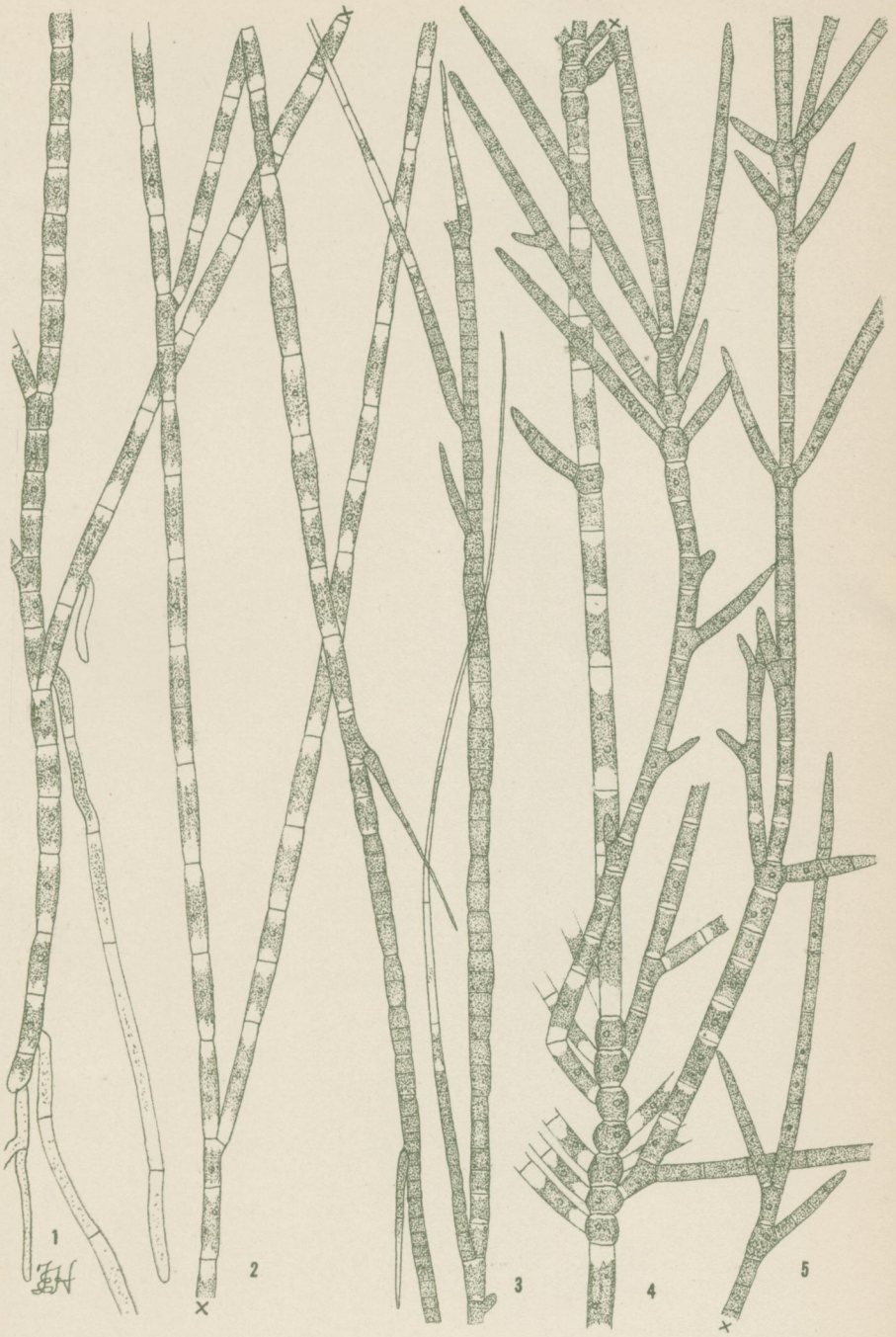

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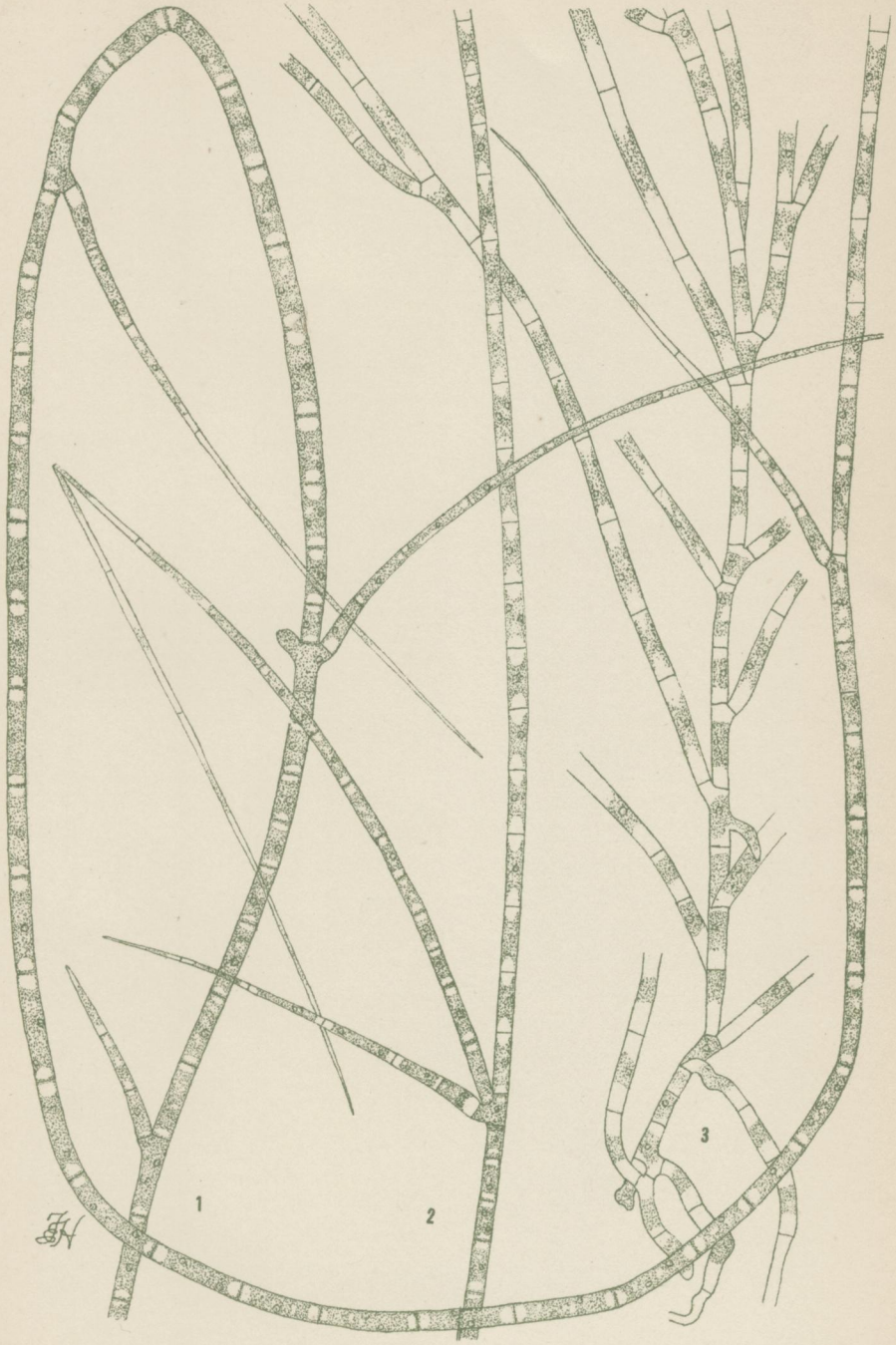
HELIOTYPE CO., BOSTON.

MYXONEMA GLOMERATUM

HELIOTYPE CO., BOSTON.



MYXONEMA ATTENUATUM

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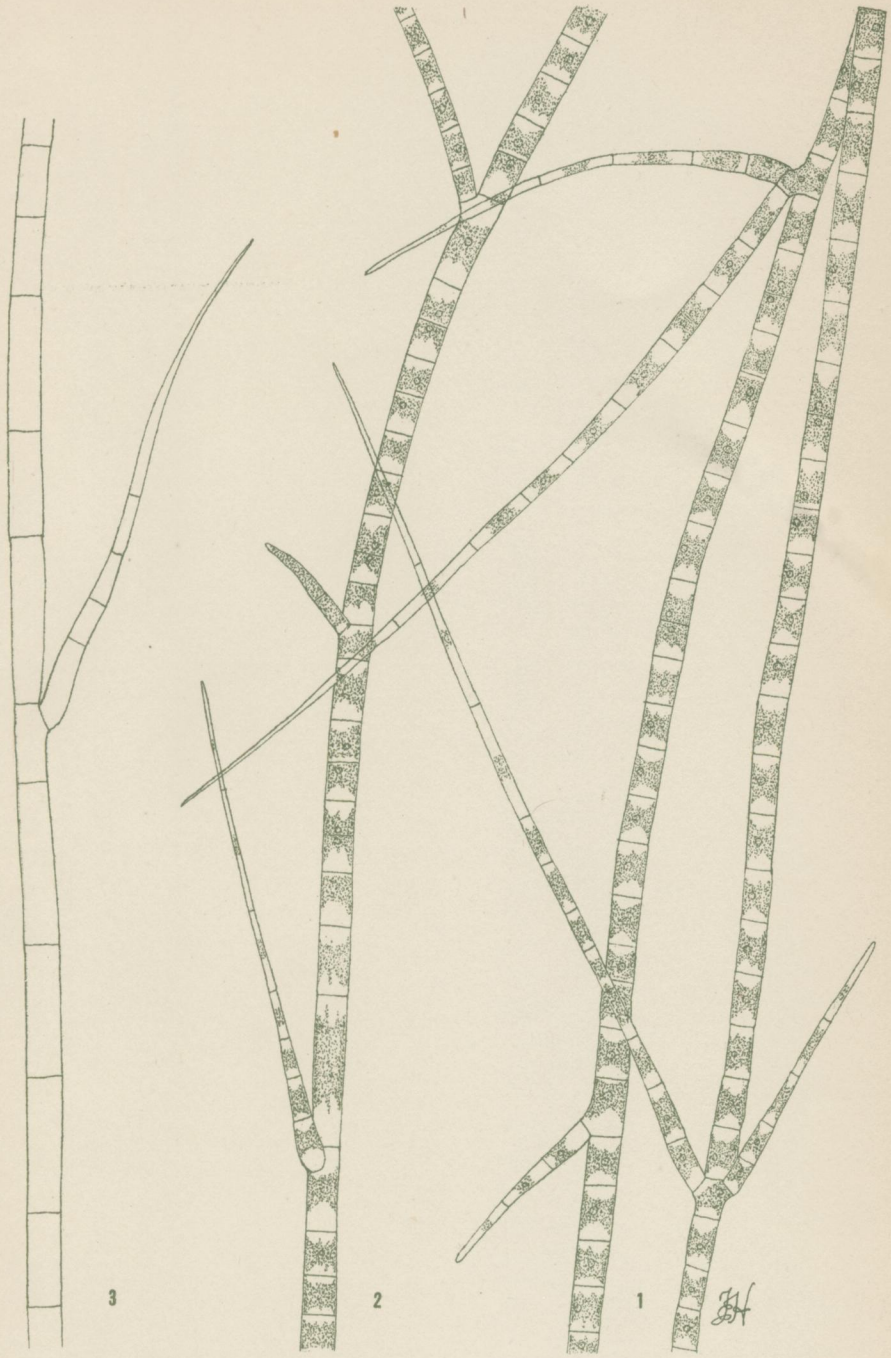


1,2. MYXONEMA STAGNATILE. 3. M. SUBSECUNDUM

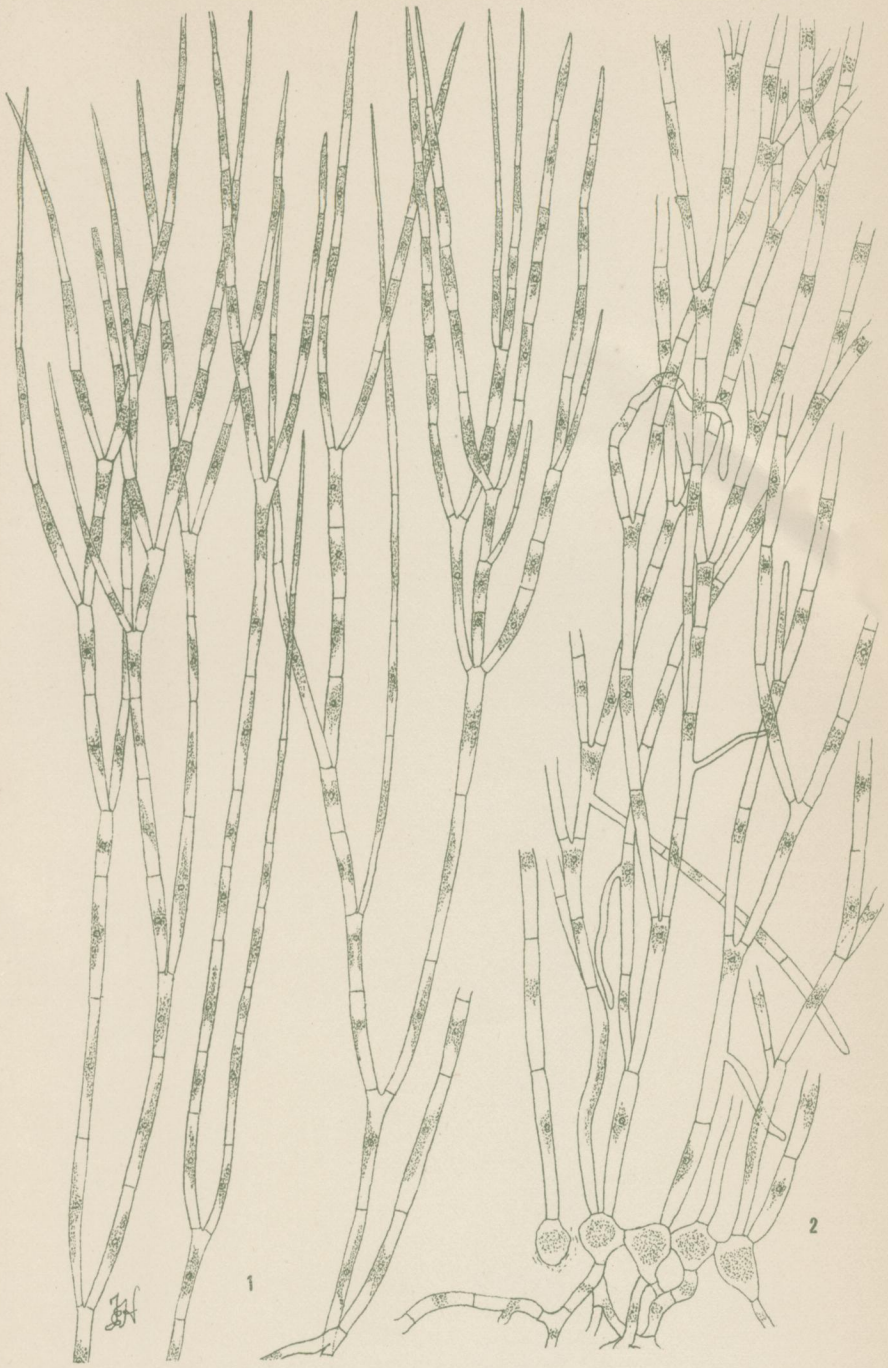
HELIOTYPE CO., BOSTON.

CHAETOPHORA ELEGANS

HELIOTYPE CO., BOSTON.

1. CHAETOPHORA PISIFORMIS. 2,3. C. INCRASSATA

HELIOTYPE CO., BOSTON.



CHAETOPHORA ATTENUATA

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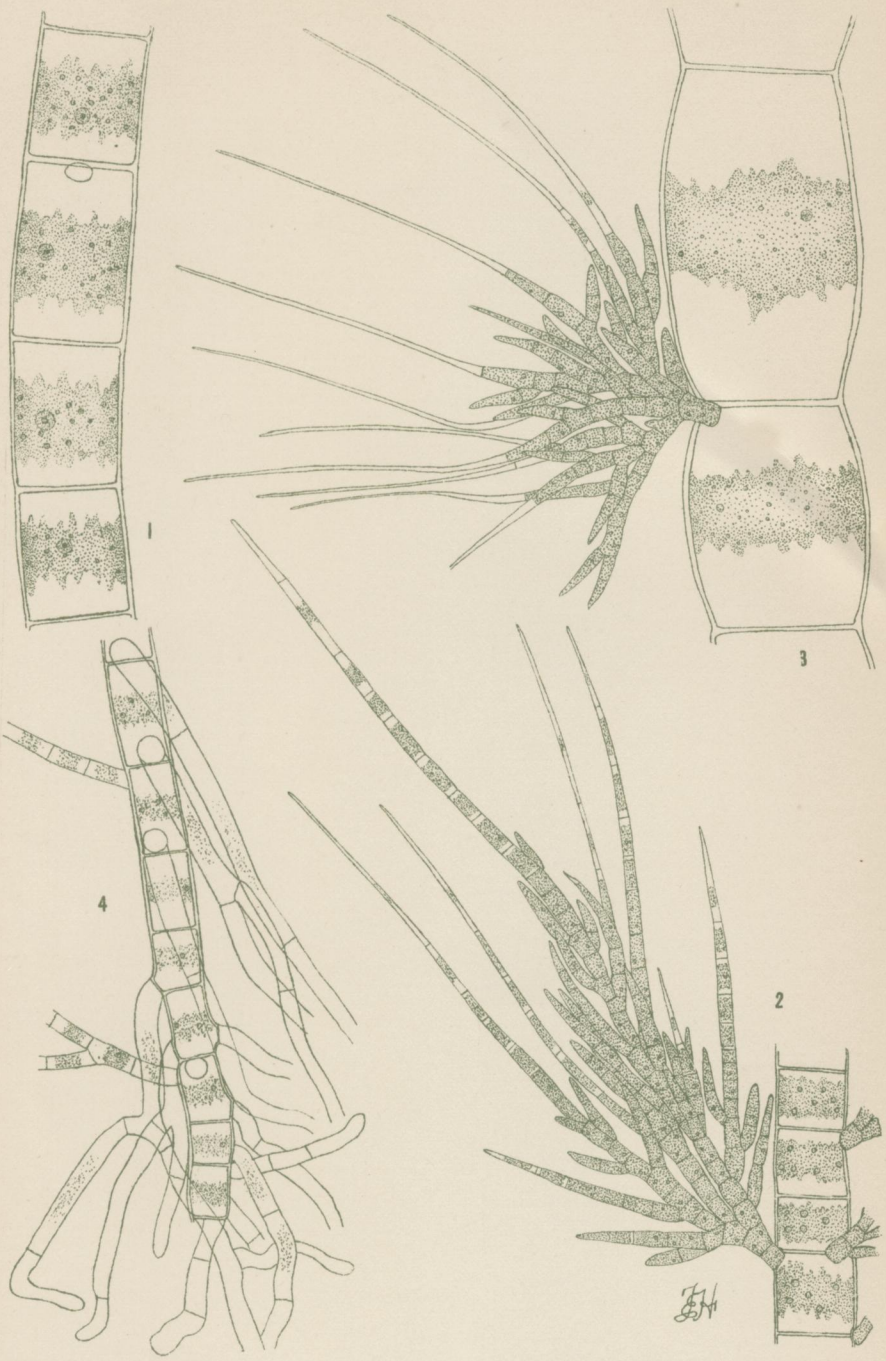
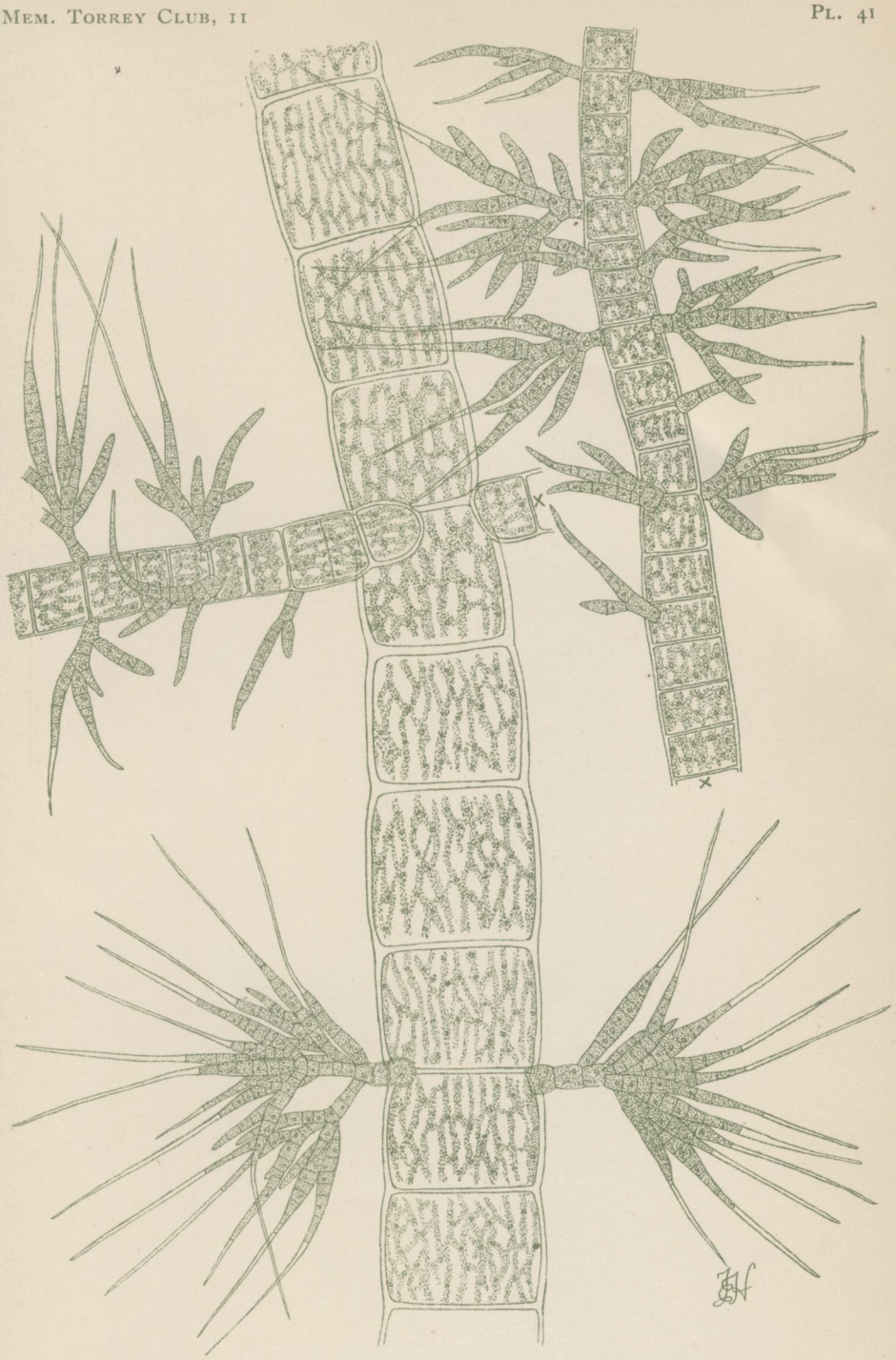


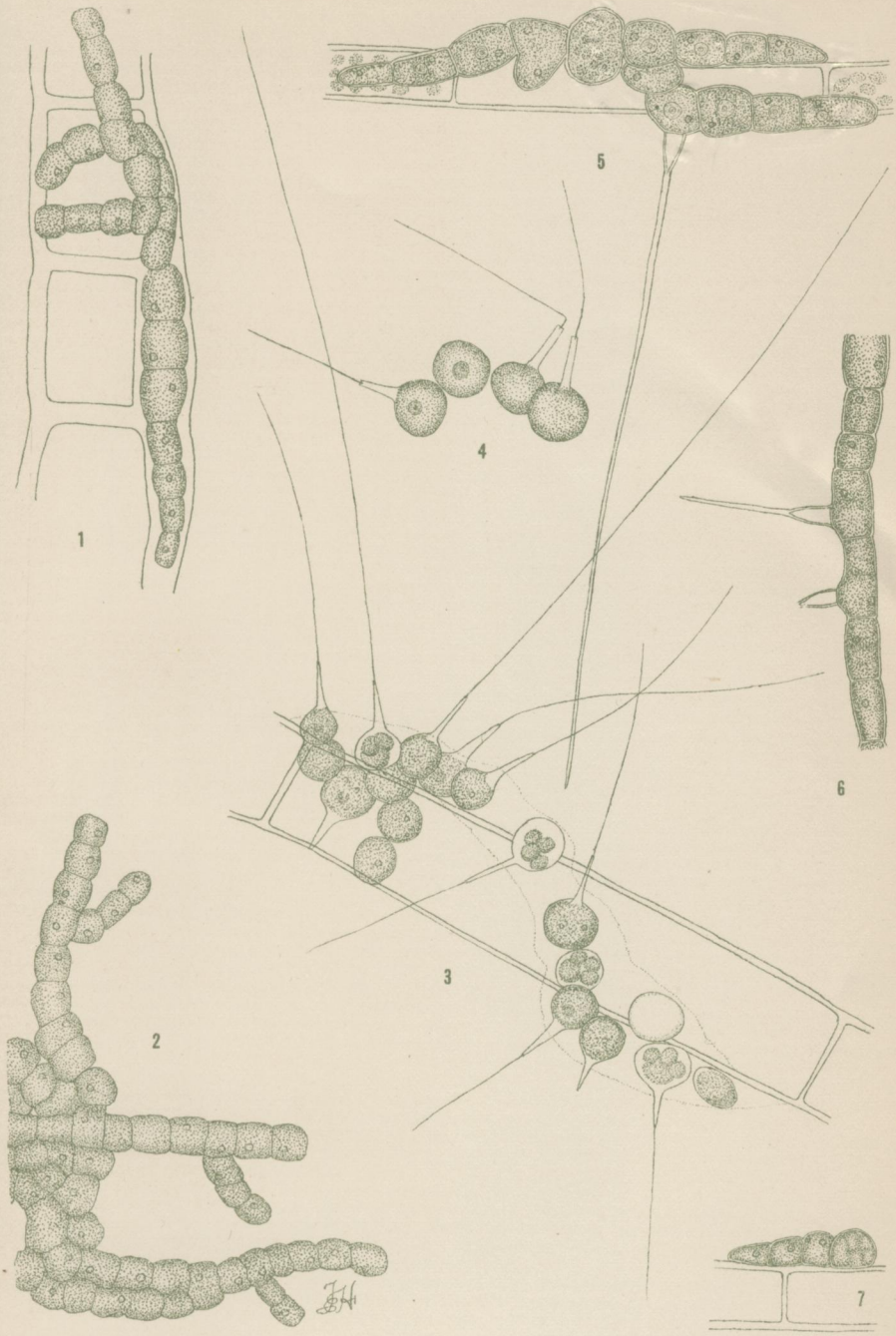
1,2. DRAPARNALDIA PLUMOSA. 3,4. D. GLOMERATA.

HELIOTYPE CO., BOSTON.



DRAPARNALDIA PLATYZONATA

HELIOTYPE CO., BOSTON.



1. ENDODERMA. 2. EPICLADIA. 3,4. CHAETOSPHAERIDIUM.
5-7. HERPOSTEIRON

HELIOTYPE CO., BOSTON.