DESMIDS

OF THE

UNITED STATES.

DESMIDS

OF THE

UNITED STATES

AND

LIST OF AMERICAN PEDIASTRUMS

WITH

ELEVEN HUNDRED ILLUSTRATIONS

ON

FIFTY-THREE COLORED PLATES.

BY THE REV. FRANCIS WOLLE,

Member of the American Society of Microscopists.

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TO

Dr. Otto Nordstedt,

OF THE UNIVERSITY OF LUND, SWEDEN,

THIS LITTLE WORK IS

Dedicated,

IN RECOGNITION OF HIS GREAT AND VALUABLE CONTRIBUTIONS

TO THE HISTORY OF CRYPTOGAMIC PLANTS,

BY HIS GRATEFUL FRIEND,

THE AUTHOR.

PREFACE.

In the "American Journal of Science and Art," A. D. 1847, Prof. J. W. Bailey, of West Point, said:—"With the exception of six or eight, I am not aware of any published account of our Marine *Algæ*. Of our fluviatile (fresh-water) *Algæ*, I find no published notice, although they appear to have been studied with some care by the indefatigable Schweinitz," and at a little later date he adds:—"It appears that to Schweinitz is due the credit of being the *first* to collect and to study any of our fresh-water *Algæ*." I refer with all the more pleasure to these remarks concerning the late Rev. L. D. von Schweinitz, of Bethlehem, Pa., that he was a friend of my youth, and the first to draw my attention to the study of cryptogamous plants. It is only proper that ample credit should be given to this the first collector of our fresh-water *Algæ* in this the first monograph published in the United States, on that class of *Algæ* known as DESMIDS.

Nearly forty years ago Prof. J. W. Bailey, contributed to the "American Journal of Science and Art," two papers, one describing a few new species of Desmids from the Catskill mountains, and the other, "Notes on the *Algæ* of the United States;" following these we have, "Microscopical Observations made in South Carolina, Georgia, and Florida—Smithsonian Institute, A. D., 1850, 50 pp." These observations cover *Infusoria* and *Algæ*, the latter comprising a list of one hundred and twenty-five species, among which appear a few newly discovered Desmids which are illustrated and described.

Horatio C. Wood, Jr., M. D., published in 1872, through the Smithsonian Institute, "A Contribution to the History of the Fresh-Water *Algæ* of North America." In this publication Dr. Wood brought together all the recorded observations that had been made up to that

time, in this country and in Europe, upon the *Algæ* of the United States. His list of *Algæ* includes about one hundred and sixty species of Desmids.

In a collection made by Stephen J. Olney, near Providence, R. I., during the years 1846–48, there were about fifty species of Desmids.

My first contribution to the literature of the fresh-water *Algæ*, appeared in the "Torrey Botanical Bulletin of New York," in 1877, wherein are described thirty Desmids not heretofore found in the United States. Every succeeding year up to 1883, I have recorded in the same journal, the results of my observations upon this interesting class of American flora; what my success has been, may be inferred from the fact that I have in my herbarium nearly five hundred well authenticated species and varieties of American Desmids.

Only the great pleasure I derived from collecting, and studying the life-history of this heretofore neglected class of plants, enabled me to make light of, and to overcome, the serious obstacles I met with at the outset of my labors. There were no home correspondents with whom to co-operate and no accessible good works to guide me in my researches over this almost wholly unexplored field. My first encouragement came from abroad. The late Dr. L. Rabenhorst, of Meissen, Prussia, and the late Alexander Braun, of Berlin, sent me many valuable communications, and to the former particularly, I furnished many sets of mounted specimens of our *Algæ* for his serial of decades of *Algæ Exsiccatæ*. I am particularly indebted, however, to Dr. Otto Nordstedt, of the University of Lund, Sweden, for his kindness in determining the identity of certain American species discovered by me with those already known in Europe; and also in confirming my impressions concerning the restriction of others solely to the United States.

My grateful acknowledgments are also due for valuable notes and papers, to Dr. V. B. Wittrock, of the Scientific Academy of Stockholm; N. Wille, of Christiana, Norway; F. Hauck, Trieste; Dr. J. Rostafinski, Cracow; G. Lagerheim, Stockholm, and others.

Meanwhile, the subject had awakened interest in various parts of the United States, and specimens began to come in from places it would have been impossible for me to have visited. Among those to whom I am particularly indebted for favors of this kind, are:—Mr. H. W.

Ravenel, Aiken, S. C., who during the past eight or more years, has sent me many interesting specimens, from his own State, Georgia and Florida; Capt. J. Donnell Smith, Baltimore, Md., who, in 1878 and 1879, sent me over seven hundred specimens of fresh-water *Algæ* gathered in Florida; in his collections the Desmids were not numerous, but they included specimens not found elsewhere; Mr. F. H. Hosford, assisted by Mr. C. G. Pringle, Charlotte, Vt., whose collections were copious in northern Vermont; and Miss Eloise Butler, Minneapolis, Minn., who was a most successful collector of Desmids; I am indebted to her for all the species in the list which are assigned to Minneapolis. My acknowledgments would not be complete did I omit to mention the practical interest taken in my labors by the Rev. H. D. Kitchel, and his son, Mr. H. S. Kitchel.

In the descriptive parts, I have abbreviated the name of the discoverer of each plant, the reader being referred for additional information, to the appended list of names alphabetically arranged with their abbreviations, and with the title of the books consulted in the compilation of this work.

Although this work is believed to be exhaustive of all now known concerning the Desmids of the United States, yet the author regards it only as the pioneer to others much larger and therefore more valuable, wherein will be recorded the achievements of those who will perhaps be indebted to this work for their first introduction to so fascinating a study as that of the fresh-water *Algæ* of our country.

F. W.

Bethlehem, Pennsylvania,
February, 1884.

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INTRODUCTION.

The following preliminary remarks may prove interesting to those who have not heretofore paid much attention to the subject which has inspired the preparation of this volume.

The term *Algæ* signifies *Sea-weeds*, and is used to designate certain marine and fresh-water plants, which because they bear no flowers, stamens nor pistils, and in fructification produce spores instead of seeds, are styled cryptogamous plants. The *Algæ* comprise not only sea-weeds properly so-called, but likewise the gelatinous, or scum-like substances found floating on or near the surface of ponds, ditch water and placid streams; only a very small proportion of the entire class of fresh-water *Algæ*, is confined to trunks of trees, shady recesses, or to rocks dripping with moisture.

Owing to the life-like peculiarities exhibited in some stages of their development and growth many of the *Algæ* were believed by Ehrenberg and other microscopists of his time, to belong to the animal kingdom, but the wholly vegetable character of the *Algæ* is now too well established to admit of further controversy.

Howsoever great in other respects, their individual differences may be, the *Algæ* possess certain characteristics which are common to them all. They are cellular, flowerless and devoid of roots; their home is in the water; the very few which affect other localities, die when deprived of moisture. Their nutriment is absorbed through their entire surface from the medium in which they live. They are totally devoid of vascular tissue, in fact, are merely congeries of simple cells on the arrangement of which depends their structural differences.

Few classes of plants present greater diversities of form than do the *Algæ*. Some are minute enough to tax the powers of our best

microscopes, while others are a constant source of astonishment because of their enormous size, stretching as some of them do, nearly two hundred feet across their marine beds, and with stems sufficiently thick wherefrom to manufacture handles for small tools and cutlery.

Those which consist of only a few cells, contrast very forcibly with others which in appearance, but in appearance only, present the branches, stems, twigs and foliage of highly developed plants; nor are they less opposite in what may be termed their sociality, from the fresh-water hermits scattered more or less sparsely in secluded places, up to those immense aggregations in mid ocean which resemble sub-aqueous forests, or form floating islands miles in diameter, where multitudes of marine creatures find permanent homes.

Equally diversified is their range of habitat; no geonomic condition suffices to exclude the *Algæ;* they greet the traveler on the confines of vegetation, near the highest mountain tops, amid snow and ice[1], and are brought up by marine explorers from great depths below the surface of the sea.

To overlook their color would be to neglect a very striking characteristic. The predominant tint of the entire class including both marine and fresh water varieties, is green; then pink grading off into all the shades of purple, and finally olive, from golden green and bright tawny to black; indeed there are few if any colors from the most gorgeous to the dullest, but are to be found among the *Algæ*. They are also interesting for the many useful purposes to which they have been and are applied. We are under no small obligation to them for aiding to keep the atmosphere in a wholesome condition, since they absorb carbonic acid largely and exhale immense quantities of oxygen. The extinction of certain kinds would prove an annoying loss to our *materia medica*. They nourish a large variety of fish and molusca, and in some localities, constitute a nutricious fodder for cattle and pigs; moreover, of some kinds there are made sauces, soups and blanc-mange which are highly appreciated by epicures, while others as fertilizers, are largely used by sea-coast farmers.

[1] In a recent publication by V. B. Wittrock, of the Scientific Academy of Stockholm, he describes the Snow and Ice flora of the Arctic Zone. The Snow flora comprises about 40 species and varieties of fresh-water *Algæ*, and the Ice flora about 10 species. They belong to 25 genera. Ten species and varieties are new.

Of what further benefit they may be to mankind it would be rash to predict, but it is within the bounds of probability, that the microscopic study of the fresh-water varieties, if pursued hereafter as ardently as during the past few years, will result in a considerable modification of our ideas concerning the generation and growth of certain life-germs.

For the behoof of the uninitiated, a few words may here not be out of place, on

HOW TO FIND, HOW TO COLLECT, AND HOW TO PRESERVE

Fresh-water *Algæ*. As a large majority of them, especially the DESMIDS, are free-floating plants, it would be a waste of time to seek them in rapid waters; they affect pools, sluggish streams and ponds; the latter afford the most satisfactory results to the explorer, when the pond is a mile or more in length and is fed by one or two creeks; the indentations on the margins of such a pond and its tributaries, usually abound in water grasses and mosses which shelter and support the floating *Algæ*.

The outfit need not consist of more than a nest of four or five tin cans (tomato or fruit) one within the other for convenience of carriage; ten or a dozen wide-mouthed vials, and a small ring-net of fine muslin at the end of a rod about four feet in length. Should a boat be needed it can usually be hired on the spot. After selecting what seems to be a good locality, drag the net a few feet among the grasses and mosses, above indicated, allow the bulk of the water to drain through the muslin, and then empty the residue into one of the cans; repeat this process as often as may be desirable. Ten or fifteen minutes after the cans have been filled, most of the surface water may be poured off, and the remainder transferred to a glass vial, where the solid contents will gradually sink, and the superfluous water can be again poured off, and the vessel filled up with deposits from other vials. In shallow places, what is known as swamp-moss (*Sphagnum*), bladderwort (*Utricularia*), Water-milfoil (*Myriophyllum*) or other finely cut-leaf water plants are likely to abound, these should be lifted in the hand and the water drained, or squeezed from them into a tin can to be subsequently treated as already stated. A few drops of carbolic acid in each vial, just enough to make its presence perceptible, will preserve the contents for months and even years from deterioration; the green coloring matter (*Chlorophyl*) may fade, but this in the

case of the DESMIDS, is of little importance; nevertheless, when practicable, always examine the material when fresh. When dried on paper for the herbarium, the specimens can still, after being moistened with water, be microscopically examined, but not with the best results, since the drying is apt to collapse, or otherwise distort the cells.

The collector will not know the value of his find, until it has been brought drop by drop under the lens of his microscope, and out of the entire mass he may discover nothing to reward his labors; this however should not discourage him, as one or two failures are to be expected prior to meeting with an adequate reward. His interest in the study will be greatly enhanced if he keeps a record of it in sketches of what the microscope reveals to him. These sketches should of course, be very exact, and in order that they may be so, it is necessary that the microscope should be provided with an eye-piece micrometer with which to measure the length and breadth of the figure to be sketched; a half inch per $\frac{1}{1000}$ (.001″) or 25 μ is the most convenient, though $\frac{1}{4}$ or $\frac{1}{8}$ of an inch may be a preferable scale for the larger forms. It is so difficult to separate specimens from their accompanying foreign matter, that it is seldom amateurs can mount them satisfactorily on slides, and therefore this method of preserving specimens is not open to recommendation.

Although in the microscopic study of the fresh-water *Algæ* much has been done within the past few years, much more remains to be accomplished. The field instead of growing smaller seems to widen out with every fresh discovery; localities thought to have been exhausted of additional possibilities, have in subsequent seasons, yielded ample returns to the patient explorer; and if the old territory is not sufficiently attractive, there are vast regions into which no student has yet penetrated, where, doubtless, the harvest awaiting the reaper dwarfs all that has been heretofore garnered.

DESMIDS.

Order, ZYGOSPORÆ; *Family*, CONJUGATÆ.

The DESMIDS form a large group, nearly equal in number of species, to that of all the other orders of fresh-water *Algæ*. They are microscopic plants, and are to be found floating free in pools, ponds and sluggish streams in all parts of the world; at least representatives of them are to be met with in every clime from the frigid arctic latitudes to the torrid equatorial zone; but unlike the higher orders of plants this wide difference in temperature is not in these *Algæ* always accompanied by corresponding structural difference; for in New Jersey, varieties have been discovered, which previously were thought to belong exclusively to the hottest parts of South America, and in the same State are also found species peculiar to the region of Nova Zembla, and Spitzbergen; we may assume these latter to have been a northern legacy to New Jersey upon the breaking up of what is known as the Glacial period, but we have no plausible reason to give for the presence in the same localities of species which are indigenous to Brazil and the East Indies. In every country however, there are varieties of Desmids that have not been found elsewhere; a remark which applies peculiarly to the United States, where nearly one hundred species wholly distinct from any heretofore known, have been discovered, and are now for the first time collectively described in this work.

The Desmids are all more or less gelatinous; certain genera as *Hyalotheca*, *Desmidium*, *Sphaerozosma*, and some species of *Cosmarium*, and of *Staurastrum*, have a distinct, wide, colorless envelope; but the majority are provided with nothing more than an extremely thin mucous covering, which, though hardly perceptible under the microscope, becomes sufficiently evident in the firmness with which [illegible] to the paper on which they are dried.

The cell, that is to say, the plant, is multiform, varying from the simple cylindrical and fusiform, to the denticulate, crenulate, lobed and otherwise much indented margins of the equal parts into which the cell is with few exceptions, beautifully and symmetrically divided. The division of the cell into two equal parts is effected by a transverse constriction, usually so deep as to leave about a third of the diameter of the constricted cell for a connecting link between the two parts; sometimes, however, the constriction is so slight as to produce merely an obtuse angled sinus on each side of the cell; a few have no constriction.

The wall (*cytioderm*) of the cells is not constituted alike for all the genera; in some cases it appears to be of a siliceous character, judging by the appearance of the empty case, and by the firmness with which it retains the contour of the cell, even years after the desmid has been collected; but usually the wall is more fragile and easily liable to collapse or rupture, unless the specimen is kept in a preservative fluid.

One of the characteristics of Desmids which confirmed many of the earlier microscopists in the belief of their animal character, was their seemingly voluntary movements. These movements are most apparent in the larger forms of *Closterium* and *Cosmarium*, but are more or less evident in all of them; they consist of slow, steady oscillations, and sometimes they go forward and backward, similar to the movement of diatomes, but slower, therefore less observable. By means of this locomotive power, they work themselves to the surface when gathered into a vessel with dirt and other foreign matter, and collect in such positions as are most exposed to the light. Many theories have been advanced to account for this phenomenon, but hitherto all have failed to establish a satisfactory explanation.

Another movement belonging to the Desmids is that of the granules within the cells. This is always present in good living specimens, and consists in a circulation of granules in the watery fluid next the cell walls; they appear to be constantly passing to and fro between the centre and the ends of the cells.

A third motion belongs to the so-called *vacuoles* of *Closteriums*, *Docidiums* and *Peniums*. In the end of many of these cells is a well-defined globular, transparent space (*vacuole*) filled with a number of small granules, significantly called, by the Germans, *tanzenden körnchen*, or dancing granules, because of their sprightly

activity. A similar behavior of the granules in the bodies of smaller Desmids, and in the cells of filamentous *Algæ*, is often observable, particularly in unhealthy plants. No satisfactory explanation of these movements has yet been given. To some they appear a mystery, but, are they more mysterious than the circulation of blood in our arteries and veins, or than that of the so-called *cyclosis* in the higher plants? Nearly, if not quite all vegetable germinal matter, displays some spontaneous activity, and it is more than probable that the like characteristic seen in the Desmids, must be ascribed to the same causes whatever they may be.

MULTIPLICATION.

Multiplication among the Desmids takes place by two processes. The one is simply a division and growth, the other is through what may be termed sexual intervention.

The first process is merely a modification of ordinary vegetative growth, that is to say, a peculiar cell multiplication by division. Plate XII, figs. 5, 6, are two semi-cells of a *Docidium*, which have separated by the development of short processes (fig. 7); these, primarily very small, commence their growth from out of the centre of the base of each semi-cell. The figure represents them somewhat advanced; they develop rapidly, and soon become exact counterparts of the original mother-cells, then they separate. Thus two cells are developed from one; the same process is repeated, the two produce four, the four eight, and so on.

Plate XIV, figs. 12, 13, represent a *Cosmarium*, the one the perfect plant, the other in process of division; the ends are the halves of the mother-cell; the parts between, the partially developed forms of the new semi-cells. Plate XVI, fig. 27, represents a similar growth of a denticulate form; the teeth are not apparent until the young parts have attained nearly their full size.

Plate XXXVIII, fig. 8, is a series of four *Micrasterias truncata*, which represent the stages of growth by division; a cell producing two, and the two, four, under the rather unusual circumstance of adherence after division; only a fragment of the series is shown in the figure. Fig. 11 is a similar fragmentary series of adhering cells which must originally have numbered no less than sixty-four. I counted thirty-eight which could not have occurred in a regular process of division.

There are some peculiarities attending the process of multiplication. The new semi-cells are not always exact counterparts of the mother semi-cell. Plate XV, fig. 18, *Cosmarium moniliforme;* here there is an enlargement of the new, central semi-cells, probably developed under more favorable circumstances than the original cell. An impoverished condition is more frequently the result. Plate XXX is a striking illustration of such an instance in *Micrasterias Torreyi.* Fig. 1 is nearest the typical form described by Bailey, the other seven are varieties which occurred by division. I found them variously attached one to the other; one half distinct from the other half, and some so different from the typical form that had they not been mingled with many others they could easily have been mistaken for other species. Did these departures from the normal type continue indefinitely, the original form would soon be lost, but the true type as described nearly forty years ago by Prof. Bailey is preserved to this day. The changes are probably due to an impoverished condition of the plant. This suggests the cause of the second mode of multiplication, viz.:—that by

REGENERATION.

This process is figured to some extent on many of the plates of our illustrations. Plate I, figs. 7–12 show how the separated, floating joints of a *Hyalotheca* are drawn together, and unite by means of a gelatinous tube (fig. 9) into which the contents of the cells gradually empty; the tube enlarges as represented in the figures of the progressive stages (figs. 10, 11) to the perfected *zygospore* (fig. 12). The three circular forms united, are the divided cells or semi-cells.

Plate III, fig. 3, are two cells separated from the filament (fig. 1) drawn together and united by a gelatinous tube mutually protruded; through this the green cellular contents (*Chlorophyl*) of the one, passes out into the other, thus producing the regenerated spore, (fig. 4).

Plate II, fig. 8, is a simpler process; the contents normally separated in each joint, flow together, (fig. 9) and condense; then enlarge (fig. 10) and finally break loose (fig. 11) to produce the new plant. Plate III, figs. 5–9 illustrate another method of reproduction; two cells are drawn together, when they unite (fig. 6) and bind themselves closely until they fuse into one body, (figs. 8, 9).

Plate VIII, fig. 2, is another instance, varying only in form, the two cells in the first stage of conjugation; fig. 3, the developed

zygospore with the empty semi-cells or husks still attached. Figs. 4, 9, 10, 11, 16, are zygospores of various species of *Closterium*. This condition of copulation and developed spores, *zygospores*, or *sporangiums* as often termed, is frequent; the next step or GERMINATION is, if not of rare occurrence, very rarely detected. Dr. de Bary, of Germany, enjoyed a favorable opportunity; he describes the whole process substantially thus—Two cells are drawn together by a conjugal influence which we have no means of detecting; the semi-cells separate, (Plate XXIV, fig. 27) and pour out their contents; those of the one cell unite with those of the other, at first without a distinct investment, but soon the mass acquires a membranous envelope (figs. 28, 29), forms a matrix, or sporangium in which are reproduced new plants possessed of invigorated vitality. The envelope of the matrix or *zygospore* is primarily thin and smooth, but by degrees it acquires increased thickness, and in the *Cosmariums*, usually a granular, tuberculated (fig. 28), or more frequently a spinous surface (fig. 29); the spines being sometimes simple but commonly forked at their extremities. The next step so difficult to be traced is the opening of the wall of the zygospore (fig. 29), setting free small spheres of sarcode; as they issue they enlarge and acquire a gelatinous, or thin membranous wall. The wall thickens and the sphere enlarges (fig. 30), the contents constrict (fig. 31) first in one direction and then transversely to the plane of the first incision (fig. 32); these parts develop and set free two or four new plants in size and form like the mother cell, except in the cytioderm or membrane; this is not granular, but smooth, and so remains until after the multiplication by division takes place. After the first division, the new semi-cells assume the characteristic granular surface; the result of this first division is two plants each composed of one granulated and one smooth semi-cell. The second division will make two perfect cells and two which retain the one smooth semi-cell; the third division produces eight cells, all of which except the original two semi-cells will be of typical form.

Hofmeister's views are somewhat at variance with those of De Bary in regard to numbers; he affirms that the contents of the sporangiums of *Cosmariums* are transformed by repeated binary subdivisions into eight or sixteen cells, which assume the original form, but not full size of the parent, before they are set free by the rupture or diffluence of the wall of the sporangium.

The sporangiums of *Closterium*, *Staurastrum* and of other genera are supposed to germinate in the same manner as *Cosmarium*. Plate

XXIV, fig. 33, is a cluster of *Closteriums* surrounded by a membrane, found by Ralfs; he however questions whether this is a germinating sporangium.

Encysted clusters of Desmids are not necessarily evidence of germination. I have found many such cysts enclosing sometimes only one large specimen, as *Euastrum verrucosum*, but more frequently six or eight smaller Desmids in one cyst; these were at first a source of perplexity. Upon consultation with men and books I found Huxley to say: "Encystment is very common among all the *Ciliata;* and a species of *Amphileptus* has been seen to swallow, or rather envelope a stalked bell-animalcule, and then become encysted upon the stalk of its prey."

Prof. Smith writes with reference to a case of encysted diatomes: "the group of *Navicula* seen, are simply a group that were devoured and their protoplasm digested by an *Amoeba*. They constantly are ejected in this way from the body of the *Amoeba* after the nutriment has been abstracted, and look like an encysted mass with an envelope complete."

This subject of multiplication by regeneration is full of interest for the microscopist, and opens a large and unexplored field.

The frequent variations in outline of form in certain species is calculated to mislead, and perhaps suggest notions of variation of species, but close observation will soon dispel such notions, and prove that they are merely temporary results of exhausted vitality in the process of multiplication by division; they occur most frequently in the latter part of the summer season. After regeneration through copulation, the zygospores become winter resting spores and lie dormant until the following spring, then germinate and reproduce the true counterpart of the original form of the species.

DESMIDS OF THE UNITED STATES.

Order, ZYGOSPOREÆ.

Green or brown *Algæ*, unicellular, either free cells or united into filamentous *fascia*. Sexual propagation takes place by an act of copulation followed by conjugation or *zygose*. Two cells of like appearance are attracted to each other, and unite; the contents of the two cells flow together, commingle, and form a primordial cell called a *zygospore;* this develops a double or triple episporium, or membranous envelope.

In rare cases twin *zygospores* are developed.

Family, CONJUGATÆ.

Cells free, or united into simple series or filaments; no branches and no terminal growth. Contents of cells (*cytioplasm*) *chlorophyllous* green, arranged in parietal bands, axillary lamina, or stellate nuclei.

Sub-Family or Group, DESMIDIEÆ.

Composed of symmetrical cells, usually constricted in the middle, often of beautiful, ornamental forms, single or conjoined into filform series, and sometimes involved in a maternal jelly. Asexual multiplication takes place by transverse division, or separation of the semi-cells, (Plate XIV, fig. 13; Plate XVI, fig. 27); and development of new parts similar to the mother semi-cells.

Copulation takes place between two floating or free cells (Plate XXIV, fig. 27) and produces a *zygospore* with a firm middle membrane, and usually a more delicate inner and outer coating. The *zygospore*, after a longer or shorter period of rest, develops one or more regenerated daughter cells.

Genus, GONATOZYGON, D. By.

Cells long, cylindrical, or truncate spindle form, without constriction, united into fragile, filiform straight series; at maturity they separate and become geniculate, copulate and produce spherical zygospores; these separate quickly from the empty cells.

Two species only have been recognized in this country.

G. ASPERUM, (Ralfs) Rab. Plate I, fig. 1.

Cells long, cylindrical, ten to twenty times as long as wide, very slightly, or not at all reduced in thickness at the ends. Cytioderm fine-granularly roughened.

Diameter 11–12 μ.

Occurs frequently in ponds of New Jersey.

G. PILOSUM, Wolle. Plate I, fig. 2.

Cells twelve to twenty times as long as wide, loosely connected; cytioderm more or less densely clothed with small, straight hairlike spines; cells cylindrical, terminal one of a filament slightly attenuated, end rounded.

Diameter 15 μ.; with spines 25 μ.

Habitat the same as the preceding.

Genus, HYALOTHECA, Ehrb.

Plate I, figs. 3–14.

Cells short, cylindrical, usually with a slight obtuse constriction in the middle; disciform in end view, closely united into long filaments, which are inclosed, each in an ample, colorless mucous sheath. *Chlorophyl* mass in each cell, end view, six to ten radiate.

H. DISILIENS, (Smith) Breb. Plate I, figs. 3, 4, 5.

Filaments elongated, cells slightly contracted in the middle, usually about half as long as broad. Variable in size.

Diameter 20–36 μ.

Frequent in ponds and sluggish, shallow waters. The frequency of this plant soon familiarizes it; usually it is found intermingled with other forms, but sometimes it has entire control of small pools, trenches and outlets of springs. In its younger state it is attached to the muddy bottom, or sticks or stones; but more commonly, it is found in floating masses. The filaments are generally fragile, but sometimes they

occur elongated and strong. When gathered in proper season, and kept in water for a few days, the cells separate at the articulations, and float in free joints, which being nearly square, readily turn over and present the circular end view, with the stellate arrangement of the *chlorophyl*. I have had a quantity in good condition for observing the successive stages of conjugation. The cells separated the same day the collection was made; and soon thereafter copulation of cells commenced. Plate I, figs. 7, 8, are two floating cells, one in front and the other in transverse view; they are drawn to each other by some hidden conjugal influence, put forth a mucous tube and unite as fig. 9, then each cell breaks into two; thus four parts are united; sometimes all present themselves to view, but more commonly only three are visible, as figs. 10 and 11. The *chlorophyl* concentrates to the space between the cells; fig. 10, shows an early stage; fig. 11, a more advanced condition; and fig. 12, the developed *zygospore*. Single matured *zygospores* are frequently noticed in gatherings from waters where the plant prevails.

H. MUCOSA, (Mert) Ralfs. Plate I, fig. 13.

Filaments scarcely fragile; joints not constricted, but having at one of the ends a minute bidentate projection, the adjoining end of the next joint being similar. These projections are visible only in older plants.

Diameter 19–21 μ.

This plant is not so frequent as the preceding, but it appears to be widely distributed, not in masses, but frequently mingled with other filamentous forms. Had it from ponds of Pennsylvania, New Jersey, Vermont, Rhode Island, South Carolina and Florida.

It is easily distinguished from the preceding by its wider mucous sheath, by the straight margin of the cells, by the longer joints and by the central gathering of the *chlorophyl*. The mucous sheath being entirely colorless is not easily discerned except when surrounded by turbid water.

H. UNDULATA, Nord. Plate LIII, fig. 8.

Cells about twice as long as wide, sides concave and angles rounded, closely connected; filaments are involved in a wide colorless gelatinous sheath. The constriction of the cells, and the rounded angles make an undulate margin.

Diameter 9–12 μ, without sheath.

Frequent in ponds of New Jersey, Pennsylvania, etc. There are two forms very nearly allied, this *H. undulata*, and *Sphaerozosma excavatum* (Ralfs,) both about the same thickness and same length of cell, and both in a colorless gelatinous envelope; the only point of separation is in the attachment of the cells; in the *Hyalotheca* the cells adhere by the whole plane of the end, and in the *Sphaerozosma*, they are connected by two sessile glands on the margin. To my mind this distinction is scarcely tenable.

H. DUBIA, Kg. Plate I, fig. 14.

Cells about as long as wide, not constricted, closely united into short fragile filaments, without gelatinous sheath.

Diameter 13–21 μ.

This form occurs now and then in waters of ponds in New Jersey. As the name implies, it holds a somewhat dubious position. It is without the mucous envelope characteristic of the other species and is usually smaller. Fruiting specimens have not been observed.

Reasoning from observations on the life history of an allied genus, *Bambusina*, I venture to suggest that the forms referred to this species, are merely undeveloped conditions of other species.

Genus, BAMBUSINA, Kg.

Plate I, figs. 15–24.

Cells or joints barrel-shaped, surrounded by one or two narrow median bands, closely united into articulate, nodose filaments. Chlorophyl bodies and zygospores as in *Hyalotheca*.

B. BREBISSONII, Kg. (*B. Borreri, Cleve; Didymoprium Borreri, Ralfs.*) Plate I, figs. 15–21.

Cells somewhat longer than broad, hub or barrel-shaped, surrounded in the middle with two narrow bands, and another often visible between these and the ends of the cells.

Diameter 18–25 μ.

Frequent in quiet waters from Maine to Florida and far west. A pond at Pleasant Mills, New Jersey, furnished me with good conditions of development. The lowest traceable stage is represented by fig. 17. A gelatinous sheath enclosing a series of green cells; fig. 18, four cells around which

the envelope is diffusing; these unite, end to end, then widen and produce a form as fig. 19; fig. 20 is somewhat more advanced, showing small notches in the sides; fig. 21, the beginning of the central inflation and the bands; these continue to develop until the perfect plant is produced.

Var. GRACILESCENS, Nord.

Wittrock and Nordstedt have, in their series of *Algæ exsiccata*, No. 367, a small variety under this name. It is very small, but the features are those of the typical plant. It was collected in Brazil. The same small form occurs here; have memorandum of it from Long Wood Pond, and Wood Lake of northern New Jersey.

B. DELICATISSIMA, Wolle. Plate I, figs. 22, 23, 24.

Cells sub-cylindrical, surrounded in the middle by two narrow, thick bands, twice the diameter of the cylindrical body, cells four times as long as wide.

Diameter of body, 6–8 μ.; of bands, 13–17 μ.

Pond, Pleasant Mills, New Jersey.

The characteristic features of this plant are the small size, the cylindrical form of the body, the elevation of the bands which surround it, and the elongated proportion of the body.

Genus, DESMIDIUM, Ag.

Plate II, figs. 1–14; Plate III, figs. 1–4.

Filaments fragile, elongated, triangular or quadrangular, regularly twisted, two chlorophyl masses in each cell barely touching in the middle. Margin of cells incised or entire.

D. CYLINDRICUM, Grev. (*Didymoprium Grevillii, Kg.*) Plate III, figs. 1–4.

Cells about half as long as broad, with a thickened border at their junction, medianly more or less deeply incised; transverse view elliptic, with the angles somewhat drawn out. Filaments surrounded with a mucous sheath.

Zygospore spherical, formed by the conjugation of two cells, the chlorophyl passing through a gelatinous connecting tube from one cell to the other (figs. 3, 4).

Specimens occur frequently in pools and ponds all over the country, rarely unmingled with other forms. It is readily distinguished by its large size, deep incisions of the border, and twisted outline.

D. QUADRATUM, Nord. Plate XLIX, fig. 5.

Differs from the preceding in the cells being nearly as long as broad, and viewed from the side, quadrate. The breadth of the cells is only about one-fifth more than the length; the thickness, the same as the length. Chlorophyl mass in each cell in end view, more or less radiate.

Diameter 45 μ.; length, 33–38 μ.; thickness, 33–38 μ.

Found this form repeatedly during the past four years, but rarely, except in ponds, Brown's Mills, New Jersey. It varies in size from the Norway typical plant, in being considerably larger; otherwise it appears to be identical.

D. LONGATUM, Wolle. Plate XLIX, fig. 6.

Filaments thin; cells in front view nearly twice as long as wide; in side view nearly $2\frac{1}{2}$ times longer than broad; closely united without a thickened border at their junction; end view broadly elliptic.

Diameter, widest part, 28μ.; thickness, 16–18 μ.; length of cell, 35–40 μ.

This interesting new species from Brown's Mills, New Jersey, was found late in the season (September 22, 1883); no gelatinous sheath was observable; the filaments were hyaline except two *chlorophyl nuclei* in each cell.

D. SWARTZII, Ag. Plate II, figs. 1–6.

Filament triangular, with a single longitudinal, waved, dark line, formed by the third angle, (compare figs. 6, 8, 13); joints in front view somewhat quadrangular, broader than long, with two slightly angular crenatures on each lateral margin, united at the whole of their end margins by a thickened border; end view triangular with the chlorophyl three-rayed. Zygospores oval.

Diameter 36 μ., more or less.

Frequent in shallow pools, trenches and the like.

The spores are formed by the flowing together of the two masses of chlorophyl in each cell; the united body assumes a

spherical form; this enlarges, and as it increases in size, forces the sides of the cells apart to more than twice the original diameter (fig. 3); when mature the sides separate and the spores are set free.

D. QUADRANGULATUM, Kg. Plate II, figs. 13, 14.

Filament quadrangular, varying in breadth from its twisting, having two longitudinal waved lines; joints in front view broader than long, with two somewhat rounded crenatures on each lateral margin. End view quadrangular.

Diameter 50–60 μ.

This is a form which prevails in England and on the Continent, but has not yet been found in this country. I insert it from Dr. Wood's contribution in anticipation of yet finding it.

D. APTOGONIUM, Breb. Plate II, figs. 6, 7. Plate XLIX, fig. 7.

Joints in front view, quadrangular, broader than long, with two rounded crenatures on each lateral margin, united at the outer portion only of each end margin by mutual projections, thus producing intervening central oval or oblong foramina.

Diameter 25–38 μ.

Not so frequent as *D. Swartzii*, but it appears to be widely scattered from Pennsylvania and New Jersey as far south as Florida, and probably also northward and westward.

D. BAILEYI, (*Aptogonum Baileyi*, Ralfs). Plate II, figs. 8–12.

Filaments triangular, twisted as the preceding, joints united by each end of the lateral margins only, excavated between the angles as the preceding form; the lateral margins are straight, not bicrenate, a characteristic which separates it from the other species.

Diameter 25 μ., more or less.

Found frequently in sluggish waters, without being confined to any particular State or States.

The process of fruiting is not unlike that of D. Swartzii, the separated portions of chlorophyl (fig. 8) unite and concentrate (fig. 9), then enlarge (fig. 10), press out the sides to more than twice the diameter of a sterile filament, then break apart and set the spores free.

Genus, PHYMATODOCIS, Nord.

Cells closely united in sheathless filaments, not at all or only slightly twisted; cells deeply constricted in the middle, the two semi-cells somewhat twisted, giving the margins an irregular outline; filaments quadrangular with sides longitudinally excavated.

P. NORDSTEDTIANUM, Wolle. Plate XLIX, figs. 1–4.

Cells rectangular, about as long as wide, deeply constricted in the middle, the sinuses somewhat enlarged inwardly and rounded at the base; the sinuses between the cells similar, slightly deeper; end view quadriradiate with wide and deep sinuses between the rays, apices rounded, emarginate; the two semi-cells somewhat twisted so that the end of one ray projects more than that of the other and produces an irregular outline; membrane smooth.

Diameter 37–40 μ.

This new species, hitherto found only in pond at Brown's Mills, New Jersey, differs from the form collected in Brazil, in being one-fourth smaller; in having the lobes or rays in end view straight, not curved to one side, and in having the sinuses of the cells not narrow linear, but somewhat enlarged inwardly and rounded at base.

Genus, SPHAEROZOSMA, Corda.

Plate IV, figs. 1–16.

Cells closely united side to side by a narrow isthmus or by means of glandular processes, deeply incised on each side, thus forming bilobed cells, and often giving a pinnatifid appearance to the fragile filaments.

Filaments often surrounded by a colorless gelatinous envelope.

Brebisson separated the forms which have the cells united without glandular processes with a new genus SPONDYLOSUM. The distinction is hardly tenable. The modes of union, like the gelatinous sheaths, are inconstant, hence should not be made generic or specific characteristics.

This genus differs from the preceding in the *compressed, flat*, not round, triangular nor square filaments, but deeply incised cells, and especially in the frequent presence of the minute gland-like connecting processes.

S. PULCHRUM, Bailey. Plate IV, figs. 1, 2.

Cells twice as broad as long, deeply incised on each side, ends rounded, junction margin straight, filaments twisted, frequently enclosed in a gelatinous envelope.

Diameter 60–82 μ.

Var. PLANUM, Wolle. Plate IV, fig. 3, 4.

Similar to typical form, except in size and in the absence of the twist in the filaments.

Diameter 30–38 μ.

Var. INFLATUM, Wolle. Plate XLIX, fig. 8.

Differs from the preceding in the central inflation, producing a short isthmus between the cells.

Diameter 38 μ.

The typical form appears to be widely scattered throughout many States: Rhode Island, Massachusetts, Pennsylvania, New Jersey, South Carolina and Florida. The variety *planum* I found in a trench aside the Rail Road near Metuchen, N. J. The water was green with the abundance of it. The variety *inflatum* occurs sparsely in ponds of New Jersey.

S. FILIFORME, Rab. Plate IV, figs. 5, 6.

Cells about as long as wide, constricted in the middle with a deep, acute incision; ends of lobes rounded, connected by two sessile glands.

Diameter 12–18 μ.

Pond waters of Pennsylvania and New Jersey.

General appearance very near S. pulchrum variety, but smaller, and length of cells equal to the diameter. Did not observe a gelatinous sheath mentioned by Rabenhorst; Kirchner admits no sheath. Fig. 6 is very near Corda's *S. lamelliferum*.

S. EXCAVATUM, Ralfs. Plate IV, figs. 8, 9, 10–12.

Cells twice as long as broad, with a deep, wide sinus on each side, connected by two small sessile glands.

Diameter 9–12 μ.

Not infrequent in ponds; sometimes it occurs with, and sometimes without, the gelatinous sheath.

S. VERTEBRATUM, (Breb.), Ralfs. Plate IV, fig. 13.

Cells about half as long as broad with a deep narrow constriction, connected in the centre by a simple, rather thick gland; more or less remote. Semi-cells narrow, elliptic, smooth. Filaments twisted, usually surrounded by a mucous sheath.

Diameter 12–14 μ.

Rather rare; the best specimens found were from Splitrock Pond, Sussex Co., New Jersey.

S. SERRATUM, Bailey. Plate IV, fig. 7.

Cells broader than long, deeply notched, or divided into two transverse portions with acute, spinelike projecting ends which give a serrated outline to the chain. Cells closely united by two short glandular processes. Usually surrounded by a wide gelatinous sheath.

Diameter 22–33 μ., including the projections.

Prof. Bailey collected this species in South Carolina, Georgia, and Florida, 1848; it is found frequently in New Jersey, Pennsylvania and other northern States.

According to Wallich this species should be classed with *Onychonema*, a new genus made by him to take in such spinous forms as *S. serratum*.

The glandular processes connecting the cells are sometimes long, nearly equal to the length of a semi-cell; in this condition it approaches very near to *Onychonema laeve*, Nord., a Brazil form. The specimens vary considerably, but they do not seem to admit of separation. The cells are often only slightly inflated, sides nearly straight; the spines, in young condition nearly obsolete, or very small and straight, and the glandular processes sometimes short, barely discernable, and again so long that they lap over the cells.

S. WALLACHII? Jacobsen. Plate IV, fig. 15.

A peculiar form of which I found only two short specimens in pond, Brown's Mills, N. J. They are not identical with the form described by Jacobsen. I record the figures of them provisionally until other specimens may be found to verify a good species.

Diameter 10–12 μ.

S. SPINULOSUM ? Delp. Plate IV, fig. 14.

Another variety of which I found only a single specimen, in a pond, known as Chain Dam, Northampton Co., Pennsylvania. It is not the same, but near Delponte's described form. It needs verification.

Diameter 10 μ.

S. RECTANGULARE, Wolle. Plate XLIX, fig. 9.

Filament wide; cells twice as wide as long, deeply constricted in the middle; semi-cells somewhat tapering near the ends, producing acute-angled sinuses between the cells, and between the semi-cells; ends truncate concave. Membrane smooth.

Diameter 50–55 μ.; thickness 18–20 μ.

This form is recorded with hesitation; it was one of the latest finds in the fall of 1883; the specimens were limited, but appeared to be in good condition, but for so much of a novelty, corroborative specimens are needed.

Genus, MESOTAENIUM, Naeg.

Palmogloea, Kg. Plate III, figs. 5–15.

Cells straight, short cylindrical, or oval, ends rounded, not constricted in the middle. *Chlorophyl lamina* axillary, sometimes divided in the middle.

Copulation takes place by two cells uniting side by side, the contents flowing together.

Kirchner remarks that copulation in this genus is a simple union of two cells, leaving no husks or remains of empty cells; (compare figs. 5–9). This process accords with my observations, but Wood illustrates another mode transferred in figs. 13–15, in which the contents of the cells flow together and are surrounded by a new membrane; in this case the remains of the old cells are present.

These plants occur frequently in small pools, on dripping rocks, damp walls, wet ground and the like; sometimes singly but more frequently associated in families in a gelatinous mucus.

M. BRAUNII, D. By. (*Palmogloea macrococca*, Kg.) Plate III, figs. 5–9.

Cells cylindrical, 2–2½ times longer than wide, ends flatly

rounded. Zygospore square, angles rounded, sides usually somewhat concave.

Diameter 16–19 μ.

Found floating, in families, in gelatinous scum, mountain pools.

M. MICROCOCCUM, Kg. Plate III, fig. 10.

Cells oval or elliptical, about twice as long as wide, ends sometimes slightly narrowed and rounded.

Diameter 6–11 μ.

Usually in gelatinous masses on old wet wood, timbers of sluices, etc.

M. ENDLICHERIANUM, Naeg. Plate III, fig. 11.

Cells cylindrical, 3–4 times as long as wide, ends bluntly rounded.

Diameter 9–11 μ.

Occasionally intermingled with filamentous forms, in gelatinous gatherings.

M. CLEPSYDRA, Wood. Plate III, figs. 12–15.

Living on rocks and mosses, swimming in a transparent, sometimes light-green jelly; cells obtusely truncated, rounded at the ends, 2–3 times longer than broad; *chlorophyl lamina* axillary, mostly indistinct, often wanting; *endochrome* light green; nucleus generally distinct; *zygospores subfuscous*, either globose or of an irregular form, somewhat resembling that of an hour-glass; external coat irregularly excavated and sulcate.

Diameter given by the author is $\frac{13}{7500}''$, this would be .00173 = 43 μ. Evidently an error, the plant cannot be so large.

The author adds, "This species was found near Chelten Hills, growing amid mosses on the rocky juttings over which the water was dripping. It occurs as a rather firm, transparent jelly, mostly of a light greenish tint in which the cells are often placed quite thickly.

Genus, SPIROTAENIA, Breb.

Plate III, figs. 16–22.

Cells straight fusiform, single or aggregated in a gelatinous mucus; not constricted in the middle, ends round. *Chlorophyl* arranged in one or more spiral *laminæ* on the inner surface of the wall.

S. CONDENSATA, Breb. Plate III, figs. 21, 22.

Fusiform, or cigar-shaped, ends rounded, eight to ten times as long as broad, with a single, broad, closely wound chlorophyl spiral band, its revolutions numerous.

Diameter 18–25 μ.

Found in meadow pools, ponds, etc. Has been collected in many States of the Union, from New York and New Jersey, south to Florida, and westward to Minnesota.

S. OBSCURA, Ralfs. Plate III, figs. 16–19.

Fusiform, deep green, five to eight times longer than broad, ends attenuated, apices rounded. Chlorophyl arranged in a number of narrow spiral, parietal, bands.

Diameter 8–15 μ.

The locality in which this species occurred most frequently to me, was in small pools aside streamlets on the open slope of our mountain sides, but found it also in New Jersey. European specimens are quoted as large as 30 μ. in diameter. I have found none so large.

S. BRYOPHILA, (Breb) Rab. (*S. muscicola*, D. By). Plate III, fig. 20.

Cells cylindrical, two to four times as long as broad, ends obtusely rounded, chlorophyl a single, broad, smoothly defined, widely wound spiral band; its revolutions one or two.

Diameter 8 μ.

Dr. Wood reports this species, measure and form, from near Philadelphia, growing among some masses which were kept constantly wet by overhanging dripping rocks. It formed little transparent masses of almost colorless jelly, looking like little drops of dew.

Genus, PENIUM, Breb.

(Netrium, Naeg. Cylindrocystis Menegh.)

Plate V, figs. 1–22.

Cells straight cylindrical or fusiform, not incised nor constricted in the middle; ends more or less obtusely rounded. *Chlorophyl lamina* axillary; when seen transversely, radiately divergent, arms often forked, and containing starch granules.

Individuals swim free, scattered, or associated in gelatinous masses; cell membranes smooth or finely granulate, transparent or fuscous, or reddish, often longitudinally striate.

Multiplication takes place by division, and by zygospores developed by the copulation of two cells. Comp. Introduction.

P. DIGITUS, (Ehrb.) Breb. Plate V, figs. 1, 2. Plate LIII, fig. 1.

Cells ovately cylindrical, or broadly elliptical, 3–5 times longer than broad, each end subtruncately rounded, (Plate LIII, fig. 1). *Chlorophyl lamina* lobate in the periphery, interrupted in the middle. Plate V, fig. 1, is a variety, more elliptic than the typical form. Fig. 2 is a transverse section.

Diameter 60–80 μ.

This species appears to be widely distributed from Maine to Florida and westward.

P. LAMELLOSUM, Breb. Plate V, fig. 4.

Cells oblong or fusiform cylindrical, often with a slight depression in the middle, more or less attenuated towards the obtusely rounded ends. Arrangement of chlorophyl usually somewhat like the last, but not separated in the middle.

Diameter 55–80 μ.

Not so common as the preceding.

P. OBLONGUM, D. By. Plate V, fig. 17.

Cells oblong cylindrical, 3–4 times as long as wide, not constricted in the middle, slightly tapering towards the ends; aspices flatly rounded. Zygospore spherical, not unlike fig. 7.

I find this form mostly in fresh spring water, in gelatinous gatherings.

P. MARGARITACEUM, Breb. Plate V, figs. 5, 6, 11.

Cylindrical, usually 8–9 times longer than broad, rarely, only twice as long; not at all, or scarcely constricted in the middle; ends rounded, ornate with pearly granules arranged in longitudinal series which often give a denticulate appearance to the margin.

Diameter 24–28 μ.; length ordinarily about 225 μ. I have had specimens measuring 375 μ.

Prevails over a wide range. I have it from Vermont, Connecticut, and almost every State southward to Florida, also from the west to Minnesota.

It varies somewhat in size, but is easily recognized by the arrangement of the granules.

P. INTERRUPTUM, Breb. Plate V, figs. 14, 15.

Broad cylindrical, not constricted, 5–6 times as long as wide, suddenly tapering, cuneate near the ends, apices rounded. Chlorophyl deep green, in matured plants interrupted by three transverse pale bands; cytioderm smooth.

Diameter 38–44 μ., rarely only 16–20 μ.

Habitat the same as the preceding, rather more frequent; readily distinguished by its transverse bands and cuneate ends.

P. CLOSTERIOIDES, Ralfs. Plate V, fig. 18.

Cells narrowly lanceolate, 5–6 times longer than the greatest diameter; sensibly attenuated from the middle to the rounded apices. Chlorophyl contents interrupted in the centre.

Diameter 40–44 μ.

Ponds, New Jersey and Pennsylvania.

In its general appearance and in the arrangement of the chlorophyl, this plant has a strong resemblance to a Closterium, but varies in being always straight and having the opposite margins symmetrical.

P. TRUNCATUM, Ralfs. Plate V, figs. 9, 10, 21, 22.

Cylindrical, not constricted, 3–4 times longer than wide, ends truncate, square. Zygospores smooth, spherical.

Diameter 11–12 μ.

Ponds, northern counties of New Jersey. The chlorophyl is usually more or less interrupted in the middle, producing a pale transverse band; membrane smooth or finely punctate.

P. MINUTUM, Cleve. Plate V, figs. 19, 20.

Slender, cells 4–6 times longer than broad, sides straight, ends rounded, without inflation, and without punctures.

Diameter 11–15 μ.

This small form, perhaps more properly a *Calocylindrus*, (Plate XII, fig. 12), has not come under my notice. It is

reported by Bailey and Olney, from Florida and from Rhode Island. The measures are taken from Rabenh. Fl. Alg. The figure in Ralfs Br. Desmids, and referred to as belonging to this species is certainly distinct and is a *Docidium*.

P. POLYMORPHUM, Perty. Plate V, fig. 12.

Sub-cylindrical, smooth, various sizes usually intermingled in larger families; 3–4 times longer than broad, ends more or less attenuated, apices rounded; cytioderm somewhat longitudinally striated.

Diameter 11–15 μ.

Pools, or wet earth, Charlotte, Vermont. Collected by F. Hosford.

P. BREBISSONII, (Menegh), Ralfs. Plate V, figs. 7, 8.

Cells smooth, cylindrical with rounded ends, transverse central band inconspicuous; conjugating cells persistent.

Diameter 16–17 μ.

Usually congregated in a mucous stratum in small pools and wet grounds, Princeton, New Jersey (Bailey) and other localities in the State. The plant mentioned by Wood appears to be nearer *Closterium obtusum*, Breb.

P. NAVICULA, Breb. Plate V, fig. 16.

Small, broadly fusiform, 4–5 times longer than broad, tapering from the centre to the rounded apices. Chlorophyl lamina entire; cytioderm smooth.

Diameter 12–17 μ.

Zygospores are said to be nearly square, somewhat drawn out between the attached remains of the copulating cells. The plant occurs frequently in trenches and small ponds of Pennsylvania and New Jersey; the fruiting cells, or zygospores have not come under my personal observation.

P. JENNERI, Ralfs.

Smooth, cylindrical with rounded ends, zygospores orbicular, situated between the conjugating cells which are deciduous.

Diameter 14–15 μ.

I have not recognized this form. Bailey reports it from Florida. Rabenhorst describes it as scarcely distinguishable from P. Brebissonii; 2½–5 times longer than broad; zygospores mostly globose, membrane somewhat fuscous, sub-granulate.

P. CRASSA, D.By. Plate V, fig. 3.

Cells short, ovate-cylindrical, 1½–2 times as long as wide, chlorophyl not separated, but concentrated into two or more nuclei in each cell.

Diameter 25–29 μ.

Collected by E. S. Cheeseman, Knowlesville, New York, in gelatinous mucus in an aquarium.

P. RUPESTRE, Kg. Plate V, fig. 13.

Cells ovate elliptical, length about two diameters; apices rounded.

Diameter 20–25 μ.

Rabenhorst unites the preceding with this form. They are very near in size, but not the same in shape, the one is more cylindrical and the other inclines more to an ellipse in form. Collected in a mucous gathering on dripping rocks.

P. CLEVEI, Lund. Plate L, fig. 27.

See Calocylindrus.

Genus, CLOSTERIUM, Nitsch.

Cells simple, elongated, lunately curved or crescent-shaped, entire, in the centre not constricted but frequently marked with from 1–5 transverse striae; the cytioderm or wall, thin, moderately firm, smooth or more or less distinctly striate.

The chlorophyllous cytioplasm is mostly arranged in longitudinal parietal laminæ, broken in the middle by a pale transverse band; at each end there is usually a clear, circular, colorless or straw-colored vesicle, or *vacuole*, which contains minute granules in constant motion. As the specimen dries the "dancing granules" disappear, and the vesicle vanishes. Compare Introduction, page 16.

A distinct circulation of granules may be noticed in good living specimens.

The Closterium in normal condition is always green, but may be found of various tints of reddish brown; these changes of color take place as life becomes extinct. The striated forms have a firm cytioderm and retain their outline when dry or empty; others, not striated are more flexible and collapse when dried. The chlorophyl escapes by a slight separation of the semi-cells, and leaves the case colorless.

Faded specimens of the striated forms are best adapted for examination; the striae, barely discernable in green condition, become distinct; the cases flatten somewhat in drying, the breadth in the centre increases and the ends appear more attenuated, hence some allowance should be made in describing them.

Conjugation takes place by a process which appears the same as in other *conjugatæ*. Two cells drawn into close proximity, put forth small tubular prominences by which they unite, the chlorophyllous cytioplasm of the two cells, concentrates at their junction, in the connecting tube; this enlarges more and more until the whole of the contents of the two cells are commingled, and condensed into a seed-like mass. This becomes smooth, spherical, sometimes quadrangular, and is known as the zygospore. Compare Plate VIII. The coupling usually takes place from the concave sides, but not universally; have found them united from the convex sides also.

SECTION 1.—Cells more or less cylindrical, slightly bent, ends scarcely, or not at all tapering; zygospores orbicular or square.

C. OBTUSUM, Breb. Plate VI, fig. 1.

Cylindrical, lightly curved, 5–10 times longer than broad, ends not tapering, broadly rounded, cytioderm colorless and smooth.

Diameter 5–11 μ.

Often in gelatinous masses on planks, on the sides of flumes, Pennsylvania.

C. JUNCIDUM, Ralfs. Plate VI, figs. 2, 3.

Cells long cylindrical, somewhat curved and tapering towards the ends; 20–30 times longer than broad, apices obtusely rounded; vacuole small and indistinct.

Diameter 11–12 μ.

Variable in thickness and length; occurs frequently in ponds from Maine to Florida.

C. MACILENTUM, Breb. Plate VI, fig. 6.

Very long cylindrical, slightly curved and reduced in thickness near the ends, apices rounded; 20–40 times longer than the diameter. Cytioderm smooth, colorless, or yellowish, usually with 1–4 transverse striae. Zygospore spherical, smooth.

Diameter 12–13 μ.

Ponds, Pennsylvania, New Jersey. Not rare.

C. GRACILE, Breb. Plate VI, figs. 4, 5.

Long cylindrical, 20–30 times as long as broad, nearly straight, ends somewhat curved and slightly reduced in thickness; cytioderm smooth and colorless. Zygospores according to Brebisson quadrangular, with rounded angles each of which bears a short spine.

Diameter 5–6 μ.; zygospore 28–30 μ. long; 22 μ. broad.

Not infrequently intermingled with other desmids from ponds, New Jersey, Pennsylvania, etc.

C. LANCEOLATUM, Kg. (C. tenue, Bailey). Plate VIII, fig. 14.

Cells semi-lanceolate, 6–10 times longer than broad, gradually tapering, ends subacute, chlorophyl fillets several; larger granules in a single series. Empty frond colorless and destitute of striae.

Diameter 50–55 μ.

Pools, Florida; New York, (Bailey).

Stouter and proportionately shorter than *C. acerosum*.

C. DIDYMOTOCUM, Corda. Plate VIII, figs. 12, 13.

Broad cylindrical, slightly curved, 6–12 times longer than broad, slightly tapering towards the ends which are broadly truncate, square; vacuole distinct containing many "dancing granules;" cytioderm yellowish, finely longitudinally striate.

Diameter 30–32 μ.

Not abundant, but turns up now and then with other forms, in smaller ponds of Pennsylvania and New Jersey.

C. DECUSSATUM, Kg. Plate VI, figs. 9, 10.

Cylindrical, curvature scarcely appreciable; 7–12 times longer than broad; very slightly tapering near the obtusely rounded ends, cytioderm distinctly decussately striate.

Diameter 20–25–30 μ.

Frequent in ponds, Mt. Everett, Massachusetts, August 1882, and ponds northern part of New Jersey. Kützing of Germany appears to have been the only individual who observed this species. He sent a drawing to Ralfs, but he questioned the correctness of his friend's vision; he remarks, "Prof. Kützing represents the striae as regularly crossing each other, so as to form diamond-shaped reticulations. As this appearance is not unusual in dried specimens, when the

flattened cell permits the striae of both surfaces to be visible together; I will venture to suggest the possibility that Prof. Kützing's drawing may have been taken from a cell in that condition."

The correctness of Kützing's observations is readily established by an examination of the plants as found in Gilder and other ponds on Mt. Everett. They are cylindrical and may be rolled over to display the decussated striae on every side alike.

C. ANGUSTATUM, Kg. Plate VI, figs. 21, 22, 23.

Cells sublinear, 16–18 times longer than wide, very slightly attenuated; ends obtusely rounded. Cells present 4–5 somewhat prominent longitudinal striae; 2 or 3 transverse bands or striae are also frequently distinct; vacuole subremote from the apex, small. Dried specimens brownish yellow.

A variety is frequent with the striae loosely crossing each other, decussately.

Diameter 15–25 μ.

Ponds, Berkshire Mountains, Mass.

SECTION II.—Cells slightly bent, the back (dorsum) more or less convex, the opposite (ventral) side almost straight, distinctly attenuated from the middle to the ends. Zygospore globular, smooth.

C. LUNULA, Ehrb. Plate I, fig. 26.

Cells large, semilunar, 5–6 times longer than broad, smooth, or very finely striate, indistinct, back high convex, lower side straightish, ends attenuated, rounded. Chlorophyl globules numerous; vacuole usually distinct and contains many actively moving granules.

Diameter 80–110 μ.

Frequent in small ponds.

The figure is not a good typical form. It should not be curved so much at the end.

C. CUCUMIS, Ehrb. Plate VI, figs. 17, 18.

Cells smooth, stout, semilunate; ends broadly rounded.

Ehrenberg's figure represents this species about five times longer than broad; in form somewhat resembling *C. Lunula*, not so large, and lower side more concave. Ehrenberg collected it in the State of New York. The figures are from plants found in New Jersey and Pennsylvania. They are evidently closely allied to *C. Lunula*.

C. ACEROSUM, (Schrank) Ehrb. Plate VI, figs. 7, 11.

Linear fusiform, or slightly curved, 15–24 times longer than wide, lightly tapering towards the ends; apices narrowly truncate, or obtusely rounded, transparent or yellowish; cytioderm rather indistinctly, or not at all striate. Chlorophyl globules 11–14 arranged in a simple axillary series in each semi-cell; vacuole small with numerous corpuscles. Zygospore globose.

Diameter variable, 35–62 μ.

One of our most common species, often forming gelatinous floating masses on small ponds and pools. I have it from many States, and probably it exists in every one.

The entire chlorophyl of this species often retracts itself from the cell-wall and breaks up into a number of oval or globular forms, every one of which acquires a firm envelope. Plate VIII, fig. 17, represents one of these forms.

C. NASUTUM, Nord. Plate VI, fig. 12.

Large, fusiform, only slightly curved, about five times as long as wide, gradually tapering from the middle to near the ends, then suddenly contracting, making the sides parallel, to the truncate or rounded apex. Cytioderm smooth.

Diameter 75 μ. more or less.

Ponds, Berkshire Mountains, Massachusetts.

The only counterpart to this form, hitherto found, is from Brazil, and is represented in Witt. and Nord's *Algæ Exsiccatæ*, No. 366.

C. TURGIDUM, Ehrb. Plate VI, fig. 15.

Dorsum convex, lower margin somewhat concave, inclining upward at the rounded ends; upper margin with a depression near each extremity; empty cells reddish brown, striæ numerous, fine but distinct.

Diameter 64–75 μ.

Wet, marshy places, Pennsylvania.

C. ATTENUATUM, Ehrb. Plate VIII, fig. 5.

Somewhat curved, attenuated, suddenly contracted at the end into a narrow conical point; empty frond reddish, faintly striated.

Diameter 34–42 μ.

I quote this diagnosis from Ralfs' Br. Desmids; think we ought to find, but am not satisfied that I had a genuine species.

C. STRIGOSUM, Ehrb. Plate VI, figs. 13, 14; and Plate LIII, figs. 9, 10.

Long fusiform, at the ends somewhat bent, 19–24 times as long as broad, slightly tapering from the middle to the thin, finely rounded apices. Vacuole small and indistinct. Cytioderm colorless, smooth.

Diameter 10–16 μ.

Pond waters, Pennsylvania and New Jersey. Plate LIII, figs. 9, 10, represent a fruiting form, collected in abundance near Ocean Beach, July, '83. In form near *C. parvulum* but proportionately so much longer than that species, I take it for a variety of *C. strigosum*. Diameter of cells 10 μ. length 200 μ.; twenty times longer than wide.

SECTION III.—Cells more or less falcate; dorsum and ventral margins both convex, arched in the same direction, ends tapering. ♀ A. forms slightly curved; ♀ B. forms strongly curved, sometimes almost semi-circular.

C. STRIOLATUM, Ehrb. Plate VI, figs. 8, 20.

Cells slightly bent, 8–16 times longer than broad, ends reduced to about one-fourth the largest diameter, apex obtusely rounded. Vacuole full size, containing many active granules. Cytioderm of older forms, reddish brown, distinctly striate. Zygospore orbicular, smooth.

Diameter 30–48 μ.

Frequent in shallow pools.

I find three varieties, the one 6–8 times longer than broad (Plate VI, fig. 8); another 10–15 (Plate VI, fig. 20); and the third only 4–5 times longer than broad. They may be recognized as varieties, *intermedium*, Ralfs; *elongatum*, Rab.; and *tumidum*, Rab. The latter is very near Nord's. *subcostatum*. The variety *elongatum* is more slender and more delicately striate than the others.

C. COSTATUM, Corda. Plate VI, fig. 19.

Fusiform, more or less curved, 6–8 diameters in length, ends rounded; tapering from the middle to about one-third the largest diameter; vacuole large, containing many dancing granules. Membrane in front view has 5, or rarely 6–8 longitudinal striae or costae. Zygospores spherical or ovate.

Diameter 63–70 μ.

Frequent in marsh pools and the like localities.

C. LINEATUM, Ehrb. Plate VI, fig. 16.

Long, straight and cylindrical in the centre, ends greatly attenuated and slightly incurved, apices obtusely rounded, distinctly striate; chlorophyl globules, about twenty in each semi-cell, placed in a single axillary series; vacuoles small, remote from the apices.

Diameter 24–36 μ.

Pennsylvania, New Jersey, and probably every State.

C. DECORUM, Breb. Plate VII, fig. 1.

Moderately arched, 12–16 diameters in length, gradually tapering from the centre to one-fourth or one-fifth of largest diameter; ends rounded; vacuole small. Cytioderm finely striate. Zygospores angular in European specimens.

Diameter 34–41 μ.

Occurs occasionally in sluggish waters, Pennsylvania and New Jersey. This form is separated from *C. striolatum*, mainly by the larger number of striae; the one has 12–15 and the other 20–30.

C. AREOLATUM, Wood. Plate VII, figs. 3, 4.

Fusiform, straightish, or very slightly curved, the ventral side often a little concave in the middle; 9–10 times longer than broad, moderately attenuated at each end; the apices truncately rounded; cell-membrane reddish brown, thick and firm, distantly profoundly striate, and very minutely but distinctly granulate or areolate; midian sutures very distinct, 4–10 in number.

Diameter 60 μ.

Dr. Wood remarks: "I found this species growing in a quiet pool of pure water, in a wild, deeply wooded ravine, near Danville, Central Pennsylvania. It was in great abundance, forming a translucent greenish jelly, one or two gills of which might have been readily gathered." "This species is very closely allied to *C. turgidum*, Ehrb., agreeing pretty well with it in general outline and size. I think, however, the peculiar markings upon the membrane are sufficient to separate it." "The turning up of the ends, generally so marked in *C. turgidum* is mostly entirely absent in this species, rarely there is some tendency to it."

C. AMBLYONEMA, Ehrb.

A form bearing this name was accredited to the United States by Dr. Ehrenberg. Prof. Bailey, about thirty years since, examined the character of the plant, and pronounced it the same as *C. lineatum*.

C. ACUTUM, Breb. Plate VII, figs. 11, 12.

Small, slightly bent, 6–12 times longer than broad, gently tapering from the middle to the rounded ends; cytioderm colorless and smooth. Zygospores angular.

Diameter 9–11 μ.

Not rare in marsh pools, Pennsylvania and New Jersey.

C. DIANÆ, Ehrb. Plate VII, figs. 8, 9. Plate VIII, fig. 4.

Crescent shape, sometimes a full semi-circle as variety *arcuatum*, Breb., attenuated from the middle to the rather sharp ends, vacuole not definitely defined; transverse striae sometimes evident. Ends are separated by about 10 diameters. Zygospore spherical, smooth.

Diameter 16–20 μ.

Quiet waters Rhode Island to Florida.

C. ACUMINATUM, Kg. Plate VII, figs. 18, 19.

Similar to *Dianæ*, somewhat larger and less curved, ends sharper, vacuoles more distinct; membrane very finely striate, or smooth.

Diameter 25–28 μ.

Not rare in marsh pools; conjugated cells frequent. Pennsylvania.

C. JENNERI, Ralfs. Plate VII, fig. 5.

Crescent shaped, small, slightly tapering, six to eight times longer than broad, ends obtusely rounded; vacuole large containing many active granules; cytioderm colorless, smooth.

Diameter about 14 μ.

Rhode Island (Bailey); Pennsylvania, New Jersey.

C. VENUS, Kg. Plate VII, fig. 6.

Small, more or less slender, nearly semi-circular, eight to twelve times longer than the diameter; gradually tapering

from the middle to the sharp ends; vacuole distinct; cytioderm colorless and smooth; chlorophyl homogenous.

Diameter 8–10 μ.

South Carolina, (Ravenel); Pennsylvania, New Jersey, frequent.

C. PARVULUM, Naeg. Plate VII, fig. 7; and Plate VIII, fig. 16.

Six to eight times as long as wide; differs from *C. Venus* in being rather less arched and stouter, vacuoles not so well defined, and chlorophyl lamina more evident.

Diameter 12 μ.

SECTION III.—Cells falcate as the preceding; upper margin very convex, lower side concave with a more or less conspicuous central inflation, ends tapering. Zygospores spherical, smooth.

C. EHRENBERGII, Menegh. Plate VII, fig. 16.

Large, stout, five to six times as long as the central diameter; upper margin very convex, lower side ventricosely much inflated; ends rounded; cytioplasm with large granules, numerous, scattered; no striae, and no central suture evident. Of the zygospore, Archer says, "it is smooth, placed between the slightly connected empty conjugating fronds, the endochrome during the process of conjugation emerging from the opened apex of a short conical extension from the under side of each younger segment (or shorter one) of each pair of recently divided fronds; the conjugating fronds being produced immediately previously by the self-division of a pair of old fronds —two sporangia (zygospores) being thus the ultimate produce of the two original fronds."

Diameter 75–110 μ.

Ponds, Pennsylvania and New Jersey; common.

Var. IMMANE, Wolle. Plate VII, fig. 17, similar to the typical form except in size.

Diameter 208 μ.

Not infrequent in Budd's lake, and larger ponds of New Jersey.

C. MONILIFERUM, Ehrb. Plate VII, fig. 16.

Very near *C. Ehrenbergii*, but somewhat smaller, six to nine times longer than broad, ends subacute; cytioderm light

straw-colored, smooth or finely striate; large chlorophyllous granules in a single longitudinal series in the centre of the cell.

Diameter 46–55 μ.

There appear to be two varieties of this species; one with rather broad truncately rounded ends; the other, smaller with more pointed ends.

Georgia; Rhode Island; (Bailey). Pennsylvania and New Jersey; occurs frequently.

C. LEIBLEINII, Kg. Plate VII, figs. 13 and 20.

In outline bears a strong resemblance to the two preceding, but is shorter, stouter, upper margin more convex and ends more acute; lower margin concave with a central inflation.

Diameter 40–60 μ.

Found in ponds with the two preceding.

C. RALFSII, Breb. Plate VII, fig. 10.

Stout, finely and densely striated, curved, rapidly attenuated into somewhat linear beaks which are shorter than the ventricose body; 6–8 times longer than broad.

Diameter 42–47 μ.

Pond near Perth Amboy, New Jersey.

Color of this species changes from green to a yellow brown; the upper margin is convex, the lower concave but ventricose at the centre; chlorophyl vesicles rather irregularly disposed in a single row; a transverse suture is usually evident in the middle.

SECTION IV.—Cells more or less curved, ventral margin also somewhat inflated, but the ends drawn out into beak or seta-like extensions. Zygospores angular.

C. ROSTRATUM, Ehrb. Plate VIII, figs. 1, 2, 3.

Lanceolate-fusiform, ends thin, drawn out to nearly half the length of the body; cytioderm light yellowish, densely but finely striate; chlorophyllous vesicles and vacuoles usually indistinct; the latter when seen has 12–15 actively moving corpuscles.

Diameter 23–40 μ.

Frequent in ponds, Pennsylvania, New Jersey, Vermont, Connecticut, Florida.

In this vicinity, Bethlehem, Pa., copulating specimens are of common occurrence.

C. KUETZINGII, Breb. Plate VIII, fig. 8.

Straight in the middle, smaller than the last, narrow lanceolate, each extremity tapering into a long slender setaeous beak which is curved at the obtuse ends, and less than the length of the body.

Diameter in middle 17 μ.

Rather rare in ponds, Pennsylvania and New Jersey.

C. SETACEUM, Ehrb. Plate VIII, figs. 6, 7, 9, 10, 11.

Very slender. Smaller than the preceding; 20–25 times longer than broad, upper and lower margins equally convex; ends tapering into long seta-like beaks, colorless, somewhat enlarged at extremities, longer than the length of the body; striae close, faint, central suture solitary. Zygospore cruciform.

Diameter 10–11 μ.

Frequent in Pennsylvania, New Jersey, Massachusetts, etc. Solitary and conjugating. Bailey reports it from Rhode Island, Georgia and Florida.

Genus, DOCIDIUM, Breb.

Cells straight, cylindrical or fusiform, elongated, apices rounded, truncated or divided; transverse view circular; constricted at the middle, with or without a suture between the semi-cells which are usually inflated at the base.

Docidium, like Closterium, has in most instances terminal vacuoles which contain numerous "dancing granules." The presence or absence of these vacuoles, and the arrangement of the chlorophyllous cytioplasm, whether parietal or axillary, have been made points for generic separation between otherwise similar forms. These distinctions seeming too uncertain and variable in different stages of growth, I put them all together, and retain DOCIDIUM in preference to *Pleurotaenium*, as the older name.

D. CRENULATUM, (Ehrb.) Rab. (*Pleurotaenium nodulosum*. D. By. *Docidium nodulosum*, Ralfs.) Plate IX, fig. 1.

Cell very stout, the thickened sutures forming a projecting rim; 8–16 times longer than broad, scarcely attenuated; regularly inflated at intervals so as to form an undulated margin;

the basal inflation the most prominent; ends suddenly contracted and truncated; cytioderm coarsely punctate.

Diameter 40–60 μ.

Frequent in ponds from Vermont to Florida.

D. CLAVATUM, (Kg.,) D. By. Plate IX, fig. 8.

More slender than the last, suture not prominent, 16–24 times longer than broad, sensibly enlarged at the ends, more or less clavate; apices broadly rounded or truncate; cytioderm firm, colorless, densely and irregularly punctate.

Diameter, smaller forms 23–25 μ., larger forms 36–42 μ. Figure 8 has not the proportionate length.

Pennsylvania, New Jersey, South Carolina and Georgia.

D. TRABECULA, (Ehrb.,) Naeg. (*Docidium Ehrenbergii*, Ralfs). Plate IX, figs. 2, 3, 4; and Plate XI, figs. 1–7.

Long cylindrical, eight to twenty times longer than broad; tapering moderately from the centre to the ends; apices truncately rounded, not dentate; suture forming a sharply defined rim, the inflation adjoining often having a smaller one above it. Sometimes there is a contraction near the apex (fig. 2). Cytioderm smooth. Zygospore globose, smooth, surrounded by a colorless gelatinous envelope.

Diameter 25–35 μ. Length 180–450 μ.

Occurs frequently, and will probably be found in every State of the Union.

D. TRUNCATUM, Breb. Plate IX, figs. 6, 7.

Cells stout, six to eight times longer than broad, with a single inflation at the base of the semi-cell, tapering to the truncate, or broadly rounded, entire, ends; suture forms a thick rim which projects on each side.

Diameter 50–75 μ.

Florida, Minnesota, Pennsylvania.

Peculiarities of this species are the large diameter and shortness of cells in comparison with the breadth; the attenuated ends, truncate, or broadly rounded apices, solitary inflation at the base of the semi-cells and consequent even sides. Florida furnished the best developed forms.

D. FLOTOWII ? Rab. A variety. Plate IX, fig. 5.

Large, about eight times longer than the larger diameter; suture distinct; solitary inflation at base of semi-cells; sides straight, tapering slightly in straight lines from the centre to the broad truncate apex, each angle furnished with a prominent tooth; cytioderm firm, coarsely verrucose.

Diameter at base of semi-cell 68 μ.; at apex 50 μ.

From pond on Mt. Everett, Massachusetts. A large, firm and distinct form; not identical with the described plant, but it is tolerably near it.

D. BACULUM (Breb.,) D. By. Plate XI, figs. 3, 4.

Rather long, cylindrical, straightish margins slightly tapering towards the ends, or nearly parallel; apices truncate, rounded. Cytioderm smooth and colorless.

Diameter 14–22 μ.

In general form very near *D. Trabeculum*, but smaller and devoid of the terminal vacuoles.

Ponds, Pennsylvania, New Jersey and Florida. Bailey found it also in Georgia.

D. CORONATUM, Rab. Plate XI, figs. 9, 10.

Cells stout, cylindrical, slightly tapering from middle to ends; suture projecting on each side; semi-cells inflated at the base and bordered by one or two rows of tubercles at the apex, which produce a crenulate appearance.

A smaller form has the suture imperfectly developed. Vacuoles, with active granules, are usually large and distinct.

Diameter 22–56 μ.

Ponds, Pennsylvania, New Jersey, Massachusetts.

D. CORONULATUM, Grun. Plate LIII, fig. 16.

Smooth or finely punctate, subcylindrical, slightly attenuated near the ends; apices truncate, ornate with a crown of pearly teeth. Twelve times as long as broad.

Diameter in middle 38 μ. Near the ends 33 μ.

The original form of this species was found in the East Indies; the plant was somewhat thicker, but of about the same proportionate length, and so near otherwise, I adopt the name. Collected it in northern New Jersey; found

the finest specimens in Green Pond, commonly several united; had as many as ten cells in a series. They are without a suture, and apparently without vacuoles.

D. CONSTRICTUM, Bail. Plate XI, fig. 2.

Cells with moderately deep constrictions, which separate four equal, gently curving prominences on each semi-cell; end view entire. Apex furnished with a few conspicuous teeth of which four are ordinarily in view. Plant 10–12 times longer than broad.

Diameter 40–50 μ.

This species bears some similarity to *D. nodosum* in its wavy margins, but the undulations are less prominent, and the transverse sections are quite distinct, in the one they are circular in the other undulate; compare Plate XI, fig. 11, sections of *D. nodosum*.

D. NODOSUM, Bail. Plate XI, figs. 11, 12, and Plate XII, fig. 20.

Semi-cells with four prominent nodes separated by constrictions; end view six crenate, formed by whorls of tubercles; 8–10 times longer than broad.

Diameter 45–55 μ. in centre; ends about half as thick.

Frequent in ponds, Pennsylvania, New Jersey, Massachusetts.

D. REPANDUM, Wolle. Plate XI, fig. 1.

Smooth or punctate, about twenty times longer than broad, margins repand or undulate from the base of the semi-cell to near the end; only slight variation in diameter from base to end; apices truncately rounded, and sometimes slightly dilated. No suture.

Diameter 25 μ.

Sparsely found in Pennsylvania and New Jersey.

D. DILATATUM, (Cleve) Lund. Plate L, fig. 32.

Cells slender, cylindrical, 15–20 times longer than broad, undulate-nodose; base moderately inflated and longitudinally plicate; no suture evident; semi-cells usually with eight inflations and corresponding constrictions; apices roundly truncate and more or less dilated.

Diameter 13–16 μ.

Brown's Mills, and other ponds, New Jersey.

D. SINUOSUM, Wolle. Plate XI, figs. 6, 8; variety fig. 7.

Slender, undulate, smooth, cylindrical; 20–24 times longer than broad; semi-cell with eight constrictions; ends truncate, straight or slightly concave, each angle furnished with a short stout tooth; basal inflation not plicate.

Diameter 12–14 μ.

Var. BREVE, Wolle. (fig. 7) only half the length, and only four constrictions to a semi-cell.

Diameter 12–14 μ.

Very near the preceding, but armed with teeth at the apex, not plicate, and sometimes only half the length. Pond, Pleasant Mills, New Jersey.

D. UNDULATUM, Bail. Plate XI, fig. 5.

Cells small, cylindrical with undulating margins, 18–20 times longer than the diameter; moderately constricted in the middle; inflation at base of semi-cells very slightly larger than the undulations, apices rounded.

Diameter 10–12 μ.

Bailey found this species in fresh waters of Florida; I have it from the same State, and from ponds at Hammonton and Dennisville, New Jersey.

D. HIRSUTUM, Bail. Plate X, fig. 13.

"Semi-cells many times longer than broad, slightly inflated at base, surface hirsute, a small species resembling *D. Trabeculum* in form but strongly hirsute on its outer surface." These, the words of Prof. Bailey; his figure has the appearance of a *Gonatozygon*, but guided by his comparison with *D. Trabeculum*, I judge my figure represents the same plant. The cytioderm is densely hirsute throughout.

Diameter 24–30 μ.

Sluggish waters, eastern Pennsylvania.

D. SPINOSUM, Wolle. Plate X, fig. 12.

Cell large, subcylindrical, 8–10 times longer than the larger diameter; margins undulate with three or four, more or less prominent inflations; central constriction deep, and suture conspicuous; apex truncate, about two-thirds as wide as the

base of the semi-cell, cytioderm firm, clothed with densely set spines; two or three rows around the apex firmer and longer than the others.

Diameter 40–48 μ.

Pond, Dennisville, New Jersey.

D. crenulatum, Ehrb., *D. nodosum*, Bail., *D. hirsutum*, Bail., have features in common with this form. I have separated it in view of the armor of spines with which it is clothed; these are not hairs, nor gelatinous contractions, but decided and firm spines.

D. VERRUCOSUM, (Bailey) Ralfs. Plate X, figs. 4, 5.

Cells cylindrical, tapering very slightly from the centre to the apex; margins made crenate by numerous whorls of quadrangular prominences. Length about twelve times the breadth.

Diameter 25–33 μ.

Occurs frequently in ponds, Mt. Everett, Mass., and sparsely in quiet waters, northern New Jersey. Bailey found it originally in Rhode Island and New York.

D. MINUTUM, Ralfs. Plate L, figs. 29–31. Plate X, fig. 9.

Slender, elongated, smooth, cylindrical, linear or slightly tapering, ends round; 10–30 times longer than broad; a single inflation, more or less prominent at the base of the semi-cell.

Diameter 7–9 μ., or more rarely 10–12 μ.

Ponds, Florida, Massachusetts and New Jersey.

This minute plant is near a form described by Delponte as *P. rectum*, but it has twice the diameter. Ralfs describes his *D. minutum* which has the same diameter as ours, only five or six times longer than wide. Our forms vary greatly in proportionate length and breadth; the shortest however, is ten times as long as broad. They vary also much in thickness and in the central inflation; sometimes the constriction is barely perceptible, and again marked by a strongly inflated border. The various forms frequently occur in groups, and evidence specific relationship.

D. TRIDENTULUM, Wolle. Plate X, fig. 10.

Near the preceding in form and structure but average some-

what larger, and often granulate; apices crowned with a few prominent teeth, usually three in view.

Diameter 12–13 μ.

Pleasant Mills, Brown's Mills, etc. New Jersey.

The inflation at the base of the semi-cells is more prominent than is usual in D. *minutum*.

D. COSTATUM, Wolle. Plate X, fig. 2.

Fusiform, 7–8 times longer than broad; slightly constricted in middle; inflated gradually from the base of the semi-cell to about one-third the length, then gradually tapering to the truncated, slightly dilated and dentate apex; margins with regular crenae, produced by twenty or more distinct transverse costae or rib-like lines.

Diameter, widest part 25 μ., constriction 20 μ., ends 15–17 μ.

Found by H. D. Kitchel in pond, Berkshire Mountains, Massachusetts, 1882.

The specimens which came under my observation were not vegetative—too old; this species needs verification.

D. VERTICILLATUM. (*Triploceras Verticillatum*,) Bail. Plate X, figs. 1, 11.

Cells large subcylindrical, with numerous whorls of small, oblong, often tooth-like prominences; 7–16 times longer than broad; ends with three bidentate diverging processes.

Diameter ordinarily 38–45 μ.

Var. TURGIDUM, (fig. 11), Wolle. Shorter and stouter, often 60 μ.

Of frequent occurrence in pond waters, Maine to Florida.

The number of whorls varies from 12–16 in a semi-cell. In living condition the cells are green, but more commonly they are found of brownish red color.

D. GRACILE, (*Triploceras gracile*,) Bail. Plate X, figs. 3, 6, 7, 8.

Differs from the last in usual smaller size of cell, smaller and more acute tooth-like prominences of the whorls.

Diameter 20–28 μ., exceptions, up to 40 μ.

Habitat the same as the former.

The whorls appear to be composed of a double series of teeth, but frequently the second row is barely evident. Fig. 3 is of unusual size. Fig. 7 represents a condition of dissolu-

tion; the contents have escaped, and the parts constituting the cell have separated, contracted and assumed a partially inverted position.

CALOCYLINDRUS, D. By.

Cells straight, cylindrical, ends rounded or truncate; semi-cells without basal inflation, or longitudinal plication; chlorophyl parietal or axillary.

C. RALFSII, (Kg). Kirch. (*Cosmarium cylindricum*, Ralfs). Plate XII, fig. 17.

Cells cylindrical, about twice as long as wide. Semi-cells subquadrate in front view, broadest at the extremity; cytioderm more or less granulated.

Diameter about 24 μ.

Pools fresh water, Pennsylvania, New Jersey.

C. MINUTUS (Ralfs). Kirch. (*Penium minutum*, Cleve). Plate XII, fig. 12. Plate V, figs. 19, 20.

Cylindrical, 4–6 times as long as broad, slightly constricted in the middle, ends rounded, membrane smooth.

Diameter 11–16 μ.

Florida, South Carolina, (Bailey), Rhode Island, (Olney).

This minute and apparently variable plant has not come to my notice. It is classed by different authors both as a *Penium* and a *Docidium*.

C. CUCURBITA, (Breb.) Kirch. (*Cosmarium Cucurbita* Breb). Plate XII, fig. 14.

Cells punctate, cylindrical, about twice as long as broad, slightly constricted at the middle, rounded at the ends.

Diameter 22–25 μ.

Pennsylvania and New Jersey.

C. CURTUS, (Breb). Kirch. (*Cosmarium curtum*, Breb). Plate XII, figs. 15, 16.

Cells somewhat fusiform cylindrical, about twice as long as wide, slightly constricted at the middle, the ends subconically rounded, cytioderm smooth.

Diameter 20–32 μ.

Pennsylvania, New Jersey, and other States.

Fig. 16 represents a small form collected several succeeding summers, in gelatinous masses on the muddy bottom of a small pool; thousands were present; the other (fig. 15) is the larger, typical form.

C. CONNATUS, (Breb). Kirch. (*Cosmarium connatum*, Breb). Plate XI, figs. 8, 9.

Cells short and thick, subcylindrical, about one and one-half to two times longer than broad, ends broadly rounded; constriction forms a wide, shallow sinus; cytioderm distinctly punctate.

Diameter 45–75 μ.

Pennsylvania, New Jersey, Florida, New York, Vermont, Minnesota, etc.; probably distributed everywhere.

This is one of the largest species of the genus and most common. The end view is nearly a perfect circle; front view of a semi-cell constitutes about two-thirds of a circle; a distinct border is always present, and often appears striated.

Var. MINOR, Nord. Plate XII, fig. 10. Plate XLIX, fig. 18.

This form is in all essential points like the last, except in dimensions.

I have found almost every possible variety of size, measuring in diameter from 20 to 40 μ. This fact furnishes a presumptive evidence that the smaller forms are merely undeveloped conditions; young plants evolved from sporangiums, in accordance with Hofmeister's theory; See INTRODUCTION p. 19.

C. PSEUDOCONNATUS, Nord. Plate XII, fig. 11. Plate XLIX, figs. 10, 11.

Similar to the two preceding in form and structure, but in size usually smaller than the typical plant. The distinctive feature is in the arrangement of the chlorophyl; this is not homogenous, but divided in each semi-cell, in front view, into two parts, and in end view, into four parts.

Marsh pools, Pennsylvania.

The value of the arrangement of the chlorophyl as a specific character, needs, I think, further corroborative evidence.

C. CLEVEI, (Lund), Wolle. (*Penium Clevei*, Lund). Plate L, fig. 27.

Cell subcylindrical, 2½–3 times longer than broad, somewhat constricted in the middle; semi-cells cylindric-subconical, ends distinctly attenuated and rounded at apices; vertical view a perfect circle. Nuclei large, elliptic, single or rarely twinned. Membrane finely punctate, at apices subgranulate punctate.

Diameter 40–50 μ. Length 115–118 μ.

Brown's Mills, New Jersey.

The plant is slightly larger than Lundell's form, but so good a counterpart in form and structure, I take it to be the same species; by measurement the constriction is somewhat deeper. The decided constriction makes the natural position of this form, I think, a member of the present genus, notwithstanding the observations made by Lundell in the arrangement of the chlorophyl.

C. THWAITESII, Ralfs. Plate XII, fig. 19. Plate L, fig. 28.

Cells two to three times longer than broad, fusiform in front view; circular in end view; constriction a shallow sinus; ends high-rounded, cytioderm not at all, or very indistinctly punctate; chlorophyl scattered.

Diameter about 30 μ.

Florida, (Bailey); frequent in pond, Spring Lake, Monmouth County, New Jersey.

C. DIPLOSPORA, Lund. Plate XII, fig. 18.

Cell large, twice as long as broad, subcylindrical, moderately constricted in the middle, very slightly but distinctly enlarged from the centre towards the ends; apices broadly rounded; end view circular; cytioderm colorless and smooth. Cytioplasm has usually a tint of reddish brown.

Diameter 25–30 μ; length 53–58 μ.

Frequent in ponds, Berkshire Mountains, Massachusetts.

C. COSTATUS, Wolle. Plate XII, fig. 13.

Cell ovaliform, nearly twice as long as wide; moderately constricted in the middle. Front view a constricted oval, end view circular; cytioderm longitudinally costate; costae 5–7,

distinct, converging at the apices. Color of older plants reddish brown.

Diameter 50 μ; length 90 μ.

Pond, Mount Everett, Massachusetts, 1882.

According to some authors this plant might be classed with *Docidium*, but having no inflation at the base of the semi-cells, and no plication in the cell-walls, I give it a place here.

Genus, COSMARIUM, Corda.

Cells oblong, cylindrical, elliptical or orbicular with margins smooth, dentate or crenate; always more less deeply constricted in the middle; ends rounded or truncate and entire, not emarginate, lobed nor sinuate; end view oblong or oval, sometimes with a swelling in the middle of the longer sides; chlorophyllous cytioplasm parietal, or more or less concentrated in the centre of the semi-cells, or divided into two masses; cytioderm, (cell-walls) smooth, punctate, warty, or very rarely, spinous. Zygospore spherical, tuberculated or spinous, seldom smooth or angular.

The plants of this genus are recognized by their short form and entire end. They are usually about 1½ times as long as wide; sometimes shorter and sometimes longer, rarely over two diameters in length. Ends always entire, not emarginate or incised.

They may be conveniently divided as follows:

1. Chlorophyl parietal—distributed on the inside of the walls of the cells.
2. Chlorophyl more or less concentrated into one or two masses, (nuclei,) in each semi-cell.
   - ½ End view round, oval or elliptic without central inflation.
     1. Cytioderm (cell-wall) smooth, or punctate.
     2. Cytioderm verrucose.
     3. Cytioderm spinous.
   - ½ End view round, oval or elliptic with a central inflation on each side.
     4. Cytioderm smooth or punctate.
     5. Cytioderm verrucose or spinous.

C. OVALE, Ralfs. Plate XIII, figs. 8, 9.

Large, oval or elliptical, nearly twice as long as broad, ends rounded; central constriction deep linear; isthmus about one-

third of the diameter of the cell; semi-cells with straight base, angles rounded and sides convex, gradually converging. Cytioderm granularly rough with one or two rows of larger pearly granules near the margin, producing a dentate appearance.

Diameter about 100 μ. (range from 62 to 112 μ.)

Ponds, Pennsylvania, New Jersey, New York, South Carolina, Rhode Island, Minnesota, etc.

C. De Baryi, Archer. (*Pleurotaenium cosmarioides*, De By). Plate XV, fig. 5.

Cells oblong, twice as long as broad, with flatly rounded ends; constriction narrow, straight, linear. Cytioderm smooth or finely punctate; chlorophyl parietal.

Diameter 50–54 μ.; length 104–110 μ.

Ponds, Berkshire Mountains, Massachusetts.

C. Cucumis, Corda. Plate XV, figs. 6, 7, 8, 9.

Cells oval, one and one-half to one and three-fourths times longer than broad, ends broadly rounded; constriction linear; cytioderm smooth; chlorophyl covering the inside of the walls of the cells.

Diameter 46–56 μ. Thickness 36–40 μ. Isthmus about one-third of the diameter of the cell.

Frequent from Maine to Florida.

Besides the measures given, forms are found of much smaller dimensions. Figs. 7, 8, 9 represent such; every possible size from the largest to the smallest, and down to a diameter of 15 μ. are not rare. These I consider undeveloped, or young conditions of the plant evolved from zygospores. Compare Introduction, p. 19.

C. constrictum, Delp. Plate L, figs. 1–4.

Cells smooth, about one-half longer than broad; deeply constricted; sinus acute-angled; semi-cells near a three-fourth circle, with inferior angles rounded; end view oval; lateral view of cell an oblong with ends rounded and middle constricted. Somewhat in character with *C. Cucumis*, but proportionately shorter.

Diameter 30–38 μ.

Frequent in smaller ponds, New Jersey, Pennsylvania, etc.

C. SCENEDESMUS, Delp. Plate L, figs. 7, 8, 9.

Cells smooth, not as long as broad, depressed, constriction deep, sinus narrow linear; semi-cells subsemicircular, base nearly straight, ends a depressed arch, angles rounded; end view elliptic; side view circular.

Diameter 32–38 μ.

Reminds strongly of *C. Phaseolus*, but has no reniform base, and no central inflation. Sinus of fig. 7 too much ampliated.

Occurs frequently.

C. QUADRATUM, Ralfs. Plate XVIII, figs. 8, 9, 10.

Smooth, deeply constricted at the middle; semi-cells in front view quadrate, with a slight protuberance on each side above the base, giving the sides a retuse appearance, angles rounded; chlorophyl in larger forms usually divided into two masses.

Diameter, smaller form 20–23 μ; larger form 40 μ.

Ponds, Pennsylvania, rather rare.

The apices of the two forms differ; the smaller ones are more or less retuse, and the larger ones convex. The length of each is twice the diameter.

C. ANCEPS, Lund. Plate XVIII, fig. 11.

Small, full twice as long as broad, hexagonal-oblong; sinus narrow linear; side view oblong with sides slightly emarginate; apices rounded; semi-cells quadrate, rather longer than broad, tapering moderately from base to end; end view sub-circular. Membrane smooth; isthmus half the diameter of the cell.

Diameter 17–18 μ.; length 45–50 μ.

The only plant I have found to harmonize with this description, was collected by J. D. Smith in Florida. It agrees very well except in length, being nearly equal to three diameters.

C. PARVULUM, Breb. Plate XVIII, fig. 12, 13.

Cells small, ovate elliptical, lightly constricted, apices truncate, two to nearly three times as long as wide; margins entire, or sometimes lightly crenulate; semi-cells short conical, broadly truncate or sometimes with apex retuse; cytioderm smooth or finely punctate.

Diameter 18–22 μ.

Florida, collected by J. D. Smith.

C. GRANATUM, Breb. Plate L, fig. 13. Plate XV, figs. 14, 15.

Cells one and one-half times as long as broad; constriction narrow linear; semi-cells trapezoidal, with straight bases, rounded angles, sides gradually converging; apex truncate; variable in size.

Diameter 20–32 μ.; isthmus about one-third the diameter.

Frequent in quiet waters. Pennsylvania, New Jersey, Massachusetts, Florida, and Minnesota.

Plate L, fig. 13, is the typical form; the others, Plate XV, figs. 14, 15, are varieties, near Wille's variety *elongatum*.

C. MONILIFORME, Ralfs. Plate XV, figs. 16, 17, 18, 19.

Cells twice as long as wide; semi-cells spherical, united by a narrow isthmus; four semi-cells often in series; cell membrane smooth.

Diameter 16–24 μ.

Frequent in ponds, Pennsylvania, New Jersey, Massachusetts, Florida, etc. Fig. 18 represents a peculiarity noticed now and then, that in multiplying by division, (Introduction p. 18), the new daughter semi-cells are larger than those of the mother cell; if this is not always the case such are frequently found.

C. GLOBOSUM, Bulnh. Plate XLIX, figs. 14–17.

Cells small, light green, bicocciform, scarcely compressed, nearly one third longer than wide, very slightly constricted, sinus acute; semi-cells circular exclusive of the confluent bases, entire, cytioderm smooth or finely punctate.

Diameter 20–24 μ.; length 25–33 μ.

Not infrequent in ponds intermingled with other forms.

Plate XV, fig. 20, represents a variety which stands between this species and *moniliforme*.

Diameter about 20 μ.

Pennsylvania, New Jersey, Massachusetts.

C. BIOCULATUM, Breb. Plate XV, figs. 21, 22.

Cells small, somewhat longer than broad; constriction deep, producing a gaping notch on each side. Semi-cell compressed, oval, with convex base, short convex sides and rather flat apex. Cytioderm smooth or finely punctate. Zygospore globose, without spines.

Diameter 15–16 μ.; length about 17 μ.

Rhode Island, Massachusetts, Pennsylvania, New Jersey, etc.

C. QUIMBYII, Wood.

Cells small, subelliptical, profoundly constricted in the middle, joined by translucent bands into families; semi-cells seen from the front elliptical, and nearly twice as long as broad; from the vertex elliptical, from the side roundish. Chlorophyl masses single in each cell. Cytioderm thin, smooth.

Diameter 18 μ.; length 25 μ.

"This plant was found in a Spring near Camden, N. J., upon whose bottom it formed a gelatinous translucent, greenish mass. The cells are joined by bands into families, in which the little parent cell is generally very distinct, it, or rather the two cells into which it first divides, remaining in the centre of the group." Wood, p. 35.

I would suggest this to be very near, or identical with *C. tinctum*, Ralfs.

C. TINCTUM, Ralfs. (*Sphaerozosma tinctum*, Rab). Plate XVI, fig. 31.

Cells small, somewhat longer than broad; isthmus broad, constriction outwardly enlarged; semi-cells oval; chlorophyl a single mass; cytioderm smooth, often tinted with yellow, brown or red.

Diameter 10–15 μ.

Of the Sporangium, Ralfs writes, "It is large in proportion to the cells, and quadrate with an empty segment of the fronds permanently attached at each corner. Sometimes the fronds couple in a crossed position, when the sporangium appears variously twisted or distorted."

I find single specimens of this plant occasionally, but have not had a satisfactory group of them, or fruiting specimens.

C. TUMIDUM, Lund. Plate XV, figs. 23; Plate XVIII, fig. 20.

Cells somewhat longer than broad, constriction narrow linear. Semi-cells suboval, rather flat base, apex broad convex, with one chlorophyllous mass. Cytioderm punctate and more or less granularly rough in the central part, margin smooth. Plate XVIII, fig. 20, appears to be a variety of this form, coarsely granular.

Diameter 20–33 μ.

Pennsylvania, New Jersey, etc.

In front view this species bears some resemblance to *C. Phaseolus*, Breb., but differs in being proportionately

longer, and in not having the base of the semi-cells reniform, and in not having an entirely smooth membrane. Some specimens are very distinctly punctate, others not so evidently except away from the margins. Kirchner makes two varieties; *a. genuinum*, cytioderm distinctly granular in the middle; *b. subtile*, cytioderm finely punctate over the whole cell.

C. SEJUNCTUM, Wolle. Plate L, figs. 18–20.

Membrane smooth, slightly longer than broad; semi-cells semicircular with angles rounded, separated by a wide nearly linear sinus; isthmus connecting the semi-cells is narrow, less than one-fourth the breadth of cells.

Diameter 20–25 μ.; length 25–30 μ.

Pond near Malaga, New Jersey, and Minneapolis, Minnesota.

C. NITIDULUM, De Not. Plate XVIII, figs. 16, 17, 18; and Plate LII, figs. 9, 10.

Cells small, smooth, of nearly equal length and breadth; constriction deep, sinuses narrow linear; basal angles of semi-cells obtusely rounded, sides rounded, ends roundly truncate; viewed from the vertex elliptic; from the side, subovate.

Diameter 22–30 μ.; length 25–35 μ.

Not infrequent in pond waters. The figs. 16, 17, should have the ends moderately flattened.

C. PSEUDONITIDULUM, Nord. Plate XVIII, fig. 19.

Varies from the preceding in its somewhat larger size and more quadrangular form. The basal angles of the semi-cells beside being rounded, protrude slightly.

Diameter 38 μ.

Found this form only in Northampton County, Pennsylvania.

C. LAEVE, Rab. Plate XV, fig. 10.

Cells one and one-third to one and two-thirds longer than broad, constriction deep; sinus narrow linear; semi-cells with high-rounded ends, usually somewhat retuse. Cytioderm finely granular.

Diameter 14–16 μ.

I have recognized two forms of this plant; the one longer than the other; the longer slightly retuse, which is the typical form; the other not retuse, and not so long. The figures represent the variety.

Sometimes found in considerable numbers in gelatinous gatherings on dripping rocks and in small pools.

C. VARIOLATUM, Lund. Plate XVI, figs. 3, 4.

Small elliptical, twice as long as wide, constriction deep, narrow, linear; semi-cells, base straight, sides rising at right angles, then curving gradually and producing an almost circular apex, sometimes slightly retuse; end view broadly elliptical; side view obovate. Cytioderm more or less punctate; isthmus one-third of the whole diameter. Chlorophyl nucleus single.

Diameter 15–17 μ.

Ponds, southern New Jersey, Hammonton, etc.

C. CONTRACTUM. Kirch. Plate XVI, fig. 1. Plate L, fig. 24.

Cells one and one-half times as long as wide; sinus produced by the constriction, deep and narrow, widening outwardly from the base. Semi-cells oval, with convex base and convex apex, containing each one chlorophyl nucleus; cytioderm distinctly punctate.

Diameter 24 μ.

Denmark, and other ponds, New Jersey.

C. SEXANGULARE, Lund. Plate XVI, figs. 8, 9. Plate XLIX, fig. 13.

One-fifth part longer than wide; constriction deep; sinus linear within and widening outwardly. Semi-cells more or less hexagonal-elliptic; ends truncate, sides obtusely rounded; end view elliptical; side view circular. Cytioderm finely punctate.

Diameter 25–42 μ.

Occurs frequently in ponds, Pennsylvania, New Jersey. The hexagonal feature of the semi-cells is not always as distinct as described; in the figures 8 and 9 it was inadvertently omitted altogether, nevertheless, they represent a common form of the species.

C. DEPRESSUM, (Naeg.) Lund., not Bailey. Plate L, figs. 10, 11, 12.

Cells usually slightly shorter than wide; constriction deep; sinus widening outwardly; semi-cells compressed oval; the long sides flattened, the others rounded; one chlorophyl mass in each. Membrane finely punctate.

Diameter 20–25 μ.

Frequent in pond, Spring Lake, N. J. They are smaller in size than the European form; otherwise identical.

Bailey in his contribution, describes another plant under the same name. Naegeli's description has claim of priority, hence must stand. In order to avoid further confusion, I change the name of the former, and in honor of the author call it *C. Baileyi.*

C. BAILEYI, Wolle. (*C. depressum, Bailey*). Plate XVI, figs. 17, 18.

"Elliptical, binate, division in the plane of the longest axis. Segments entire, nearly twice as long as broad, rounded above, very much flattened at base;" cytioderm punctate.

Diameter 36–48 μ.

Florida, (Bailey); and ponds, Mount Everett, Mass.

"This species resembles *C. bioculatum*, Breb., but the segments are much closer together, and are angular, not rounded at the basal extremities." Compare Note under *C. depressum.*

C. OBSOLETUM, Reinsch. Plate XLIX, fig. 12.

Cells elliptic, about one-fourth more in breadth than length. Deeply constricted; sinus rounded at the base, then gradually narrowed towards the lateral angles of the semi-cells which come close together; semi-cells in end view elliptical; side view circular. Isthmus about one-third the diameter of the cell. Membrane punctate or smooth; chlorophyl concentrations or nuclei, two.

Diameter 110 μ.; length 80 μ.

I adopt Reinsch's name for this plant. In general form it is the same; the two distinct nuclei also correspond, but in size it is much larger and the angles of the semi-cells are not at all or but slightly contracted. I collected it in a sluggish streamlet, Ocean Grove, N. J. It is near *C. Baileyi*, but differs in the form of the sinus, and in having two nuclei in each semi-cell; it is also twice the size.

C. SINUOSUM, Lund. Plate XVI, fig. 2.

Twice as long as wide, rectangular, constriction not deep, sinuses narrow linear, not widened outwardly; semicells quadrangular, equilateral, sides and apices somewhat retuse; end view subcircular; lateral view elliptic-oblong; membrane smooth; isthmus one-third of the diameter of cell; nucleus single.

Diameter 16–18 μ.

Pond, Berkshire Mountains, Mass.

C. MENEGHINII, Breb. Plate XVI, fig. 7.

Cells 1–1½ times as long as wide; constriction forms a narrow linear sinus; semicells subquadrate, base straight, apex flat, truncate or slightly concave; sides straight or concave, corners rounded, diagonally truncate or slightly retuse; single chlorophyl mass in each semicell. Very variable. Kirchner makes three varieties.

a. genuinum, with sides and ends and upper angles retuse.

Diameter 20–22 μ.

b. angulosum, Rab., sides and ends straight, upper and lower angles diagonally truncate.

Diameter 18 μ.

c. concinnum, Rab., more elongated, semicells nearly quadrilateral, all angles truncate, or rounded.

Diameter 9–26 μ.

Found frequently; probably has a wide range north, south, and west.

C. POLYGONUM, Naeg. Plate XVI, fig. 30.

Small, polygonal, about as long as wide, entire, sinus very narrow; semicells hexagonal-oblong, angles subacute or obtuse; apices straight or rounded; cytioderm smooth or punctate.

Diameter 15–20 μ.

Ponds, New Jersey and Massachusetts. Not frequent.

C. LUNATUM, Wolle. Plate XVI, fig. 16.

Cells nearly as long as wide, circular, constriction deep and forms a wide rounded or oval sinus; semicells lunately curved,

back circularly arched, base concave; angles of the two semicells, more or less acute, approximate closely. Cytioderm punctate; isthmus usually less than one-third of the diameter. End view elliptical; side view circular.

Diameter 25–28 μ.

Brown's Mills, N J.

C. ACULEATUM, Wolle. Plate XVI, fig. 15.

Medium size, suborbicular, length slightly less than the diameter; constriction deep, forming, by the incurving of the angles of the semicells, two elliptical sinuses; cytioderm primarily more or less densely aculiated; later the aculei drop off and leave short granule-like stumps; end view elliptical.

Diameter 33 μ.; length 30 μ.; breadth of constriction 10 μ.

Pond, Minneapolis, Minn. Collected by Miss E. Butler, 1882 and 1883.

C. SMOLANDICUM, Lund. Plate XVI, figs. 35, 36.

Cells somewhat longer than wide; isthmus narrow, constriction deep, sinus narrow linear; semicells semicircular with straight base and arched back sometimes subtruncate, angles (inferior) obtuse, mounted with a papilla; end view elliptical; lateral view circular. Membrane distinctly punctate. Chlorophyl masses two in each semicell.

Diameter 34–48 μ.

Various localities, Pennsylvania and New Jersey.

Usually the cells are about one-eighth longer than broad; they vary considerably in size. At Pleasant Mills, New Jersey, there is a variety which is somewhat depressed, measuring one-eighth less in length than breadth. The distinguishing feature of this species is the papilla at each angle.

C. EXIGUUM, Archer. Plate XVI, figs. 13, 14.

Cells very small, smooth, oblong, $1\frac{1}{2}$–2 times as long as broad; medial constriction slight; semicells subquadrate, containing one chlorophyl nucleus; ends obtusely rounded.

Diameter 12–15 μ.

Florida, collected by J. D. Smith, 1878.

C. NOTABILE, Breb. Plate XVI, fig. 11.

Cells small, about twice as long as broad, margins entire or moderately undulate-crenate; ends truncate; semicell more

or less pyramidal, base somewhat reniform, end broadly truncate; angles rounded, cytioderm smooth or finely granulate.

Diameter 22–28 μ.

Ponds of eastern Pennsylvania.

C. UNDULATUM, Corda. Plate XVI, fig. 20.

Cells $1\frac{1}{2}$ times as long as wide, ends broadly rounded, margins undulate; deeply constricted, sinus gradually enlarged outwardly; semicells semiorbicular; sides and back broadly rounded, margins undulate crenate, usually with nine crenae to a semicell; cytioderm smooth. Zygospores spherical, armed with long spines bi- or tri-fid at apices.

Diameter 40–44 μ.

Var. CRENULATUM, Wolle. Plate XVI, figs. 10, 19, is usually smaller in size and numbering ten to fourteen crenae to a semicell. This variety is near *C. crenatum* but is separated by the rounded ends. The typical form is from South Carolina and Rhode Island, (Bailey); the variety from ponds, eastern Pennsylvania and New Jersey.

C. CRENATUM, Ralfs. Plate XLIX, figs. 31, 32.

Cells oblong, usually nearly twice as long as wide, deeply constricted in the middle; semicells crenulate at the margins, flattened at the ends; generally have twelve or fourteen crenae; cytioderm punctate. Zygospore globose, studded with protuberances which terminate with a divided apex.

Diameter 30–38 μ.

Rhode Island, New Jersey, Pennsylvania, and other States. Not frequent but occurs every now and then.

C. NAEGELIANUM, Breb. (*C. crenatum, Naeg*). Plate L, fig. 21.

Small, somewhat longer than broad, sinus narrow linear; semicells, with sides sinuate-crenate, converging from the broad flat base to the broadly truncate, entire or imperfectly quadricrenate ends; cytioderm finely granulate or smooth.

Diameter 20 μ., or a little more or less.

Not rare. Bears some resemblance to *C. crenatum* in front view, but is smaller and proportionably much shorter; the crenae of the sides are usually less in number, and those of the ends imperfectly developed.

C. VENUSTUM, Rab. Plate XVI, fig. 37.

Length of cell equal to about 1½ diameters; constriction deep; sinus narrow linear; semi-cells have a flat base, rounded lower angles, sides somewhat convergent; each with two notches of equal size; ends truncate, and slightly retuse. One chlorophyl mass in each semicell; membrane smooth.

Diameter 24–30 μ.

Occasional in ponds, Pennsylvania and New Jersey.

C. REINSCHII, Arch. (Dublin Microscopical Club). Plate XVI, fig. 12.

Somewhat longer than broad, deeply constricted, sinus narrow linear; ends truncate; sides convex, erose dentate or notched. Membrane smooth; end view elliptic without a central inflation.

Diameter 30–35 μ.

Not frequent, but is found in Lake Hopatcong, N. J., and in ponds, eastern Pennsylvania.

C. HOLMIENSE, Lund. Plate XVI, fig. 23.

Cells twice as long as wide, elliptic-rectangular, moderately constricted, sinus narrow linear; semicell subquadrate, sides straight or subconvex, slightly converging until near the somewhat dilated apices; ends obsoletely crenulate; dorsum truncate-undulate, angles rounded. Viewed from the vertex elliptic with the poles obtuse-angled; side view rectangular-elliptic; membrane smooth. Chlorophyl homogeneous or in a single mass.

Diameter 33 μ; length 63 μ.

Collected by F. H. Hosford, Mt. Mansfield, Vt., 1881. Differs slightly from Lundell's figure in the crenulations, and in being less constricted near the ends.

Var. INTEGRUM, Lund. Plate XVI, figs. 24, 25.

Differs from the typical form in having no crenulations nor plications near the apices, and no undulations on the ends.

Diameter 32–36 μ.

Mountain spring, Rockdale, Pa.

C. ANSATUM, Kg. Plate XVI, fig. 22.

Cells twice as long as broad; constriction wide but not deep; semicells have a flat base, rounded lower angles, sides con-

verging, concave; ends truncately rounded; membrane punctate; end view oval.

Diameter 28–31 μ.

Ponds, Pennsylvania, rather rare.

Scarcely separable from a variety (fig. 28) of *C. Holmiense*, except by the punctate membrane and the usually wider sinus; the latter is not correctly represented in fig. 22, should be two or three times wider and not quite so deep.

C. PYRAMIDATUM, Breb. Plate XIV, figs. 16, 17.

Cell scarcely twice as long as broad, suboval; constriction deep, linear; semicells pyramidal, rounded at basal angles, sides convex, gradually converging to the somewhat truncate ends; punctate; end view broadly elliptic.

Diameter 50–85 μ.

A common species found probably in every State of the Union.

Var. STENONOTUM, Nord. Plate XIV, figs. 18, 19.

This subspecies is separated from the typical form by the shape of the sides of the semicells, which are somewhat retuse near the apices; for perfect identity the ends ought not to be retuse; my specimens are slightly concave.

Size about the same as the typical plant.

Found this variety in collections made by Miss E. Butler, Minneapolis, Minnesota, and by A. D. Balen, Plainfield, New Jersey.

C. PSEUDOPYRAMIDATUM, Lund. Plate XV, figs. 11, 12.

In habitat, in form and proportions like the true plant, but only about half the size. It corresponds with *C. pyramidatum*, variety *minus*, Reinsch; Rab. Alg. Exsic. No. 1902.

Besides these, Ralfs has a *Forma major*, which I have included in my general grouping, (fig. 17).

C. RALFSII, Breb. Plate XV, fig. 1.

Orbicular or suborbicular, deeply constricted, sinus narrow linear; semicells nearly semicircular; inferior angles obtuse, dorsum high convex; cytioderm smooth or finely punctate.

Diameter 60–100 μ.; length 70–120 μ.

Pennsylvania, New Jersey, not frequent, but turns up every now and then, sometimes in considerable numbers.

In size, form, and arrangement of chlorophyl, this species is often a good representative of *C. Candianum*, Delp.

C. PACHYDERMUM, Lund. Plate XV, figs. 2, 3.

Cells $1\frac{1}{3}$–$1\frac{1}{2}$ times longer than broad; sinus narrow linear; semicells with straight base, rounded angles; sides rise nearly at right angles and then converge, forming a high arch; they contain two chlorophyl masses; viewed from the vertex, oval; isthmus wide, cytioderm firm, distinctly punctate.

Diameter 75–100 μ.

Had specimens from Budd's Lake, New Jersey; from Nebraska Notch, Vermont, collected by C. G. Pringle; and from Mt. Everett, Massachusetts.

This species is separated from *C. Ralfsii* by its usually greater proportionate length, firmer cytioderm, and wider isthmus.

C. GALERITUM, Nord. Plate XVI, figs. 46, 47, 48.

Cells slightly longer than wide, with narrow isthmus, deep constriction and narrow, slightly gaping sinus; semicells triangular with straight, or somewhat reniform base, rounded lower angles, convergent, straight, or slightly convex sides; ends more or less truncate; membrane smooth; end view oval; side view circular.

Diameter 40–55 μ.

Springs and ponds, Pennsylvania and New Jersey.

Fig. 47 represents a small form found in a pond on Mt. Everett, Mass., measures only 29 μ. diameter. The smaller size, straight sides, and more broadly truncate ends may prove it to be a different species. I note it provisionally a variety of the typical plant.

C. POLYMAZUM, Nord. Plate XVI, figs. 38–40.

Cells about as long as wide, deeply constricted; sinus narrow linear, widening somewhat outwardly; semicells subelliptic, margins with about sixteen crenae, and within the margins a concentric series of granules to correspond; area smooth with six papillae arranged in the form of a triangle, three in the first row nearest the margin, then two, then one; seen from the vertex, elliptical, truncate at ends, with a papilla at each angle and from these two longitudinal series of granules;

three papillae on each side (omitted in the figure); lateral view circular, with end truncate, and two rows of granules extending from the angles of the truncate end of one semicell to those of the other; the margins of the sides ornate with three papillae.

Nordstedt made this form, found by him in Norway, a variety of Lundell's *C. monomazum*, which has not occurred here; the other *C. polymazum*, is frequent in Denmark Pond, N. J.

C. Donnellii, Wolle. Plate XVI, figs. 41, 42.

Cells nearly as long as wide, suborbicular; sinus narrow gaping; semicells somewhat flattened, semicircular with angles rounded; margin formed of about eighteen large pearl-like granules; area smooth with a series of three larger granules, or papillæ in the centre. End view oval, three papillæ on each side.

Diameter 37–45 μ.

Found in collections made by J. Donnell Smith in Florida, 1879.

C. taxichondrum, Lund. Plate XVI, figs. 32–34.

Cells suborbicular, slightly longer than broad; sinus deep, narrow, linear, barely widened at the mouth; semicells semicircular, margin of base nearly straight, membrane thickened at the angles; face ornate with a single large granule at the isthmus, and two somewhat arched rows near the dorsal margin, one with three and the other with five or six granules; seen from the vertex, elliptic with five or six granules on each side; cytioderm punctate; isthmus one-fourth of the diameter of the cell. Chlorophyl nuclei two.

Diameter 40–50 μ.

Occurs frequently in ponds, northern New Jersey and Pennsylvania.

C. pseudotaxichondrum, Nord. Plate L, figs. 22, 23.

Scarcely as long as broad, deeply constricted, sinus considerably widened outwardly; semicells semicircular with the middle more or less truncate or depressed; the angles somewhat thickened and often terminating in a tooth-like point; above the basal line is an arched transverse series of four

granules; end view elliptical with four granules on each side; lateral view circular, with two inconspicuous granules on opposite sides; membrane punctate. Isthmus about one-third of the diameter.

Diameter 30 μ.

Brown's Mills, New Jersey, is the only locality which has hitherto furnished this form. The original, found in Brazil, differs somewhat in the "*sinu lineari, extrorsum vix ampliato;*" Our form has the sinus decidedly enlarged towards the mouth.

C. ANISOCHONDRUM, Nord. Plate XVI, figs. 43–45.

Cells subquadrate, length and breadth nearly equal; sinus, narrow linear; semicells subsemicircular, dorsum broadly truncate; in centre two horizontal rows of large granules of three each, and two intermediate granules below and above; smaller granules, more scattered on each side; viewed from the vertex, elliptic, with three larger granules on each side and a number of smaller ones within the margin; the middle bare; lateral view obovate, circular. Isthmus one-third the diameter of cell.

Diameter 30–38 μ.

Denmark pond and other ponds of northern New Jersey. The original of this species was collected on the Sandwich Islands and described by Dr. Nordstedt.

C. KITCHELII, Wolle. Plate XVIII, figs. 1–3.

Cells suborbicular, about one-fourth longer than broad, deeply constricted; sinus narrow linear; semicells semicircular, margins crenulate, with about 18 crenae; within, two concentric rows of granules corresponding with the crenae; area smooth excepting two, rarely three, transverse rows of three larger granules each, in the middle; viewed from the vertex, ovate-elliptic with three larger granules on each side, and four series of smaller granules extending from end to end; lateral view circular with two granules on each side, and four central series.

Diameter 40 μ.

Collected by Rev. H. D. Kitchel in a pond near Hammonton, New Jersey. This species is readily recognized by the large marginal granules, end and side view, and by the

four parallel central series of smaller granules. It bears some resemblance to *C. polymazum*, but differs in the central granules and in the double row of marginal smaller granules.

C. TRACHYPLEURUM, Lund. Plate XVI, figs. 26–29.

Cells about one-fourth longer than the diameter; isthmus narrow; sinus narrow, enlarged outwardly; semicells subreniform; ends truncate, nude in centre; the margins of the sides armed with five or six conical spines; the area close to the margin, is set with numerous conical spines arranged in short concentric series; the middle is ornate with seven granules, six in a circle and one in the centre; between these granules punctate; viewed from the vertex, elliptic with three prominent granules on each side; within the margin and near it, is a series of conical granules; lateral view circular. Chlorophyllous nuclei, two.

Diameter 33–40 μ.

Frequent in ponds, eastern Pennsylvania and New Jersey.

C. TRIPLICATUM, Wolle. Plate XIX, figs. 3–6.

Cell about one-fourth longer than broad, subrectangular; angles obtuse; sinus between the semicells linear; margins irregularly granulate crenate; membrane rough with larger and smaller granules; the larger ones arranged in series of three; three on the margin of each of the superior rounded angles, three within the margins, and three near margin between the angles; on the margin of the sides near the inferior angles two larger granules, and within the margins a few scattered smaller ones; end view quadrangular-oval with two series, usually of six larger granules, on each of the longer sides, one of the series on the margin, and the other within. Zygospores spherical, with long spines, fig. 6.

Diameter of cell, 40 μ; length about 50 μ.

Ponds, Pennsylvania and New Jersey.

The nearest approach to this species is *C. Ungerianum*, Naeg. It is separated by its smaller size, the details of outline and the arrangement of the larger granules.

C. SEELYANUM, Wolle. Plate XVIII, figs. 33–35.

Cells small, quadrangular, deeply constricted; sinus narrow linear; semicells twice as wide as long, with a small rounded

notch in the middle of the sides, the superior angles somewhat produced laterally; dorsum slightly produced in the middle and crenated; membrane at the superior, and at the inferior angles and near the margin of the ends, each with three or four granules; in the centre a circular cluster of larger granules.

Diameter 25–30 μ.

Frequent in pond at Elmira, N. Y., 1882.

$\frac{2}{2}$ Membrane granular without a central inflation.

C. MARGARITIFERUM, Menegh. Plate XIII, figs. 1–3.

Cells about one one-half times longer than broad, sinus narrow, usually more or less enlarged outwardly; semicell semiorbicular, somewhat reniform or oval, with rounded inferior angles, convex sides and broadly rounded, not truncate end. Cytioderm rough with pearly granules; end view elliptic; zygospores orbicular.

Diameter 25–50 μ.

This species varies in size and form. The rough membrane distinguishes it from *C. crenatum* and *C. undulatum;* its rounded ends from *C. Botrytis*, its smaller size and less positive kidney form from *C. reniforme.* It appears to be as widely distributed as the most common of this genus.

C. PUNCTULATUM, Breb. Plate XIII, fig. 4.

This form is very similar to *C. margaritiferum*, but it is smaller, the pearly granules less conspicuous, and the ends more flattened. The membrane is sometimes not granular, but punctate. It is found in the same localities, and appears very nearly related.

Diameter of cells 20–30 μ.

C. BOTRYTIS, Menegh. Plate XIII, figs. 5–7.

Cells one, and nearly two times as long as broad; sinus narrow linear; semicells with nearly straight base, sometimes inclining to reniform; sides converging from the inferior rounded angles to the flat, truncate end; cytioderm evenly covered with large pearly granules. Zygospores orbicular, spinous with long, thin spines, the ends much divided.

Diameter 35–62 μ.

A very common plant, and very variable in the size, and in the proportions of length and breadth.

Var. TUMIDUM, Wolle. Plate XVII, figs. 3–5.

In outline, front view, very near *C. Botrytis*, yet entirely unlike it in side and end views, which show a central inflation. Found it in only one locality in a meadow pool, near Bethlehem, Pa. Further observation may prove it a distinct species.

C. BREBISSONII, Menegh. Plate XIII, figs. 10, 11.

Cells somewhat longer than broad; semicells semiorbicular, rough with conic spines or granules; end view elliptic or oval.

Diameter 45–65 μ.

Cells generally larger than *C. margaritiferum*; semicells more oval, but separable only by the armor of conicalgranules.

Not so frequent as the preceding, but appears to be widely distributed.

C. CONSPERSUM, Ralfs. Plate XIV, figs. 1, 2.

Cells somewhat longer than broad, quadrilateral, angles obtusely rounded; constriction deep, produces a linear notch on each side; granules pearly, large, depressed, giving a crenulate appearance to the margin.

Diameter 50–73 μ.

A beautiful and conspicuous species, frequently found in large numbers; it is easily distinguished by its large size and quadrangular form.

C. TETRAOPHTHALMUM, (Kg.) Breb. Plate XIII, fig. 13.

Cells one-third to one-half longer than broad; semicells semiorbicular somewhat elevated, rough with pearly granules which give a crenate appearance to the margin; chlorophyl masses two, often very conspicuous.

Diameter 60–78 μ.

Rather common. The semicells are usually near in form to two-thirds of a circle. The transverse view is broadly elliptic. The four chlorophyl nuclei, which are frequently very prominent, two in each semicell, probably suggested the name, *four-eyed*.

C. INTERMEDIUM, Delp. Plate XIII, fig. 12.

Cells very near the preceding (*C. tetraophthalmum*,) somewhat smaller, semicells more absolutely semiorbicular, not so elevated.

Diameter 45–50 μ.

Habitat same as the preceding.

C. DENTATUM, Wolle. Plate XIII, fig. 15.

Cell about one-half longer than wide; constriction deep, forms gaping sinuses; cytioderm rather closely set with small pearly granules; the margins of the rounded sides of the semicells dentate with large and distant conical projections, or teeth; ten to twelve on each side. The ends broadly rounded are devoid of projecting teeth. End view of cell oval; lateral view elliptic with a constriction in the middle.

Diameter 90–100 μ.; length 145-160 μ.

This plant has hitherto been found only in Pennsylvania, New Jersey, Florida and Massachusetts.

It is separated from *C. ovale*, its nearest kin, by the shape of the semicells, which are not triangular, or conical, but broadly oval, and by the nudity of the apices.

C. LATUM, Breb. Plate XIII, fig. 14.

Large, slightly longer than broad; constriction deep, sinuses narrow, somewhat enlarged within; semicells broad reniform, sides rounded, and back (dorsum) broad, rather flatly rounded, margins dentate-crenulate; cytioderm covered with pearly granules which are disposed in curved, concentric series.

Diameter about 60 μ.

Bears a resemblance to *C. margaritiferum*, but it is somewhat larger; and according to Brebisson, more flatly rounded in the middle, and base more reniform. Find it rather rarely intermingled with other forms, and sometimes question the characters for a good species.

C. RENIFORME, (Ralfs). Arch. Plate XIV, figs. 10, 11.

A diagnosis of this species would not differ from the last, *C. latum*, except in the size of pearly granules, which are nearly twice as large, (well shown in the empty cell fig. 11) and in the more decided reniform figure of the semicells.

The only habitat hitherto found for this form, is a pond in Florida; collected by J. Donnell Smith of Baltimore, Md., 1879.

C. OCHTHODES, Nord. Plate XIV, figs. 3, 4.

Cells one and one-half times longer than broad, somewhat elliptic-oblong, deeply constricted, sinuses narrow linear; semicells semicircular or subtriangular, sides convex; apices trun-

cately rounded, or frequently slightly retuse in centre; margins densely crenated; viewed from the vertex, elliptic, from the side, obovate. Membrane densely verrucose, verrucae large, depressed, arranged in subregular or concentric series.

Diameter 52–70 μ.

Hitherto have found this variety only in eastern Pennsylvania. The original of the species was found in northern Sweden, and described by O. Nordstedt; it bears a resemblance to *C. Botrytis* and *C. tetraophthalmum*, but differs in the form of the verrucae which are short cylindrical truncate; in *tetraophthalmum* the verrucae are triangular hemispherical obtuse, and in *C. Botrytis* triangular with subacute apices.

C. PORTIANUM, Archer. Plate XIV, figs. 12–14.

Cells about one-third longer than broad, deeply constricted; semicells oval, remote, separated by a wide sinus; isthmus about one-fourth the diameter of the cell, membrane granular.

Diameter 25–33 μ.

Frequent in ponds, Pennsylvania, New Jersey, Massachusetts, Minnesota and Connecticut.

C. ORBICULATUM, Ralfs. Plate XIV, figs. 20, 21.

Twice as long as wide; semicells spherical, connected by a narrow isthmus; cytioderm covered with large granules. Zygospore, according to Ralfs, orbicular, studded with large verrucae.

Diameter 20–33 μ.

Meet with it frequently in ponds of New Jersey and Pennsylvania.

C. EXCAVATUM, Nord. Var. *duplo major*, Lund. Plate LIII, figs. 14, 15.

Cells nearly twice as long as wide, constriction wide and deep; end view orbicular; semicells subspherical with truncate base; verrucae of membrane, producing a crenulate margin.

Diameter 21–25 μ.

Not rare in ponds, Pennsylvania, New Jersey, etc.

Wille of Norway describes a form "*elliptica*," most nearly allied to ours in front view, but elliptical in end view. Nord.'s and Lund.'s described forms are orbicular in end view.

C. SUBORBICULARE, Wood. Plate XXIV, fig. 24.

Cells small, a very little longer than broad, with the margin irregularly crenate, or crenate-undulate; semicells from the side orbicular, from the vertex elliptical; sinus very narrow, but within somewhat excavated; cytioderm thick, sparsely coarsely granulated; granules subdistant, in each cell arranged in one or two curved marginal series and in a central group of two or three short rows.

Diameter 30 μ.; length, 33 μ.

Saco Lake, New Hampshire, (Lewis).

C. AMOENUM, Breb. Plate XIV, figs. 5, 6, 7.

Cell twice as long as broad, sides parallel, ends rounded; constriction deep, linear; semicells rough with large, obtuse, papilla-like pearly granules; side view much compressed, about thrice as long as broad; semicells contain two chlorophyl nuclei.

Var. TUMIDUM, Wolle, has the sides, front view, not parallel, but swollen or rounded.

Diameter 20–25 μ.

Rhode Island (Olney), Florida (Bailey).
Frequent in Pennsylvania, New Jersey, Massachusetts.

C. ORTHOSTICUM, Lund. Plate XVIII, figs. 4, 5.

Cells slightly more in length than the diameter, deeply constricted, sinus narrow linear; semicells subelliptic, sides rounded, base and dorsum nearly straight, coarsely verrucose; verrucae in 6–8 vertical series; from the vertex elliptic, verrucose on and near the margins, area punctate; from the side, circular. Chlorophyl nucleus single.

Diameter 20–30 μ.

Ponds, northern New Jersey and Mount Everett, Mass.

C. ELEGANTISSIMUM, Lund. Plate XIV, figs. 8, 9.

Cells two to two and one-half times longer than broad, perfectly cylindrical, ends arched; slightly constricted; viewed from the vertex, circular; margins verrucose-crenate; membrane with emarginate verrucae disposed in twenty-two longitudinal series, of which about nine are visible in front view;

these are arranged transversely also, in eight or nine series on each semicell; the same contains two chlorophyllous nuclei.

Diameter 29–33 μ.

I found this plant in collections made in Florida; it differs somewhat in size from Lundell's Swedish form, being more variable in length, varying from two to three diameters; the number of longitudinal series, if actual series, is greater than specified; the transverse series agree.

C. NOTABILE, Breb. Plate XVI, fig. 11.

Length of cell nearly equal to two diameters, margins somewhat undulate-crenate, ends broadly truncate; semicells, base somewhat reniform, sides converging from the base to the broadly truncate end; angles rounded; cytioderm smooth or finely granulate.

Diameter 25–30 μ.

Met with rather rarely in shallow pools and on dripping rocks.

C. HAMMERI, Reinsch. Plate XVIII, figs. 27, 36, 38.

Small, smooth; semicells in form of a truncate cone, the end either straight or slightly retuse, the sides rounded below and slightly concave above; the truncate ends about one-half the diameter of the cell; end view usually a regular ellipse; lateral view of cell oblong with central constriction.

Diameter 20–24 μ.

Frequent in ponds. Reinsch describes several forms; a larger and a smaller size, one with straight ends, another emarginate; end view usually elliptic. Among our varieties I find one with inflated centre; of eleven drawings made in my sketch book nine are without central inflations, and two with them, the latter even more inflated than the variety *retusiforme*, found in Norway, and described by Wille.

C. NYMANNIANUM, Grun.

Cells somewhat hexagonal, finely punctate; semicells slightly broader than long; base rather flat, sides converging from the base to the broadly truncate end, lower part prominently rounded, sinuate near the end; apex often retuse.

Diameter 36–38 μ.; length 50 μ. more or less.

In front view, this is a common form, barely separable from the following—*C. sublobatum;* in lateral, and in end view however, they ought to be distinct by the absence or the presence of a central inflation. All the specimens examined personally, evidenced more or less of an inflation, or at least a tendency to it; have not been convinced of having a genuine, *C. Nymannianum.* I set them down to *C. sublobatum.*

Semicells with central inflation; cytioderm smooth or punctate.

C. SUBLOBATUM, Archer. Plate XVIII, figs. 21, 22.

Cells somewhat oblong, about one-half longer than broad, sinus linear; semicells swollen at the base, gradually narrowed towards the truncate ends; inferior and superior angles rounded; apex broadly truncate, sides sinuate; with central inflation.

Diameter 38–44 μ.

Ponds, Pennsylvania, New Jersey; not abundant but probably widely distributed.

C. RETUSUM, Perty. Plate XVIII, figs. 25, 26.

Small, of nearly equal length and breadth, entire; sinus deep, linear; semicells with subreniform base, sides sinuate and converging to a truncate end; angles rounded; end view centrally protruding.

Diameter 22–30 μ.

Pennsylvania and New Jersey.

C. MARGARITUM, Wolle. Plate XIX, figs. 25, 26, 27.

Suborbicular, from one to one and one-third times as long as wide; sinus narrow linear; semicells somewhat semicircular, margins undulate-crenate, or emarginate; two or three surface swellings near the base which cause prismatic reflections from the smooth pearl-like membrane.

Diameter 22–25 μ.

Found the first of this form in Splitrock pond, New Jersey, but occasionally since in other localities of the same State, and in Pennsylvania.

C. TITHOPHORUM, Nord. Plate XIX, figs. 28, 29, 30.

Cells about as long as wide, circular, deeply contricted; sinus an acute angle considerably amplicated (angle about 20°);

semicells from the base cuneate-semicircular; end view elliptical with a prominent central elevation; laterally seen, obovate-circular with a mamilliform prominence on each side.

Diameter 28 μ.; length 30 μ.

Collected this form from ponds on Mount Everett, Mass. It corresponds so nearly with a plant found on the island of Java, described by Dr. Nordstedt, I adopt the name of his choice.

C. HOMALODERMUM, Nord. Plate XVII, figs. 19, 20.

Slightly longer than broad, deeply constricted; sinus narrow linear with the mouth considerably ampliated; semicells trapezoid with a subreniform base; sides retuse; ends truncate, and often retuse; superior angles obtuse, inferior broadly rounded; seen from the vertex, elliptical-oblong with the middle, somewhat inflated; lateral view ovate. Ends about half as wide as the breadth of the cell. Cytioderm finely, often indistinctly, punctate.

Diameter 40 μ.

Ponds, Mount Everett, Mass.

The typical plant was found in the Arctic region, on the island of Spitzbergen. It is described by Dr. Nordstedt as measuring 48–51 μ. in diameter, about one-fifth larger than our plant; hitherto found only in one locality, 1881 and 1882.

C. CRUCIATUM, Breb. Plate XVIII, figs. 23, 24.

Length and breadth nearly the same, ends broadly truncate; deeply constricted; sinus narrow, enlarged outwardly; semicells trapezoid-reniform, inferior angles obtuse; sides incline towards the truncate end; margins somewhat crenate. Two nuclei in each semicell; membrane finely granulate or punctate.

Diameter 22–24 μ.

Swamp and marsh pools; rather rare.

C. PHASEOLUS, Breb. Plate XVIII, figs. 28-32.

Cells about as long as wide, smooth; constriction deep, forming a linear, excavated, notch on each side; semicells reniform; end view elliptic with a slight projection in the middle of each side.

A common species to be found, probably, in every State of the Union.

C. BIERME, Nord. Plate XIX, figs. 23, 24.

Small, about as long as wide, deeply constricted, sinus wide at the mouth; semicells elliptic, base and back somewhat truncate; in the centre a large verruca; viewed from the end, elliptic, with a prominent cylindrical verruca in the centre of each side; lateral view, obovate furnished with a similar verruca. Membrane smooth.

Breadth 13 μ.; length 14 μ.

Denmark Pond and Budd's Lake, N. J.

C. SCHLIEPHACKEANUM, Grun. Plate XVIII, figs. 14, 15.

Very small, subquadrate, as broad as long, smooth, entire, deeply constricted; semicells depressed, ends broadly truncate, or plane-convex; sides convex, often projecting at an obtuse angle; centre more or less inflated.

Breadth 12 μ.; if not equal, slightly less in length.

Occurs occasionally in large numbers, but more frequently it is found singly in ponds of Pennsylvania, New Jersey, Massachusetts, Minnesota.

$\frac{2}{2}$ Cells with a central inflation, membrane granular.

C. ORNATUM, Ralfs. Plate XVIII, figs. 39–45; Plate XLIX, figs. 22–24.

Cells of nearly equal length and breadth, constriction deep, narrow; semicells with a somewhat reniform base, angles broadly rounded, end truncate; sides inflated below, and contracted and concave near the end, thus producing a truncate projection which in end view forms a rounded lobe; membrane rough with pearly granules which give a dentate appearance to the margin.

Diameter 33–45 μ.

Not uncommon; probably no form is more generally distributed throughout the earth. It is variable in size, in the arrangement of the central granules and in the projection.

Var. PROTRACTUM. Plate XLIX, fig. 22; Plate XVII, fig. 29.

The figure (Plate XLIX) represents a form collected July, 1883, by my friend, Dr. Kitchel, in Lake Minnetonka, Minn. He found it freely intermingled with the typical form (fig. 23). It is in all its parts except the more protracted ends, so like

the true form, I consider it merely a variety of *C. ornatum*. Plate XVII, fig. 29, is a good representation of *C. protractum*, Naeg., but the specimens, found in large numbers, clearly show their connection with *C. ornatum*. Compare note under *C. protractum*.

C. SPORTELLA, Breb. Plate XLIX, figs. 28–30.

Very nearly as long as broad, deeply constricted; semicells subreniform, sides somewhat dilated and rounded, end broadly truncate, margins erose-spinous or denticulate; cytioderm granular.

Diameter 33–36 μ.

Harvey Lake, Luzerne County, Pa. Bears some resemblance to *C. ornatum*, but ends do not protrude; granules are more spinous than rounded, producing the erose appearance of the margins. Found many specimens in this one locality, but did not recognize the form elsewhere.

C. PROTRACTUM, (Naeg.) Archer. Plate XVII, figs. 27–28.

But slightly longer than wide, constriction deep, sinuses narrow linear, often ampliated from the acute angles; semicells with tumid base, twice as broad as long, angles rounded, sides deeply sinuate below the truncate end. Viewed from the vertex, elliptic with a central inflation; membrane granular.

Diameter 70–80 μ.

The plants recognized by different authors as of the present species, by their protracted ends of the cells, are very variable in size and details of form. Plate XVII, figs. 27, 28 represent the true form; from pools in marshy grounds, Pennsylvania. Fig. 29 is another form, less than half the size, found in numbers in a pond near Branchville, Sussex County, N. J. Plate XLIX, fig. 22 is a third variety from Minnetonka Lake, Minn., intermediate in size, but so closely related to *C. ornatum* in size, form, and arrangement of granules, I call it a *variety* of that species. The other (fig. 29) is evidently of the same connection, hence I transfer it from the position given it by Naegeli to companionship with the latter.

C. COMMISURALE, Breb. Plate XVIII, figs. 49–51.

Semicells short reniform, three times broader than long,

rough with pearly granules; end view with a constriction between the central inflation and the extremities.

Diameter 34–38 μ.; length 25–30 μ.

Sparsely found in ponds of Pennsylvania, New Jersey, New Hampshire, and probably most of the States.

C. SUBCRENATUM, Hantzsch. Plate XVIII, figs. 6, 7; Plate XIX, fig. 20.

Cells with apices or ends more or less distinctly quadricrenate, sides with (4–) 6 crenae; within the margins three or four series of granules; the swelling near the basal line has usually five short series of granules; viewed from the vertex, elliptic, apices truncate-retuse, sometimes rounded; on the swollen middle are often seen five prominent granules; lateral view, ovate with basal swellings and truncate ends.

Diameter 20–26 μ.; length 23–36 μ.

Ponds, and sluggish streamlets, Pennsylvania, New Jersey, Massachusetts, Minnesota.

C. PROTUBERANS, Lund. Var. GRANULATUM, Wolle. Plate LI, figs. 13, 14, 15.

Cells about one-fifth longer than broad; constriction deep, narrow linear; semicells nearly twice as wide as long, base straight, sides somewhat diverging from the basal line; superior angles nearly right, inferior angles obtuse; near the middle of the cell, is a small granulated tumor; seen from the vertex elliptic with a central swelling on each side; lateral view nearly spherical; membrane granular.

Diameter 25–28 μ.

From a small pond near Minneapolis, Minn. This desmid is evidently not the same as found in Sweden and described by Lundell, but it possesses the principal feature, the "protuberans" derived from the excess of the diameter of the end of the semicell over the measure of the base. It differs in the less prominent central inflation, and in having the membrane granular, not punctate. Kirchner describes a new species, *C. pseudoprotuberans*, which has no central inflation, no granules nor puncta.

C. QUASILLUS, Lund. Plate XVII, fig. 13, 14, 15.

Somewhat longer than broad, constriction deep, sinus linear.

Semicells trapezoid, narrowed from the broad, straight, base to the truncate end; sides, below, granulate dentate above undulate; ends lightly undulate; angles, inferior and superior, obtusely rounded; cytioderm coarsely granulate, the verrucae in subconcentric lines; end view shows a basal, granulated protuberance.

Diameter 60–70 μ.; length 66–75 μ.

I found this form first in the vicinity of Bethlehem, Pa., in the year 1877, and then described it in the "Bulletin Torrey Bot. Club," of New York, Vol. VI, p. 186, as a new species, *C. irregulare*, in reference to the irregular size of the crenae of the sides. Later research revealed Lundell's earlier description.

Since 1877, have found the same plant in various localities in Pennsylvania, Massachusetts and New Jersey.

C. Everettense, Wolle. Plate XVII, figs. 10, 11, 12.

Cells as long as wide; constriction deep; sinus linear, often much ampliated; semicells with ends broadly rounded, or truncate, sides convex; membrane rough with large verrucae arranged in concentric series; apex usually nude, surrounded by short, acute, conical teeth; end, and transverse view show a decided central inflation.

Length and breadth, 50–52 μ.

Ponds, Mt. Everett, Mass.

C. Eloiseanum, Wolle. Plate XIX, figs. 1, 2.

Cells large, one third longer than broad; constriction forming a deep, linear, outwardly widening sinus on each side; semicells semicircular, margins set with long pointed teeth or aculei; centre inflated and granularly rough, intermediate area smooth or punctate; end view oval with a granular tumor on each side, and two somewhat converging series of teeth or aculei extending from end to end.

Diameter 75 μ.; length 100 μ.

Found in a pond in the vicinity of Minneapolis, Minn., by Miss Eloise Butler. The first specimens gathered late in the season (1882) were of a dull yellow, or brown color. Specimens of the following summer were dark green.

C. BROOMEI, Thwaites. Plate XVII, fig. 6–9.

Usually as long as broad, sometimes slightly longer, obtuse-quadrangular; sinus narrow linear; semicell oblong-quadrangular, twice as broad as long, angles, inferior and superior, obtusely rounded, base plane, end broadly truncate and often slightly retuse, or moderately convex; end and side view evidence a distinct central inflation; cytioderm rough with pearly granules arranged in suberect lines.

Diameter 30–45 μ.

Appears to be entitled to the term "common."

C. PSEUDOBROOMEI, Wolle. Plate LI, fig. 36. 37.

This new species is in all its details of structure like the preceeding, but entirely devoid of a central inflation.

Diameter 30–45 μ.

Wood Lake, northern New Jersey, furnished scores of specimens of this species the past Summer, 1883.

C. BIRETUM, Breb. Plate XVII, figs. 1. 2.

Subquandrangular or polygonal; a deep constriction forms a narrow linear sinus; semicells obtuse-quandrangular, with subreniform base, and end broad, subplane-convex, dilated; cytioderm rough with pearl-like granules arranged in concentric series; end view shows a prominent central swelling.

Diameter 55–60 μ.

Rather rare, singly among other *Algæ*, but occasionally in quantities. Had a cluster of *Oedogonium* from a sluggish stream near Closter, N. J., literally covered with specimens of this species.

C. CAELATUM, Ralfs. Plate XVIII, figs. 46, 47, 48.

Suborbicular, deeply constricted, sinus narrow linear; semicells subsemicircular, diameter equal to twice the length; margins scolloped or broadly crenate, with four crenatures at the end, one on each side at the base, and one intermediate between it and the end; the lateral, basal ones are the largest; membrane sulcated between the crenatures; rough with pearly granules; end view oval, somewhat inflated at the middle.

Diameter 40 μ., more or less.

A distinct species which turns up frequently in smaller numbers.

C. QUADRIFARIUM, Lund. Plate XVII, figs. 16, 17, 18.

About one-fourth longer than broad, deeply constricted, sinus narrow linear; semicells, semicircular; inferior angles nearly right; margin composed of 17 emarginate-truncate verrucae; within the margin a similar series; basal tumor orbicular, furnished with 12–17 larger granules; viewed from the vertex, elliptic, with a granulated tumor on the middle of each side, and four series of granules extending from end to end; lateral view has a granulated swelling on each side and four granules on the end terminating four series. Two chlorophyllous nuclei in each semicell.

Diameter 33–36 μ.; length 40–44.

Frequent in ponds, Mt. Everett, Mass.

C. KJELLMANII, Wille. Plate XLIX, figs. 19, 20, 21.

Nearly equal in length and breadth, deeply constricted in the middle, sinus linear with mouth considerably ampliated; semicells cordiform, sides nearly straight, or low convex; apex truncate with four or six light crenulations; the sides each with six indentations; granules arranged in radiating lines, none in the centre, but a basal tumor has five vertical series of granules; observed from the vertex the semicells are narrow elliptic, with a tumor on each side.

Diameter 20–25 μ.

Wood Lake, Sussex County, New Jersey.

C. BLYTTII, Wille. Plate XIX, figs. 31, 32, 33.

Small, somewhat longer than broad; semicells subreniform, apex truncate with four crenulations; sides erose-crenate (crenae three); semicells within the margin, granulate, granules arranged in two series of about fourteen and nine; in centre a small prominence. Lateral view circular with a papilla on each side; end view elliptic, with a prominence or papilla on each side.

Diameter 14–15 μ. Length 17–18 μ.

Waters of Sussex County, N. J.—Long Wood pond, Wood Lake.

C. SPECIOSUM, Lund. Plate XIX, figs. 7, 8, 9; 14, 15.

Cells about one and one-half times longer than wide; elliptic-oblong, constriction forms a narrow linear sinus; semicells with sides slightly convex, but moderately converg-

ing to the subtruncate end; inferior angles nearly square, base plane; margins crenate, crenae eighteen; within the margins granulate; granules arranged in regularly radiating, and concentric series; at the base seven to eight vertical series of smallar granules; viewed from the vertex elliptic with a central inflation, ends crenulate; lateral view subovate; thickness of cells about one-half of the diameter of the cell; isthmus equal to about one-third of the measure of the breadth.

Diameter 33–50 μ.; length 50–75 μ.

The plants recognized as the *C. speciosum* of Lundell, are usually larger than the Swedish forms, but they have the same outline, truncate end, swollen centres, arrangement of granules and crenulate margins.

C. SUPRASPECIOSUM, Wolle. Plate L, figs. 5, 6.

Large, broadly oval, about one-third longer than broad, ends truncate; deeply constricted; isthmus rather less than a third part of the breadth of the cell; sinus narrow linear; margins crenulate with thirty or more crenae to each semicell; usually about sixteen on each side and five or six on the truncate end; ornate with large undivided granules arranged in concentric and at the same time, radiating series, extending from the margin nearly half way to the centre; central area nude except five or six vertical series of smaller granules; end view shows a prominent central inflation; lateral view broadly ovate, sinuate towards the ends.

Diameter 65–70 μ.; length 90–95.

Occurs frequently in ponds, northern New Jersey and in Pennsylvania.

C. PECTINOIDES, Wolle. Plate XIX, figs. 12, 13.

Suborbicular, somewhat longer than broad, constriction deep, sinus narrow linear within and widening outwardly; semicells semiorbicular with the angles rounded, undulate on the margins with twenty or more crenulations; rough with geminate rows of pearly granules symmetrically arranged in radiating and concentric lines. On green cells the united twinned granules appear oblong and the crenulations dentate; at the base of the semicells the inflation is marked with six, more or less distinct, vertical series of smaller granules; end and side view evidence a distinct basal protuberance.

Diameter 45 μ.; length 60 μ.; somewhat variable in size.

A resemblance to forms of many sea side shells suggested the name. Not abundant but is found frequently in smaller ponds of Pennsylvania and New Jersey.

This form is near *C. pulcherrimum*, Nord., but differs in the gaping sinus, the rounded inferior angles of the semicells, the number of crenulations, and larger size.

C. PSEUDOPECTINOIDES, Wolle. Plate XIX, figs. 16, 17, 18.

Differs from the typical plant in its smaller size, less number of crenulations, and absence of the series of granules on the basal inflation, instead the granules are scattered.

Diameter 30–35 μ.

Have this form from Florida, from the White Mountains, N. H., and the Lehigh Valley, Pa.

C. NASUTUM, Nord. Plate XIX, fig. 19.

Nearly one-fourth longer than broad, constriction forms a narrow linear sinus; semicells semicircular, margins incised-crenate, crenæ eight, smooth or granulate; cytioderm rough with eight radiating series of granules; end view oval with an inflation on each side.

Diameter 30–36 μ.

Rare, differs from the typical, arctic form in being smoother, not so strongly marked with coarse granules.

C. PYCNOCHONDRUM, Nord. Plate XIX, figs. 10, 11.

About one-fifth longer than the diameter; subhexagonal, constriction deep, sinus narrow linear; end truncate quadri-crenate; angles inferior and superior obtusely rounded; sides moderately convex with about six crenæ each; at base nine to twelve vertical, or somewhat diverging series of granules; membrane ornate with additional granules arranged in lines, at the same time radiating and concentric; the former courses are double, and often triple near the margin; central area within the concentric rows, is nude. Seen from the vertex, or from the side, a basal inflation is evident; thickness of the cells, equal to about half the length; isthmus measures about half as much as the breadth.

Diameter 50 μ.; length 79 μ.

The only locality from which I had this form is Nebraska Notch, Vt., from collections made by C. G. Pringle. It differs from the typical, arctic (Spitzbergen) form in its greater proportionate length.

C. PULCHERRIMUM, Nord. Plate XLIX, figs. 25–27.

Cells oblong, ends rounded, about one-third part longer than broad, margins crenulate, constriction deep, sinus narrow linear, not ampliated towards the mouth; semicell subsemicircular, inferior angles square, basal centre inflated and furnished with about five vertical series of granules; lateral view broadly ovate, end rounded, and base of each side more or less inflated; membrane granulate near the margins, granules arranged in about four to five concentric series; area nude between these and the vertical series.

Diameter 33 μ.; length 40 μ.

This desmid is proportionately shorter than the typical forms described by Dr. Nordstedt. The one from Brazil and the other from the island of Spitzbergen, which measure one and one-third to nearly twice as long as wide. My specimens are from Minnesota, and from several localities of eastern Pennsylvania.

C. RADIOSUM, Wolle. Plate XIX, figs. 21, 22.

Cells orbiculate, about one-eighth longer than broad; semicells semicircular, separated by a deep narrow linear sinus; ends round or slightly depressed, clothed with semiorbicular granules arranged in about thirty-five radiating lines; basal inflation has about eight vertical, or somewhat diverging series of granules; lateral view subrectangular oblong; end view elliptic with central inflation.

Diameter 50 μ.; length 56–58 μ.

Sluggish waters, Northampton Co., Pa.

Genus, TETMEMORUS, Ralfs.

Cells cylindrical or fusiform, slightly constricted in the middle, narrowly incised at each end, but otherwise entire. Cytioderm mostly punctate or granulate.

The cells are elongated as in *Penium*, from which, however, this genus may be distinguished by the incised ends and by the central constriction.

T. BREBISSONII, (Mengh.) Ralfs. Plate XX, figs. 1–2; Plate L, fig. 36.

Cells in front view cylindrical, not attenuated at the truncately rounded ends; in lateral view fusiform, attenuated from the middle to the rounded ends; cytioderm striately punctate. Cells four to six times longer than broad.

Diameter 18–20 μ.

Frequent in ponds everywhere.

Var. TURGIDUS, Ralfs. Plate XX, figs. 4, 5.

This variety is larger, the constriction greater, and the semicells somewhat inflated. It approaches in form *T. granulatus* but is more constricted at the middle, its puncta are arranged in longitudinal lines, and, front and side views are unlike.

Diameter 40–48 μ.

T. GRANULATUS, Ralfs. Plate L, figs. 33, 34.

Cells five to six times longer than broad, both in front and lateral views, fusiform, and ending in a colorless projecting lip-like process; slightly constricted in the middle. Chlorophyl usually with a longitudinal series of large granules. Membrane irregularly punctate.

Diameter 38–50 μ.

Frequent in ponds, and readily recognized by its figure, both in front and lateral views, fusiform.

T. LAEVIS, (Kg.) Ralfs. Plate L, fig. 35; Plate XX, fig. 3.

In front view somewhat tapering with truncate ends; lateral view fusiform; punctae none or very indistinct; four to six times longer than broad.

Diameter 20–22 μ.

Not so frequent as the preceding, but not confined to any particular localities.

T. MINUTUS, D. By. Plate XX, figs. 7, 8, 9.

Smaller than the preceding, only three times longer than broad, membrane smooth.

Diameter 18–20 μ.

Had this species from Florida, New Jersey and Pennsylvania.

T. GIGANTEUS, Wood. Plate XX, fig. 6.

Very large, oblong, three times longer than broad, with the ends not usually attenuate but broadly rounded; suture profound, linear; cytioderm irregularly granulately punctate; somewhat plicate at the base of the semicells.

Diameter 75 μ. more or less.

Ponds, Pennsylvania, and New Jersey.

The diameter varies from 68–75 μ. and "is preserved uniform until near the end, where there is an alteration in the line of the margin so as to cause some contraction, which is however wanting in some specimens."

Genus, XANTHIDIUM, Ehrb.

Cells single or geminately concatenate, inflated, profoundly constricted; semicells compressed, entire, spinous, protruding in the centre as a rounded, truncate, or denticulate tubercle. Cytioderm firm, the spines with which it is armed, simple or bi-tri-furcately divided at the ends. Zygospore globose, smooth or spinous.

X. ARMATUM, (Breb.). Ralfs. Plate XXI, figs. 1–4.

Semicells largest at the base, about as long as broad, armed with numerous, short, stout spines terminated by two, three or more diverging points.

Diameter 62–140 μ.

Very variable in size. Fig. 1 is a finely developed form from Mt. Everett, Mass. The other two are more usual varieties found in all the States with which I had any communication.

This is the only species with spines divided at the apex. Wood has two more, as *X. arctiscon*, and *X. coronatum*, but these must be separated from this genus, and placed with *Staurastrum*.

The following have subulate spines:

X. ACULEATUM, (Ehr.) Breb. Plate XXIII, figs. 10, 11, 12.

Spines subulate, more or less scattered; central projection truncate, obscurely dentate.

Diameter 62–70 μ.

Prof. Bailey reports this species from South Carolina, Georgia and Florida.

X. BISENARIUM, Ehrb. Plate XXIII, figs. 7, 8, 9.

Cells in front view broader than long; constriction deep, sinus acute angled; spinous; spines subulate, marginal, geminate; central projection somewhat truncate and margined with pearly granules.

Diameter 65–73 μ.

West Point, N. Y. (Bailey.)

Ralfs suggests that this is the same as his *X. Brebissonii*. The number of spines appears to be variable. Bailey and Ehrenberg's figures have six pairs of spines. Brebisson's, eight; whilst some British specimens have ten to each semicell.

X. CRISTATUM, (Breb.) Ralfs. Plate XXI, figs. 5–8

Semicells with a solitary spine on each side at the base, the other spines geminate, in four pairs. Central protuberance, short conical.

Diameter 40–55 μ.

Pennsylvania, New Jersey, South Carolina, Georgia, etc.

X. ASTEPTUM, Nord. Plate 21, figs. 9, 10, 11.

About one-fourth longer than wide; semicells octangular-oval, or truncate-triangular with two diverging, somewhat curved, subulate spines on each side, and two geminate spines at each of the two superior angles. Cytioderm smooth or punctate.

Diameter 40–48 μ. without the spines.

Rather rare; quiet waters, Pennsylvania and New Jersey.

X. FASCICULATUM, (Ehrb.) Ralfs. Plate XXII, figs. 4, 5.

Semicells with four, rarely six pairs of long, subulate, marginal, spreading spines; central projection, minute conical, not beaded.

Diameter 55–65 μ. without the spines.

Var. HEXAGONUM, Wolle. Plate XXIII, fig. 5.

Large angular, with four pair of short subulate spines.

Var. MINOR, Wolle. Smaller in size, and spines short.

Plate XXII, figs. 6, 7, front and lateral view of a semicell which appears to develop a sporangium without copulation. I found but one specimen of the kind, and record it as a peculiar abnormal act.

X. ANTELOPÆUM, (Breb.) Kg. Plate XXIII, figs. 1, 2.

Differs from the preceding in smaller size than the typical *X. fasciculatum*, and in the reverse curvature of the lateral spines.

Diameter 45–50 μ.

Var. POLYMAZUM, Nord. Plate XXIII, figs. 3, 4.

Unlike the true form in the series of bead-like granules over the central protuberance.

Var. TRIQUETRUM, Lund. Plate XXII, figs. 1, 2, 3.

Instead of an oval, end view, this is triangular, similar to a form discovered by the author (Lund.) in Sweden, and to another from Brazil, described by Dr. Nordstedt.

The only locality for this variety, hitherto found, is a trench near Quakertown, Bucks County, Pa. The other forms may be called common.

Var. MINNEAPOLIENSE, Wolle. Plate LII, fig. 16.

A new form from Minneapolis, Minn., possessing the peculiarity of a fifth pair of aculei immediately over the central protuberance and bead-like series of granules.

X. RECTOCORNUTUM, Wolle. Plate XXII, figs. 10, 11.

Cells as long as wide; constriction linear, sinus sometimes slightly excavated, and sometimes gaping; semicells semicircular, finely punctate or smooth; two rows of beads above the central protuberance, the one with 6–10, and the other under it with half the number; another series of beads on the base forming a ring around the isthmus; ends broadly rounded, nude; basal angles with two pairs of aculei, or subulate spines; the one horizontal, the other vertical; transverse view somewhat in the form of an hourglass, truncate, crenate at the ends with two vertical aculei in the centre.

Diameter without spines, 55–60 μ.

Frequent in ponds, Mount Everett, Mass.

This species differs from *X. antelopæum* in having the ends of the cells bare, the upper pairs of spines not incurved nor divergent, but erect, straight, attached to the sides, and springing from the basal angle. It is also quite unlike that species in the three series of beads, and in its transverse view.

X. TETRACENTROTUM, Wolle. Plate XXII, figs. 8, 9.

About as long as broad, smooth, constriction deep, sinus enlarged outwardly; semicells subreniform or subhexagonal, base somewhat convex, ends broadly rounded; basal angles on each side armed with a pair of subulate spines; central protuberance low, over it sometimes, a series of bead-like granules.

Diameter 33–37 μ., without spines; 60 μ. with spines.

Pond, Sussex Co., N. J,

The form and character of this species, is very near *C. antelopæum*, but it is smaller and bears only two pairs of aculei, not four or six.

Genus, ARTHRODESMUS, Ehrb.

Cells simple, compressed, deeply constricted in the middle; semicells broader than long, with a single spine or mucro on each side, but otherwise smooth and entire.

A. CONVERGENS, (Ehrb.) Ralfs. Plate XXIII, figs. 19, 20, 21.

Semicells elliptic, each having its spines curved towards those of the other semicell.

Diameter 38–40 μ.

Several varieties are acknowledged to this species, one with shorter and almost straight spines, another with broadly fusiform cells. Plate XXIII, figs. 22, 23, I place with the varieties.

This species is common.

A. FRAGILE, Wolle. Plate XXIII, figs. 16, 17, 18.

Semicells broad, oblong-oval; aculei straight and parallel, *i. e.*, the aculeus of one semicell is parallel with that of the other; deciduous. Chlorophyllous nuclei, two.

Diameter 38–33 μ.; length somewhat less.

Central New Jersey, pond at Hammonton, and other waters.

A. RAUII, Wolle. Plate XXIII, figs. 13, 14, 15.

Cells slightly longer than broad, aculated or verrucose; aculei short and stout, deciduous, leaving, after falling off, large verrucae; usually six on the margin of each end, and two curved series of about six each on the membrane within

margin; semicell broadly elliptic, with a single outwardly curved aculeus at each end.

Diameter of cell without aculei 38 μ.; with aculei 63 μ.

This species was collected with swamp moss (*Sphagnum*), by E. A. Rau, in a pond near Newfield, N. J. It bears some resemblance to *A. divergens*, Rab., but it is not *subtillissime verruculosus;* also to *A. quadridens*, Wood, but it is twice the size of that plant, and not *quadridens*.

A. OVALIS, Wolle. Plate XXIV, figs. 13, 14.

Cell small, smooth, often about one-fourth longer than wide, semicells oval, armed at each end with a straight or diverging aculeus.

Diameter 20 μ., without aculei.

Ponds, Mt. Everett, Mass.

The smaller size, the straight, erect or slightly diverging spines, I consider sufficient to separate this form from *A. convergens*.

A. SUBULATUS, Kg. Plate XXIV, figs. 11, 12.

Semicells elliptic, larger than the preceding, with long, subulate, erect or somewhat diverging spines.

Diameter 30–35 μ.

Ponds, New Jersey, rather rare. I have somewhat modified the original diagnosis, by putting *diverging* for *converging*, and thus claim for this plant a distinct position.

A. ORBICULARIS, Wolle. Plate XXIV, figs. 15, 16.

Very small, smooth, orbicular; semicells united by a narrow isthmus; aculei of the two semicells nearly parallel.

Diameter, without aculei, 12 μ.

Ponds, Mt. Everett, Mass.

A. QUADRIDENS, Wood. Plate XXIV, figs. 17, 18.

Broadly oval or suborbicular, a little longer than broad, with the margin crenately undulate; semicells somewhat reniform, at each end armed with a subulate, moderately robust, acute, recurved, large spine; cytioderm with a few smallish tubercles arranged in three or four rows; semicells from the vertex acutely elliptical, with the margin crenate and the surface sparsely warty.

Diameter 19 μ.; length 30 μ.

Saco Lake, N. H., (Lewis) Wood.

A. INCUS, (Ehrb.) Hass. Plate XXIV, figs. 1–10.

Cells minute, smooth, as long as, or longer than broad, constriction a deep notch or sinus; semicells with inner or lateral margins turgid; outer, truncate; spines diverging, subulate, acute; sporangium orbicular, spinous; spines subulate.

Diameter very variable 10–36 μ.

Turned up frequently in every State in which explorations have been made.

A. OCTOCORNIS, Ehrb. Plate XXIV, figs. 19–23.

Smooth, about as long as wide; the sinus produced by a deep constriction, a wide notch. Semicells much compressed, trapezoid, each angle terminating by one or two subulate, acute spines; the intervals between the spines concave. Some specimens without reference to size, have two spines at each angle.

Diameter 16–25 μ.

Not abundant, but scattered from Maine to Florida.

Genus, EUASTRUM, Ehrb.

Cells oblong or elliptic, deeply constricted into two semicells which are emarginate and usually incised at their ends; sides symmetrically sinuate or lobed; provided with circular inflated protuberances (rarely absent); viewed from the vertex, elliptic. Zygospores spherical, tuberculose or spinous.

E. CRASSUM, (Breb.) Kg. Plate XXV, figs. 1, 2, 3.

Cell about twice as long as broad, smooth; semicells three lobed; basal lobes very broad, with a wide shallow marginal sinus; terminal lobe cuneate, partly included in a notch formed by the lateral lobes; incision in terminal lobe linear or acute angled.

Diameter 68–82 μ.

A large, and not rare plant in shallow spring, and pond waters.

E. ORNATUM, Wood. Plate XXV, fig. 4.

A species which is very close to *E. crassum;* perhaps not separable from it. The author, Wood, says "it differs in the proportionate length, being only twice instead of three times

as long as broad; in the size being only three-fourths as large; and especially in the peculiar lateral splitting, as it were, of the basal lobes."

In our observations, very few specimens of *E. crassum* ever exceed two diameters in length; they vary greatly in size, and the "lateral splitting," a delusive appearance, is common to all of them when the cells are empty.

Saco Lake, New Hampshire, (Wood).

E. OBLONGUM, (Grev.) Ralfs. Plate XXV, figs. 5, 6, 7.

Cell smooth, oblong, semicells somewhat five lobed; lobes nearly equal, cuneate; lateral lobes, or the basal only, with a broad, shallow, marginal concavity; all their angles rounded; terminal lobe partly included between the lateral lobes, usually with a linear notch, sometimes this is obsolete or very indistinct.

Diameter 68–75 μ.

This species is very variable, and if the end lobe, fig. 5, were constant with the apex so broadly sinuately excised, it should be separated; it is often incised with an acute-angled notch. The two forms, fig. 5 and fig. 6, are two distinct varieties.

Rhode Island, New Jersey, Pennsylvania, Minnesota, and other States.

E. MULTILOBATUM, Wood. Plate LIII, fig. 11.

About twice as long as wide, profoundly constricted; sinus moderately large; from the lateral view somewhat enlarged and doubly biumbonate in the middle; semicells from the front trilobate, the lobes separated by very wide sinuses; the basal lobe broadly emarginate, the central lobe obtuse, the end lobe broadly and shallowly sinuately emarginate; semicells from the vertex five lobed; cytioderm smooth.

Diameter 62 μ.; length 120 μ.

Saco Lake, New Hampshire.

This form, described by Wood, has not yet come across my path.

E. PINNATUM, Ralfs. Plate XXVIII, figs. 14, 15, 16.

Semicells five lobed; end lobe exserted, dilated, upper margin of all the lobes nearly horizontal. The basal lobes

emarginate, and the intermediate ones smaller and entire. Membrane punctate; terminal lobe with a linear notch.

Diameter 60–70 μ.

Meadow and mountain pools, Pennsylvania.

E. HUMEROSUM, Ralfs. Plate XXVIII, figs. 12, 13.

Semicells with terminal lobe dilated, emarginate, neck sometimes partly included between the elongated middle lobes which resemble processes; basal lobes large, rounded, emarginate. Cells smooth, two or three times longer than wide; notch of the end lobe indistinct, or short linear.

Diameter about 75 μ.

Sluggish waters, Pennsylvania.

If this form is not identical with Ralfs' figure, it is very near it. The plant bears some evidence of relationship also with *E. crassum* and with *E. oblongum*, and may possibly be merely a variety of these.

E. ANSATUM, (Ehrb.) Ralfs. (*E. Ralfsii*, Rab.) Plate XXV, figs. 8, 9, 10; and Plate XXIX, figs. 11, 12.

Semicells inflated at the base, and tapering upwards to the notched but not dilated extremity; end view cruciform. Cytioderm punctate. There appear to be two distinct varieties of this species, perhaps distinct plants; the one twice the size of the other.

Diameter normally 25–36 μ. Var. *major*, Diameter 62–74 μ.

Frequent in ponds and quiet waters, widely distributed. The various sizes may represent different stages of development.

E. DIDELTA, (Turp.) Ralfs. Plate XXIX, figs. 9, 10.

Cells rather more than twice as long as broad; semicells pyramidal, inflated at the base and again at the middle; end scarcely dilated, more or less rounded, notch linear; transverse view shows four shallow lobes on each side and one on each end. Cytioderm punctate.

Diameter 22–25 μ; length 45–54 μ.

There is a smaller form which measures about one-fourth less. Specimens often very close to the following, *E. ampullaceum*. Transverse view nearly the same.

Frequent everywhere, north, south and west.

E. AMPULLACEUM, Ralfs. Plate XXVIII, figs. 8–11.

Semicell less in length than breadth, base inflated, not emarginate, but having on each side, near the middle, a small tubercle, or prominence; end lobe exserted and dilated, its notch linear, or somewhat gaping. Membrane minutely punctate. Transverse view, four inflations on each side and one at each end.

Diameter 62–75 μ.

Not as common as the preceding, but not rare.

E. AFFINE, Ralfs. Plate XXV, figs. 11, 12.

About twice as long as wide; semicells three lobed; basal lobes somewhat emarginate; intermediate between them and the end lobe on each side is a prominence, the upper margin of which is nearly horizontal; end lobe exserted, dilated, its notch linear. Cytioderm minutely punctate; transverse view very near the two preceding.

Diameter 45–50 μ.

Pennsylvania and New Jersey, to Georgia.

E. URNÆFORME, Wolle. Plate LII, figs. 11, 12.

Cells about one-third longer than broad; semicells urn-shaped, three lobed; terminal lobe dilated, centrally sinuate; lateral lobes horizontal with sides converging, sinuate, basal portion protruding, emarginate, upper part broadly rounded, a rounded sinus between them and the end lobe; protuberances, one at each angle of the terminal lobe; one at each of the basal angles, two intermediate, and one between the end and the lateral lobes.

Diameter 50 μ.; length 55–60 μ.

Wood Lake, Passaic County, N. J.

This form is nearest *E. pectinatum*, Breb., but differs in most essential points.

E. VERRUCOSUM, (Ehrb.) Ralfs. Plate XXVI, figs. 1, 5.

Cells somewhat longer than broad; rough with conic granules; terminal lobe cuneate, no incision, but a broad shallow sinus; lateral lobes cuneate with ends more or less concave; semicells with one large central inflation, and a smaller one on each side; two on the end lobe.

Diameter about 75 μ., for larger typical form.

The following varieties deserve a separate note:

Var. CRUX AFRICANUM, Wolle. Plate XXVI, fig. 2.

More angular, and more distended in the lobes, gives this form a strong resemblance to an African *Micrasterias*, described by Cohn, and suggests the name.

Pond, eastern Pennsylvania.

Var. ALATUM, Wolle. Fig. 4. Very near Corda's *Cosmarium alatum*.

Marsh pools near Minneapolis, Minn., and Bucks Co., Pa.

Var. REDUCTUM, Nord. Fig. 3.

This specimen does not agree as well as many others found in the same locality and group. I therefore add a translation of the author's diagnosis from his *De Algis—Musei Lugduno-Batavi:*

"Sinus between the semicells linear; sides and angles close; end lobe scarcely dilated, apex retuse, middle lobe small; end view rectangular; tumor in the middle of the semicell obovate elliptic, others very small."

E. CIRCULARE, (Hass.) Ralfs. Plate XXVIII, figs. 1, 2.

Semicells three lobed, mostly with five basal tubercles; end notched, scarcely dilated.

Ralfs makes three varieties; *a.* semicells inflated at the base and attenuated upwards; *b.* semicells emarginate at the sides, the basal portion with five tubercles; *c.* emarginate at the sides; tubercles smaller, more numerous and scattered.

Diameter 36 μ., more or less.

Rhode Island, New Jersey, Pennsylvania; common.

E. GEMMATUM, Breb. Plate XXVIII, figs. 3, 4.

About one-half longer than broad; semicells three lobed, lateral lobes horizontal, deeply emarginate; the protuberances minutely granulate; terminal lobe dilated, broadly emarginate; transverse view broadly elliptic, with three granulate inflations on each side (not four, as incorrectly drawn) and one at each end; end view shows the terminal lobe, cruciform.

Diameter 38 μ.

Found from Rhode Island to Minnesota, and southward.

E. EVERETTENSE, Wolle. Plate XXVIII, figs. 5, 6, 7.

Cells about twice as long as broad; semicells three lobed, basal lobes wide, emarginate; end lobe dilated, notch linear; two larger inflations near the middle, and several smaller ones on each side, and on end lobe. Transverse view broadly elliptic, with two protuberances on each side; side view shows one inflation on each side.

Diameter 50–55 μ.

Collected in ponds, Mount Everett, Mass.

This form bears some resemblance to *E. affine*, but it is clearly separable by the broad basal lobe, by the absence of the intermediate prominences, and by the arrangement of the protuberances which produce distinct forms in transverse and lateral views.

E. INSIGNE, Hass. Plate XXVII, figs. 39–43.

Semicells longer than broad, inflated at the base, sides entire, and tapering into a long slender neck; end lobe dilated with linear notch; end view quadrangular, with angles slightly protruding, and a swelling on each of the shorter sides; end lobe cruciform as shown on the middle of fig. 43.

Diameter 30–35 μ.

Rhode Island, Massachusetts, Pennsylvania, New Jersey and Florida.

E. MAMMILLOSUM, Wolle. Plate XXVI, figs. 14, 15.

Cell in length twice the diameter; semicells three lobed; basal lobes wide and nearly half as high as the semicell, drawn out in the centre into a narrow column one-third to one-fourth the diameter of the body; dilated at the end, sinuate, four-parted; base with six mammiform protuberances; membrane punctate; end view oval with three diverging mammiform prominences at each end.

Diameter of centre of cell 68 μ.; length 118 μ.

Ponds, Mount Everett, Mass., and Sussex County, N. J.

E. INTERMEDIUM, Cleve. Plate XXIX, figs. 1, 2.

Large, considerably longer than broad; semicells three lobed; basal lobes inflated, conical, apices rounded; end lobe considerably dilated, cruciform, with a linear notch; two inflations, one on each side of the middle; transverse view

elliptical, with two prominences on each side, and excavation between.

Diameter 112 μ.; length 165 μ.

Var. CUSPIDATUM, Wolle. Plate XXIX, figs. 3, 4, 5.

This variety differs in being more depressed, squatty, in having the lateral lobes cuspidate, end lobe not so wide, and greater thickness to the body of the cell. End view (fig. 5.) shows a more angular figure with end lobe cruciform; cytioderm punctate.

The typical form I found in various places in New Jersey; the variety only in a *Sphagnum* bed in a pond near Newfield, New Jersey.

The original plant was found in Sweden; our true form agrees well in size and figure with it.

E. ATTENUATUM, Wolle. Plate XXVI, fig. 17.

Small, twice as long as wide; semicells three lobed, basal lobes broad, emarginate; terminal lobe a column with nearly parallel sides, apex truncate.

Diameter 35 μ.

Rather rare, but I found a considerable number in swamp pools, Bucks County, Pa., and near Ocean Beach, N. J.

E. DONNELLII, Wolle. Plate XXVI, fig. 6.

Broadly ovate, somewhat longer than broad, profoundly constricted in the middle, sinus linear; semicells trilobed; basal lobes orbicularly tumid; terminal lobe semiorbicular; margin of each side armed with seven or eight short, stout, conical teeth. Semicells with one larger central and four smaller inflations; three of them in a series on basal part, and two on the end lobe. Cytioderm punctate.

Diameter 38 μ.; length 54 μ.

Florida. Coll. J. Donnell Smith.

E. FORMOSUM, Wolle. Plate XXVI, fig. 16.

Nearly twice as long as broad, oval in outline; semicell with six marginal lobes, apices trifid, or tridentate; central tooth erect and the other two divergent; the sections of the two basal lobules more rudimentary than the others. Cytioderm smooth.

Diameter 40 μ.; length 62 μ.

This plant bears some likeness to *E. Nordstedtianum*, but is separated from it by the less prominent teeth, and especially by the vertical position of the end lobules and the wide sinus between them.

E. DIVARICATUM, Lund. Plate XXVI, figs. 18, 19.

Cells one-fourth longer than broad, constriction deep, sinus linear; semicells subtriangular, gradually narrowing from a broad base to a truncate apex; sides undulate; polar lobe short, not dilated, linearly notched; angles of the terminal lobe, and of the basal lobe, armed each with a short aculeus; vertical view elliptic, middle of each side granulate dentate, ends also dentate.

Diameter 32–36 μ.; length 40–45 μ.

Occasional in ponds, Pennsylvania and New Jersey.

E. POKORNYANUM, Grun. Plate XXVII, figs. 33, 34, 35.

Semicells trilobed; basal lobes, margins crenate or emarginate; terminal lobe erect, subcuneate, truncate, incised; membrane smooth.

Diameter 17–20 μ.; length equal to two diameters.

Rather common, often intermingled with the following two forms which are so nearly allied, that it is almost impossible to separate them.

E. EROSUM, Lund.

Very near the preceding; in front view barely separable. End lobe usually rather wider, and not so deeply incised; notch obtuse-angled. End and lateral views somewhat quadrangular with ends imperfectly tricrenate.

E. INSULARE, Witt.

This form the author gives as a variety of *E. binale*. I prefer it separated because the basal lobes are emarginate, corresponding with the preceding two. It is distinguished by a greater breadth of the terminal lobe and the absence of an incision or notch; sometimes slightly sinuate. Size rather less.

E. INERME, Lund. Plate XXIX, figs. 6, 8; Plate XXVII, figs. 30, 36.

Subelliptic; semicells subtriangular, apex somewhat protracted, truncate, deeply incised, not dilated or dentate; sides

biundulate, the basal crenæ most prominent, obtuse, and angle obliquely truncate; tumors three, inconspicuous and sometimes wanting; end view subelliptic, sides bigibbus; side view ovate. Membrane finely punctate.

Diameter 32–38 μ.

Rather common.

E. CRASSICOLLE, Lund. Plate XXVII, figs. 37, 38.

About twice as long as wide. Sinus narrow linear. Semicells slightly attenuated, three lobed; lateral lobes, lightly sinuate-bilobulate; polar lobe broad, barely dilated, apex emarginate; end view hexagonal, poles truncate, middle inflated.

Diameter 14 μ; length, 28 μ.

New Jersey—not frequent.

E. CUSPIDATUM, Wolle. Plate XXVII, fig. 32.

Diameter slightly less than length; semicells distinctly three lobed, basal lobes extending laterally their own width; end lobe subrectangular, twice the width of the other lobes, obtusely sinuate in the centre; ends of the rounded basal lobes and of the two sections of the end lobe, surmounted each with three firm, diverging, aculei.

Diameter without aculei 25 μ.; with them 33 μ.

Pond, Absecom, N. J. Coll., H. D. Kitchell, 1882.

E. PINGUE, Elf. Plate XXVII, figs. 1, 2, 3.

Somewhat longer than broad; semicells three lobed, each lobe globularly rounded; the polar lobe with a small notch; side view oval with ends slightly truncate-crenate; end and side view shows a slight central inflation of semicells. Isthmus about one-fourth the diameter of the cell.

Diameter 35–45 μ.

Ponds, Atlantic and Passaic Counties, N. J. Our plants are often without the terminal notch, but otherwise so near the form described by Elfving, I adopt the name he has given.

E. NORDSTEDTIANUM, Wolle. Plate XXVI, figs. 7, 9–13; and Plate LII, figs. 13–15.

Cells quadrangular-oblong, not quite twice as long as broad; semicells obscurely three lobed; basal lobes broad, each

divided in the middle by a rounded notch into two lobules with tridentate or spinous ends; end lobe short, more or less emarginate, the two sides of the apex usually somewhat reflexed, with a subacute or rounded notch between; lateral margins furnished with two or three horizontal spines. End, transverse and side views (Plate LII, figs. 13, 14, 15), rectangular, with broad, square, and more or less sinuate sides and ends; angles dentate.

Diameter 45–50 μ.; length 70–75 μ.

Frequent in pond near Minneapolis, Minn.; rarer in New Jersey and Pennsylvania.

E. ELEGANS, Kg. Plate XXVII, figs. 10–16; 25, 26.

Oblong, one and one-half to two times as long as wide; central constriction narrow linear; semicells with sides somewhat converging, with a constriction near the truncate, angular end, and another, often very slight, between this and the base; ends divided by a linear or acute angled notch; side view oblong elliptic, apices acute-conic; end view oval with central inflation.

Diameter 18–36 μ. Common.

E. ROSTRATUM, Ralfs. Plate XXVII, figs. 8, 9.

Varies from the preceding in the protuberant, emarginate, or angular ends having a prominent, horizontal spine on each angle.

E. SPINOSUM, Ralfs. Plate XXVII, figs. 4–7, 17.

Nearly allied to the two preceding, but separated by the more decided lateral notch in the basal lobes forming two distinct lobules, each furnished with, usually, two horizontal or diverging spines. Somewhat larger.

Diameter 35–40 μ.

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

Another form nearly allied to the above three species or varieties; separated by the absence of the lower constriction of the semicell. Size is variable, diameter 16–36 μ.

The preceding four forms are closely related, and may be accounted mere varieties. They are frequent. Having for

comparison, scores of sketches made of plants from as many localities in different States from Vermont to Florida and westward to Minnesota, this division suggested itself as the most feasible and natural. I retain the old names but with somewhat modified diagnosis.

E. BINALE, (Turpin). Ralfs. Plate XXVII, figs. 23, 24.

Cells minute, about one-half longer than broad, oblong-oval; semicells with their basal portions entire; slightly contracted beneath the ends; apex dilated, its central notch acute, broad, gaping. Transverse view with two lateral inflations; ends truncate, angles rounded.

Diameter 15–25 μ.

Plants of this species have features in common with *E. simplex*, but may be readily recognized by the proportionately shorter form and the pouting separation of the end.

E. COMPACTUM, Wolle. Plate XXVII, figs. 28, 29.

Very small, suborbicular, little longer than broad; semicell broad, transversely oval; apex a slight protuberance with a linear incision; two small prominences, one on each side of the apical projection.

Diameter 20–22 μ.; length 28 μ.

Pond, Pennsylvania.

E. OBTUSUM, Wolle. Plate XXVII, fig. 31.

Minute, twice as long as wide; semicell obovate, base flattened, sides somewhat diverging, end broadly rounded with linear incision in the centre.

Diameter 14 μ.; length 25 μ.

Ponds, Pennsylvania.

E. ABRUPTUM, Nord. Plate LII, figs. 21, 22.

Cells one and one-half times as long as broad; constriction deep, narrow linear; semicells trilobed, lateral lobes somewhat protruding above the base, near the middle; ends truncately rounded and usually dentate or granulate; end lobe incised bifid, with exterior angles furnished with short spines; transverse view rectangular with large central inflation, end margin more or less undulate granulate, or sometimes retuse.

Diameter 28–30 μ.; length 40 μ.

Passaic County (Wood Lake), N. J.

This species does not strictly conform to the description of the author, but it has so much in common that with his consent, I adopt the name he chose for his Brazilian plant.

Genus, MICRASTERIAS, Ag.

Cells simple, lenticular, deeply constricted in the centre; viewed from the front, orbicular, or broadly elliptical; from the vertex fusiform with acute ends. Semicell three to five lobed; lateral lobes entire or incisely-lobulate; end or polar lobe entire or sinuate or emarginate, and sometimes with angles produced and bifid.

In but few species have the zygospores been detected; they are large, globular and furnished with stout spines, which are at first simple, then become branched at the ends.

SECTION I.—Cell circular; segments five-lobed; lobes approximate, the end lobe narrower.

M. TORREYI, (Bailey,) Ralfs. Plate XXX, figs. 1–8.

Circular; lateral lobes deeply incised, making two or three subdivisions to each; all more or less tapering, and acute or bidentate at the extremities. End lobe narrow, not exserted, dilated at apex, concave, angles taper into acute points or spines.

Diameter 250–300 μ.

Frequent in ponds of New Jersey, Mt. Everett, Mass., and few localities in Pennsylvania.

Often variable in the number and form of the subdivisions. Plate XXX represents eight varieties, the result of multiplication by dividing. Compare Introduction, page 18.

M. PSEUDOTORREYI, Wolle. Plate XXXII, fig. 1.

Large, circular, five-lobed; basal and intermediate lobes bisected, sections more or less conical, ends deeply furcate; polar lobe broadly cuneate, end truncate-sinuate, angles cuspidate.

Diameter of cell 180 μ.

Mt. Everett, Mass.

Separated from *M. Torreyi*, by its smaller size, the less number of lobules and their greater similarity of form.

M. RADIOSA, (Ag.) Ralfs. Plate XXXI, figs. 1, 2, 3.

Cell orbicular, smooth; semicells rather indistinctly five lobed; lobes dichotomously divided; ultimate subdivisions, inflated, attenuated, furcate at the ends. End lobe narrow cuneate, emarginate, and its angles dentate.

Diameter 150–200 μ.

A beautiful species and not rare, easily recognized by its many and deep incisions; it is variable in size and number of subdivisions; the latter range from twenty to forty in a semicell.

M. PAPILLIFERA, Breb. Plate XXXII, figs. 8, 9.

Orbicular, with marginal gland-like teeth; semicells five lobed; lateral lobes dichotomously incised; incisions narrow linear, the principal sinuses bordered by a row of minute granules. The end lobe about as wide as the others, and emarginate, its angles dentate. Endochrome is usually yellowish or brownish green.

Diameter 95–112 μ.

Is found sparsely in shallow pools, but in a wide range of many States.

M. ROTATA, (Grev.), Ralfs. Plate XXXIV, figs. 1, 2, 3.

Orbicular, smooth; semicells five lobed; lobes dichotomously incised with ultimate subdivisions variously bidentate in different plants. End lobe somewhat exserted. The basal lobes have each four subdivisions, and the intermediate lobes each eight.

Diameter 200–250 μ.

M. DENTICULATA, (Breb.,) Ralfs. Plate XXXIV, figs. 4–8.

Near the preceding, but separated by the usually obtuse apices of the subdivision, often more oval form of cells, and equal number of subdivisions in the basal and intermediate lobes; polar lobe not exserted. Size about the same, but many smaller varieties. Common.

M. FIMBRIATA, Ralfs. Plate XXXVI, figs. 1–8.

Large circular; semicells five lobed; dichotomously incised; end lobe cuneate with a broad shallow notch, or concave end, and two or three mucros, or spines, at each angle.

The ultimate subdivisions are rounded and slightly emarginate, each furnished with two spines usually divergently curved.

Diameter about 250 μ. Frequent.

This species is found in various forms, as illustrated by the figures, and may be noted as

Forma,—GENUINA, (figs. 1, 2). The typical plant.

Forma,—NUDA, Wolle, (fig. 4). A form which occurs frequently with almost all the subdivisions nude, devoid of spines.

Forma,—ELEPHANTA, Wolle, (fig. 3). Of gigantic size, diameter 400 μ.

Mount Everett, Mass.

Forma,—APICULATA, Menegh, (fig. 2). With series of minute spines bordering the sinuses.

Forma,—SIMPLEX, Wolle, (fig. 8). Small, oval, subdivisions with simply one small mucro.

This may prove a distinct species; the two specimens I had from Florida were too imperfect from drying for satisfactory identification.

M. BRACHYPTERA, Lund. Plate XXXII, figs. 6, 7.

About one-third longer than broad, elliptic, deeply constricted in the middle; sinus an acute angle somewhat ampliated; semicells five lobed; polar lobe longer than the intermediate lobes and separated from them by a wide sinus; neck moderately distending to the dilated apex; (neck tapering towards the apex, Lund.), depressed centre forms a wide, shallow notch. Intermediate and basal lobes short and nearly equal in breadth; twice bisected; apices of lobules furnished each with two rather long, somewhat curved spines; angles and margins of the end lobe, and margins of the other lobes also, provided with a few scattered spines. The figures of two semicells show considerable variation in the arrangement of the spines and divisions of lateral lobes.

Diameter 140–150 μ., without spines; length 200–210 μ.

Collected near Minneapolis, Minn., by Miss E. Butler.

SECTION II.—Cells subelliptic; semicells three or five lobed; lobes radiate, the end lobe somewhat exserted, divided and arms divergent.

M. FURCATA, (Ag.) Ralfs. Plate XXXV, figs. 5, 6.

Cells five lobed; lobes bifid, their divisions linear, divergent, and forked at the apex. The end lobe exserted, its divisions divergent, producing a wide shallow sinus.

Diameter 150–180 μ.; common.

M. PSEUDOFURCATA, Wolle. Plate XXXV, fig. 4.

Five lobed, simple, not bifid; sometimes the lateral lobes appear more like one bifid lobe on each side; in either case only half as many lateral arms as characterize the preceding species, *M. furcata*.

Diameter 150–160 μ.

Not as frequent as the true form, but it has a habitat in many localities in the Middle States.

Var. MINOR, Wolle. Plate XXXVII, fig. 11.

Small, not one-half the diameter of the typical form, but so nearly like it in outline, I note it as a variety. Had but two or three specimens, from Minneapolis, Minn.

M. CRUX-MELITENSIS, Ehrb. Plate XXXV, fig. 3.

Semicells indistinctly five lobed; lobes bifid, subdivisions short, and furcate at the apices.

Diameter 100–125 μ.

Not so frequent as *M. furcata*, to which it often bears a close resemblance; it is similarly divided, but the incisions are not so deep, the subdivisions not so elongated, rather stouter and less divergent; end lobe less exserted.

M. DICHOTOMA, Wolle. Plate LII, fig. 2.

Somewhat longer than broad, smooth or finely punctate; semicells three lobed; lateral lobes twice bifid; the ultimate lobules (four resulting from one) deeply furcate or clawed at the ends; the polar or end lobe exserted on a cylindrical neck with two diverging arms clawed at the ends.

Diameter with arms 175–200 μ.; length the same to one-fourth greater. Length of body 115 μ.; breadth of neck 15–17 μ.

Hitherto found this species in three localities only: ponds, Malaga, and Bamber, N. J., and Harvey Lake, Luzerne County, Pa.

M. RINGENS, Bailey. Plate XXXV, figs. 1, 2.

Oblong, semicells three lobed, with a series of granules inside of most of the margins; basal lobes divided by a deep notch into two spreading arms, obtuse or slightly dentate at the apices; terminal lobe exserted, emarginate, extremities obtuse.

Diameter 125–150 μ.

Obtained this species from Florida only, collected by J. D. Smith.

SECTION III.—End lobe produced into four, more or less diverging, rigid, processes.

M. AMERICANA, (Ehrb.) Kg. Plate XXXII, fig. 2 and Vars. 3, 5.

Semicells three lobed; lateral lobes broad, cuneate, their margins concave, incised-serrate; end lobe broad cuneate and exserted, bipartite at the angles; the subdivisions straight, narrow, minutely dentate at the extremities, end concave.

Diameter 100–115 μ.; length about one-third greater.

The wide distribution of this species entitles it to the name it bears.

There are several varieties, the one—

Var. RECTA, Wolle (fig. 3). Is distinct in the margin of the polar lobe, which is not concave and bisected, but straight with two small prominences.

Found it in a few localities in Pennsylvania and New Jersey.

Var. HERMANNIANA, Reinsch. (fig. 5).

Distinct in the angular intersections and regularly serrate margins.

Collected in Florida. It is not an exact counterpart of the plant described by Reinsch, but very near it.

M. MAHABULESHWARENSIS, Hobson. Plate XXXVII, fig. 10.

This form stands in close relation with the preceding species and varieties; it is separated by having the lateral lobes only once bisected, not twice. The margins are finely serrated.

Diameter 125 μ., more or less.

Ponds, New Jersey, and eastern part of Pennsylvania.

M. NORDSTEDTIANA, Wolle. Plate LII, figs. 3–5.

Cells of equal length and breadth, smooth; semicells three lobed; the lateral lobes divided into two subcylindrical segments with a wide notch between; ends obtuse, furnished with three or four small spines. Polar lobe exserted on a long neck having a short conical prominence about the middle of each side; the ends diverge in two pair composed of one longer and one shorter, nearly horizontal, arms; the two are nearly parallel.

Diameter 150 μ.

Longwood pond, Passaic County, N. J., and Harvey Lake, Lycoming County, Pa.

This species has a number of distinct features; the four arms of the end lobe; the protuberances of the neck; the lateral lobes have something in common with *M. ringens*, but they are smooth or finely punctate, not granulate; there is something also to remind one of *M. pseudofurcata*, but the arms are not furcate at the ends.

SECTION IV.—Cells circular; semicells obscurely five lobed, the end lobe the broadest.

M. DECEMDENTATA, Naeg. Plate XXXIII, figs. 5, 6.

Suborbicular, granulate-punctate; semicells distinctly three lobed, or obscurely five lobed; lateral lobes divided by a small obtuse angled sinus into two lobelets, having straight, truncate margins, angles slightly produced and mucronate; polar lobe broadly truncate, separated from the adjoining lobe by a narrow linear sinus; apex broadly convex, sometimes sinuate, lateral angles slightly produced and mucronate.

Diameter 83–100 μ.

Frequent in Florida; have not found it farther north. It differs from all forms described under this name, particularly in size. The author, *Naegeli*, gives the diameter 40 μ. *Delponte* quotes subalpine forms at 50 μ.; and *Lundell*, the Sweden plant also at 50 μ. which is only half the size of our plant, but omitting the measure, the description proves them identical.

M. CRENATA, (Breb.) Ralfs. Plate XXXIII, figs. 7, 8.

Cell orbicular; semicells with five shallow lobes; end lobe

very broad, cuneate, end convex, or slightly sinuate on the margin; lateral lobelets nearly entire.

Diameter 75–85 μ.

This species is met with only occasionally, Pennsylvania, New Jersey, Florida.

M. TRUNCATA, (Corda.) Ralfs. Plate XXXVIII, figs. 6–9.

Orbicular; semicells five lobed; lateral lobes shallow; end lobe very broad, truncate, angles bidentate; lateral ones incised-dentate.

Diameter 50–100 μ.

One of the most common species of this genus. Variable in size and in the structure of the margins; sometimes the lobelets are obscurely toothed; again very distinctly notched, and another form is frequent with the angles drawn out into long spine-like points, fig. 7. The truncate ends are usually more or less rounded; fig. 8 is a peculiar form with the ends perfectly flat, and not detached from one another after multiplication by division.

M. CONFERTA, Lund. (*M. granulata*, Wood). Plate LIII, fig. 12.

Broad-elliptic, central sinus deep, narrow linear; semicells five lobed, lobes and lobules always close; polar lobe subcuneate, more or less widened from the base to the end, sides concave and apex convex but roundly emarginate in the middle, angles furnished with two or three small papillæ; lateral lobes nearly equal, bisected, and again divided, each lobule with apex furnished with two papilla-like points.

Var. HAMATA, Wolle. Plate XXXVIII, figs. 3, 4.

In this variety, the polar lobe is not *conferta*, compact, close against the adjoining lobes, as in the true form, but widely separated in the whole length; the open space is produced by the contraction of the lobe below the apex, thus giving it a hamate form.

Diameter 88–100 μ., length slightly more.

Ponds, Mt. Everett, Mass.

The only locality from which I received the typical form is Aiken, S. C., the same from which Wood had it. This species was first known in Sweden, and described by Cleve, as *M. crenata*. Lundell separated it from that species and

named it *M. conferta;* it was so recorded with figure, in his *De Desmidiaceis, quæ in Suecia inventæ sunt*, published 1871, antedating Wood's contribution, by at least one year; having a priority claim, Lundell's name is preferred. The membrane is distinctly and largely punctate, not granulate, except when in old condition.

M. TRIANGULARIS, Wolle. Plate XXXVIII, figs. 1, 2.

Cell large, orbicular or oblong; semicells five lobed. Polar lobe triangular, apex and sides nearly straight and nearly equal, the angles mucronate. The lateral lobes similar, twice bisected, apices of the lobelets emarginate or furcate.

Diameter 170–200 μ.

I found plants recognized as belonging to this new species in three distinct localities; ponds, Broad Mountain, Pa., Ocean Beach and Bamber, N. J., and Florida. They vary somewhat in outline and details of intersections, but all have the same broad more or less triangular terminal lobe with mucronate angles. Fig. 1 is the typical, Pennsylvania form; fig. 2 the Florida type. The New Jersey plant had stouter terminal lobes, and the ultimate intersections of the lateral lobes were intermediate between the two.

SECTION V.—Cells oblong.

M. JENNERI, Ralfs. Plate XXXIII, figs. 1, 2.

Cells oblong, minutely granulated; semicells five parted, lobes closely approximate, cuneate lateral ones obscurely bipartite; the subdivisions emarginate.

Diameter 100–150 μ.

This species differs from all others of this genus in the form of the cell, often twice as long as broad. Fig. 2 is very near a form which Reinsch denominated *M. angulosum*. It is proportionately shorter than the typical form of Ralfs, but otherwise so near, it scarcely admits of separation.

SECTION VI.—Lobes horizontal, attenuated, bidentate.

M. LATICEPS, Nord., 1869. (*M. disputata*, Wood, 1872). Plate XXXVII, figs. 4, 5.

Quadrangular, about as long as broad, subpinnatisected, sinuses acute; terminal lobe nearly as long as the basal lobe; both the lobes strongly attenuated; the polar lobe into an

acute point and the other into an acutely bidentate apex; ends rounded or emarginate.

Diameter 160–212 μ.

This species made its first appearance from Brazil and was described by Nordstedt in 1869 in a scientific journal of Sweden. Wood gave the same plant a new name a few years later. The former has a claim of priority hence should stand. The plant varies considerably in size, and in the form of the terminal lobes; some are more rounded than others.

It has been found in a large number of States.

M. OSCITANS, Ralfs. Plate XXXIII, figs. 3, 4.

Cells of nearly equal length and breadth; the end lobe separated from the adjoining lobe by a rounded or acute-angled sinus; lobes horizontal, conical, their extremities usually bidentate. One form has the ends of the terminal lobe acute. The end lobes are much shorter and narrower than the others. Transverse view fusiform; membrane punctate.

Diameter 150–160 μ.

Bailey reports this species from Florida and Rhode Island, but makes the measures much less. I have specimens from Florida, Massachusetts and New Jersey. They were of the given measures.

M. PINNATIFIDA, (Kg.) Ralfs. Plate XXXVII, figs. 7, 8, 9.

Ends straight; semicells deeply constricted, lobes horizontal, more or less fusiform with apices bidentate.

Diameter varies from 83–110 μ.

Somewhat like the preceding, but very much smaller, and lobes not so swollen.

Much more frequent than *M. oscitans*.

Some are found with the basal lobe wide (fig. 9) these I have named,

Var. INFLATA.

M. KITCHELII, Wolle. Plate XXXVII, figs. 1, 2.

Cells about as long as wide, sinus separating the semicells an acute angle, ampliated; basal lobes subconically produced, obliquely and broadly truncate with the two angles drawn out into somewhat diverging processes, furcate at the ends; a rounded sinus between; polar lobe separated from the basal

y an ample, rounded, or oval sinus, sides produced and e as the others; apex slightly convex.

Diameter 125 μ. in centre; ends 75 μ.; length 125 μ.

First specimens were collected by H. S. Kitchel, in a pond, Mt. Everett, Mass. It has occurred since in various places in central and southern portions of New Jersey and Florida.

The general outline of this species has some resemblance to *M. adscendens*, Nord., found on the Sandwich Islands, but it is larger, the polar lobe is more exserted, and hence the sinuses between it and the basal lobes are much wider and deeper, broadly rounded, not "*amplo-acutangulo*," and the angles are not "*bidentate*," but are simply bifurcate.

M. ARCUATA, Bailey. Plate XXXVIII, fig. 5.

Quadrangular; semicells three lobed; the basal lobes long and arcuate, subtended by the transverse projections from the ends of the slightly notched terminal lobes.

Diameter 90–110 μ.

Collected in Florida and described by Bailey. I have found it repeatedly in New Jersey, Pennsylvania and Massachusetts.

M. EXPANSA, Bailey. Plate XXXVII, fig. 12.

Semicells three lobed; basal lobes subconical, lower marginal line regularly convex; terminal lobe more slender, notched in the centre, spreading with an upward tendency to an acute, often mucronate point. Usually smaller than the preceding.

Diameter about 75 μ.

This form is near *M. arcuata*, but somewhat smaller, stouter, with more regularly arched basal lobes; apices more acute, often mucronate.

Habitat the same as the preceding.

M. QUADRATA, Bailey.

Described by the author as "Large quadrangular, three lobed, basal lobes elongated, slightly curved, bidentate; terminal lobes with two slender transverse bidentate projections."

Diameter 110–120 μ.

A species I have not recognized.

M. Baileyi, Ralfs. Plate XXXVII, fig. 6.

Cell small, granulate; semicells three lobed; basal lobes bipartite, apices obtuse, or finely dentate; terminal lobe much exserted, notched, spreading arms obtuse or bidentate at apices.

Diameter 75 μ.

New York, Rhode Island, South Carolina, Florida, (Bailey). Ponds, New Jersey, Pennsylvania. Rather rare.

M. foliacea, Bailey. Plate XXXVIII, figs. 10, 11.

Cells subquadrate, smooth; semicells three lobed; lateral lobes deeply bipartite, and again incised, their margins concave, incised-serrate; end lobe rhomboidal, exserted, angles entire, apex divided by a wide, rounded sinus, near the basal margin of which are two or more tooth-like spines.

Diameter of cells 80–95 μ.

Bailey reports this species from Worden's Pond, Rhode Island. I found it quite abundant in Gilder Pond, Mt. Everett, Mass. A singular feature was the union of many cells forming long filaments. In the process of multiplication by division (*vide* Introduction, p. 17), the terminal lobes lap one over the other and thus maintain a hold. The chains of cells collected were evidently mere fragments, or parts broken from longer filaments; they contained from 10 to 38 cells.

The details of the terminal lobe vary somewhat from the form described by Bailey. This species has been found also in Brazil, S. A.

M. muricata, Bailey. Plate XXXI, figs. 4–7.

"Semicells divided by deep indentations into three transverse portions; the basal with three sublinear processes on each side, the others with two on each side."

The divisions, in front view, do not diverge, but spread laterally, in such a manner that the one nearest the eye, more or less conceals its companions.

Diameter 100–125 μ.; length 150–200 μ.

Catskill Mountains, (Bailey); many localities in Pennsylvania, New Jersey, Massachusetts. Not abundant, but widely distributed.

M. Rabenhorstii, Kirch. Plate LII, fig. 6.

Cells of equal length and breadth, divided into three lobed semicells by a deep constriction; the sinuses enlarging out-

wardly. End lobe wider than the others; all the lobes somewhat cuneate; apex of end lobe concave; the others subrectangularly notched; the angles of all the lobes truncate and furnished, each with two short, sharp teeth. Cytioderm smooth.

Diameter 62 μ.

Collected in a pond in the vicinity of Minneapolis, Minn.

Genus, STAURASTRUM, Meyen.

Cells in front view similar to *Cosmarium*, end view, three to six or more, angular; angles obtuse, acute, or drawn out into elongated horn-like processes. Chlorophyl more or less concentrated into a central mass, margins radiating towards the margins of the semicells. Zygospores provided with spines.

This genus contains a large number of species; as all are figured, a complete analysis does not appear important, but for a general guide they may be divided into four larger sections, in the order observed in the following list:

SECTION I.—Membrane of cells smooth, or rarely punctate or indistinctly granular.

SECTION II.—Membrane verrucose, or rough with pearly granules.

SECTION III.—Membrane hairy, spinulose or aculiated.

SECTION IV.—Membrane with angles extended into arm, or horn-like processes.

SECTION I.

ST. MUTICUM, Breb. Plate XXXIX, figs. 11, 15.

Cells in front view orbicular, smooth, deeply constricted, often involved in a mucous envelope; semicells elliptic; end view triangular, or rarely quadrangular; angles rounded, sides slightly concave.

Diameter 33–38 μ. Frequent.

Var. MINOR (Figs. 14, 15) does not differ from the typical form except in size; measure only about one-half.

Var. ELLIPTICUM. Fig. 13. This form is more elliptic in front view than the others.

Both of these varieties occur, but not as frequently as the true form.

ST. ORBICULARE, (Ehrb.) Ralfs. Plate XXXIX, figs. 9, 10.

Orbicular, constriction narrow linear: semicells not elliptic, but semiorbicular; end view triangular, angles rounded, sides somewhat concave; smooth.

Diameter 30–45 μ.

Variable in size, and appearance—sometimes the sides are more concave than figured and the sinuses between the semicells are not always so closely linear. It is a common species.

ST. TUMIDUM, Breb. Plate XXXIX, figs. 1, 2.

Large, somewhat longer than broad, deeply constricted, with a distinct colorless gelatinous covering; semicells elliptic or suborbicular; end view bluntly triangular, sides somewhat convex, slightly constricted near the angles, producing a nipple-like projection. Margins appear striated.

Diameter 112 μ.

The only habitats hitherto discovered, are marsh pools, Bucks County, Pa.

ST. GRANDE, Bulnh. Plate XXXIX, figs. 3, 4.

Large, length and breadth the same, sinuses acute, much enlarged outwardly; semicells elliptic, angles obtuse; end view triangular, rarely quadrangular, sides slightly retuse, angles obtuse; membrane finely punctate.

Diameter 75–83 μ.

Marsh pools, Minneapolis, Minn.

The specimens were some time in a weak solution of carbolic acid before being examined, and in consequence the arrangement of the chlorophyl was destroyed; omitting this consideration they agree well with measures and form demanded by the diagnosis of the author.

ST. MAGNUM, Wolle. Plate XXXIX, figs. 7, 8.

Cells nearly one-third longer than broad; sinuses subrectangular; semicells broad elliptic with a short, stout, erect mucro at each end; end view triangular, sides straight or slightly concave, angles mucronate.

Diameter 82 μ.; length 100 μ.

This species, like *St. tumidum*, is usually surrounded by a wide, colorless, gelatinous sheath. I have this species from Florida, collected by J. D. Smith.

It is separated from the preceding by its intermediate size, proportionately greater length and the mucronate angles.

ST. MAJUSCULUM, Wolle. Plate XXXIX, figs. 5, 6.

Somewhat larger than *St. magnum*; in end view, sides not concave, but convex, mucronate; mucros not erect, but oblique; in front view they are curved inwardly.

Diameter 100–105 μ.; length 108–112 μ.

Two localities were productive of this form, Mt. Everett, Mass., and Longwood Pond, Passaic Co., N. J.

Found no gelatinous sheath around any of the many specimens examined.

ST. DEJECTUM, Breb. Plate XL, figs. 7–11 and 17–21.

Semicells smooth elliptic, or extrorsely lunate with sides convex and ends nearly straight, concave, or convex; each angle furnished with a longer or shorter aculeus, or awn; these are sometimes horizontal, sometimes they converge, but more frequently diverge, directed obliquely upward. End view triangular, or occasionally, four lobed.

Figs. 17–21 represent the more usual forms.

Var. MUCRONATUM, Ralfs. Figs. 8, front view and two end views.

Var. CONVERGENS, Wolle. Figs. 7, 9, 10, 11, are unusual forms collected near Minneapolis, Minn.; aculei are stout and often stand nearly at right angles with the sides; they are also of unusual size.

Diameter of the various forms 25–38 μ. without the awns.

A common species.

ST. MEGACANTHUM, Lund. Plate LI, figs. 10, 11, 12.

Cells about as long as wide (without aculei) profoundly constricted; sinus acute-angled, or subrectangular; semicells triangular-fusiform; sides somewhat convex, ends subtruncate or lightly convex, angles each terminating in a strong and long aculeus; viewed from apex triangular, or rarely four lobed; sides retuse; angles produced into a long and firm aculeus; membrane finely punctate.

Diameter 50–57 μ.; length about 50 μ. aculei 15–18 μ.

Pennsylvania, New Jersey, rather rare.

ST. BREVISPINA, Breb. Plate XL, figs. 1, 2; and Plate LIII, figs. 2, 3.

Semicells smooth, turgid-elliptic, minutely mucronate; end

view triangular with sides usually so sinuate as to produce a three lobed appearance; each lobe terminated by a short mucro.

Diameter 45–48 μ. Smaller forms occur also.

The cells of this species vary in size and somewhat in form from elliptic to subreniform, turgid.

Neither very rare nor common.

Var. INERME, Wille. Plate XL, figs. 3, 4.

Somewhat larger than the true form, but otherwise reminds one of it, notwithstanding the absence of the mucros. The author of the name, adds, "semicells in vertical view triangular, sides lightly retuse, angles unarmed."

Diameter 60 μ.

Northampton County, Pennsylvania.

ST. DICKIEI, Ralfs. Plate XL, figs. 5, 6; and Plate LI, figs. 20, 21.

Semicell smooth, subelliptic, turgid; spines short, curved towards those of the other semicell; end view triangular, sides sinuate, angles mucronate.

Diameter 36–44 μ.

Cells are about as long as broad; semicells elliptic, but having the outer margin more convex than the inner one; the mucros or spines, short, curved, and directed inwardly. It occurs not infrequently in Pennsylvania, New Jersey, Massachusetts, and probably in every State.

ST. ARISTIFERUM, Ralfs. Plate XL, figs. 15, 16.

Semicells smooth, triangular, constricted near the angles, producing a mammillate appearance. Each angle furnished with a long awn; end view with three, or rarely four awned lobes.

Diameter 15–20 μ. without the awns or spines, and with them fully twice the size.

Rather rare but it has been found in many States, from Rhode Island, New Jersey, to Georgia.

ST. LEWISII, Wood. Plate XL, figs. 26, 27.

Smooth, with a very ample sinus, obtuse-angled, which is armed with a small spine; semicells from the front broadly

triangular; from the vertex, triangular, with the angles somewhat tumid and rounded; angles furnished with a very large, acute, robust spine.

Diameter with the spines, 62 μ.

This species was first found by Lewis, in Saco Lake, N. H., and since only in one locality, the past Summer, 1883, by Miss Eloise Butler of Minneapolis, Minn.

St. CUSPIDATUM, Breb. Plate XL, figs. 23–25.

Semicells smooth, fusiform, connected by a long narrow band; aculei parallel or converging; end view triangular, or rarely quadrangular, with inflated aculeated lobes.

Diameter 25 μ; length 30 μ.

Quiet waters, Pennsylvania and New Jersey, but not frequent.

St. TRIHEDRALE, Wolle. Plate XL, figs. 12, 13.

Small punctate-granulate; semicells, in front view and in end view triangular, angles rounded, sides concave, sinus narrow linear.

Diameter 30 μ.

Pond, Mount Everett, Mass.

This species in front view, has the appearance of a *Cosmarium* near *retusum*, Perty, and *angustatum*, Nord., but the side and end views are distinct. The semicells are three sided, pyramidal forms unlike those of a Cosmarium.

St. TRIFIDUM, Nord. Plate XL, figs. 28, 29.

Cells about as broad as long, deeply constricted; semicells short cuneate, with ends dilated, and lightly retuse; superior angles obtuse trisected; viewed from vertex triangular, angles truncate, trifid; sides somewhat concave; membrane finely punctate.

Diameter 30–50 μ. Variable in size.

Not frequent, but met with in localities widely separated, Pennsylvania, New Jersey, and other States.

St. AVICULA, Breb. Plate XL, figs. 30, 31, 32.

Semicells twice as broad as long with a forked spine on each side; each angle in end view, terminated by a simple or forked spine; cytioderm smooth.

Diameter 25–30 μ. without the spines.

Rather common species; appears to be found frequently in every State in which explorations are made.

ST. COMMUTATUM, Kg. Plate XL, figs. 33, 34.

Smooth or punctate-granulate; semicells diverging, obverse semilunar; base broadly rounded, ends straight or somewhat concave; apices bifid; end view triangular, angles produced and apices bicuspidate; sides moderately retuse.

Diameter 35–38 μ. omitting the spines.

Pond, Lehigh Valley, Pennsylvania.

This form may not be strictly the plant described by the author, Kützing; it is near it, and appears to stand between it and *A. Bulnheimianum*, Rab. Have seen very few of them, hence record the name merely provisionally.

ST. BRACHIATUM, Ralfs. Plate XL, figs. 37, 38, 39; and Plate LII, figs. 29, 30, 31.

Cells smooth; semicells with three diverging processes, or according to other authors, 2-4-5 radiate, which are deeply bifid or trifid at the apex; end view with three or four rays.

Diameter 33–55 μ. Not frequent.

The figures on Plate LII, represent a form noted as variety *Notarisii*, Rab. Collected in ponds Bamber and Brown's Mills, N. J.

ST. PANICULOSUM, Wolle. Plate XLI, figs. 39, 40.

Cell hexangular, as long as broad, membrane punctate; punctules in radiating lines; semicells truncated triangles, angles rounded; inferior angles furnished with two short, straight aculei; end view triangular with one small aculeus visible on each rounded angle; sides moderately convex.

Diameter 40–50 μ.

Marsh pools, near Bethlehem, Pa.

ST. BIENEANUM, Rab. Var. *ellipticum*, Wille. Plate XLII, figs. 1, 2.

Semicells elliptic; end view triangular with angles rounded, sides more or less deeply concave; membrane finely punctate, distinctly observable when the cell is empty; punctules regularly arranged in transverse lines.

Diameter 33–38 μ.

Not numerous, but hitherto found specimens in Minnesota, Massachusetts, New Jersey, Pennsylvania and Florida.

St. INCONSPICUUM, Nord. Plate LIII, figs. 4, 5.

Small, about equal in length and breadth; very indistinctly or not at all constricted in the middle; semicells subquadrangular, ends usually slightly retuse; superior angles produced obliquely into a geniculate arm with a truncate end; end view four radiate, sides concave. Membrane smooth or finely punctate.

Diameter 14–16 μ.

Occasional in ponds, New Jersey.

St. PSEUDOPACHYRHYNCHUM, Wolle. Plate LI, figs. 32–35.

Small, smooth or imperfectly punctate, slightly longer than broad, deeply constricted; sinus wide, base rounded; semicells subcuneate; from a narrow base somewhat undulately widened to the broad, subtruncate end; angles rather broadly rounded, with a slight constriction near the apex. End view tri- or quadrangular; sides sinuate. Isthmus about one-fourth the diameter of cell.

Diameter 20–24 μ.; length 22–25 μ.

Pond, Spring Lake, N. J.

I found this new species only in one pond, but numerous; it bears the appearance of a relation to a Brazil plant described by Nordstedt, as *St. Clepsydra*, and also to a Spitzbergen species by the same author, *St. pachyrhynchum*. The name applies well to the new form, although only two-thirds the size and proportionately longer; the sides also, end view, are not "slightly concave," but deeply sinuate.

SECTION II.

CYTIODERM GRANULAR OR VERRUCOSE.

St. MARGARITACEUM, Ehrb. Plate XLI, figs. 31–35.

Semicells in front view, subelliptic, rough with pearly granules; outer margin convex, produced at each side into a more or less attenuate, short process, having the granules in transverse lines; blunt and entire at the apex. End view circular, bordered by from 4–6, rarely 7, short, narrow, obtuse, granulate marginal rays.

Diameter 30–35 μ.

Found in all States explored, from Rhode Island to Florida.

St. striolatum, Naeg. Plate LI, figs. 27, 28.

Small, as broad as long, sinus acute angled; semicells obverse reniform; angles rounded, end concave, transverse striate, five or six striæ distinct on each lobe; end view triangular, angles rounded and sides concave; each lobe transversely striate. The striæ are series of smaller or larger granules.

Diameter 22–35 μ.

Not frequent, but found occasionally in distantly separated localities, New Jersey, Pennsylvania, South Carolina, and other States.

St. tricorne, Breb. Plate XLI, figs. 36, 37, 38.

Cells rough with puncta-like granules; semicells tapering on each side into a short, blunt, mostly entire, process; end view with three or four blunt angles.

Diameter 22–28 μ.

Not in so many localities, but often numerously clustered together; Pennsylvania, New Jersey.

St. crenatum, Bailey. Plate XLI, figs. 5, 6.

Semicells cuneate; outer margins crenate; end view with three truncate and crenate angles; sides concave.

This species was reported by Bailey to Ralfs as found in Rhode Island. Probably not seen since in this country.

St. polymorphum, Breb. Plate XLII, figs. 9, 10, 24, 25.

Semicells in front view broadly elliptic, with sides tapering into short, stout processes, ends tipped with three or four small spines; membrane rough with minute, sometimes acute granules; end view triangular, angles truncate, or drawn out into short, stout processes, ends tipped with small spines. Zygospores orbicular, armed with elongate spines forked at the ends.

Diameter 25–30 μ.

Frequent in ponds and small pools.

St. crenulatum, Naeg. (Delp.) Plate XLII, figs. 26–29.

In front view hardly separable from the preceding; end view with four, five or six angles, each produced into a short, stout, somewhat tapering ray; ends tipped with short spines, which are sometimes merely rudimentary.

Diameter 30–38 μ.

Frequent in ponds, ditches and the like.

Some authors unite these forms with the preceding species; others hold them as distinct for the reason that the rays often have transverse series of large granules, which give a crenulate appearance to the margins. Our artist failed to bring out this feature as distinctly as it should be.

St. MURICATUM, Breb. Plate XLII, figs. 3–6.

Suborbicular, deeply constricted, sinus narrow linear, or slightly enlarged outwardly; rough with somewhat conical granules; semicells subsemiorbicular, angles obtusely rounded, or truncate; end view triangular, sides convex, angles rounded or truncate spinous.

Diameter 40–45 μ.

Pools and ditches, in many distantly separated localities, but not very numerous.

St. ASPERUM, Breb. Plate XLII, figs. 7, 8.

In comparison with the preceding (*St. muricatum*), granules are emarginate, or divided; semicells broadly elliptic; sinus much wider, and sides in end view straight; otherwise very near it.

Habitat and size the same.

St. RUGULOSUM, Breb. Plate XLI, figs. 41, 42.

Semicells elliptic, denticulate at their sides; end view triangular, with angles broadly rounded and sides slightly concave or straight.

Diameter about 38 μ.

Very nearly related to the preceding; I quote the diagnosis of the author. Bailey reports it from New York and Rhode Island; I add it from Pennsylvania and New Jersey. Not a rare form.

St. PUNCTULATUM, Breb. Plate XLI, figs. 43–45.

Cytioderm punctate-granulate, semicells elliptic, straight, ends broadly rounded; end view triangular, angles not produced, broadly rounded, sides lightly retuse.

Diameter 30–35 μ.

Frequent in marsh pools, ditches, dripping rocks and the like.

St. pygmæum, Breb. Plate XLII, figs. 14–21.

Small, sinuses wide, subrectangular; semicells cuneiform or broadly elliptic, often alternately attached, angles more or less obtuse, and sometimes spinous; membrane granularly rough.

Diameter 16–25 μ.

Variable in size and form. They may be separated into three divisions.

Forma,—genuina, Breb., figs. 13–15.

Forma,—truncata, Wolle, figs. 16–19.

Forma,—rhomboides, Wolle, figs. 20, 21.

Found in nearly all standing or quiet waters, sometimes in large numbers.

St. alternans, Breb. Plate XLI, figs. 26–28.

Semicell granulate, elliptic or oblong, two or three times as long as wide, and from their twisted position, unequal in front view; end view with three obtuse and rounded angles, forming short rays, alternating with those of the other semicell.

Diameter 20–28 μ. Frequent.

St. dilatatum, Ehrb. Plate LII, figs. 32, 33.

Small, granulate; semicells fusiform, equal; end view with three, four or five short, broad, truncate rays, granules arranged in transverse lines.

Diameter 40 μ. Frequent.

Distinguished from the preceding, mainly, by the semicells not being twisted.

St. silatatum, Nord. Plate XLII, figs. 22, 23.

Cells in front view fully twice as wide as long, deeply constricted; sinus with rounded base, outwardly enlarged; semicells sublanceolate, ends straight, lightly undulate; end view five lobed, margins smooth.

Diameter 30 μ.; length 13–16 μ.

Ponds, Florida.

St. cyrtocerum, Breb. Plate XLII, figs. 30, 31.

Cells, rough with minute granules; semicells, front view, subcuneate, top broadly convex, superior angles produced into short, stout, curved processes; end view triangular; each

angle produced into a curved horn-like process with end toothed or divided; granules arranged in transverse lines. Semicells often so twisted as to make one half appear longer than the other half.

Diameter 35–40 μ.

Var. MAJOR, Wolle. Plate XLIII, figs. 1, 2.

Not unlike the typical form except in size; often attains to a diameter 120 μ.

Var. PENTACLADUM, Wolle. Plate XLII, figs. 32–35.

Separated from the other forms by the number of arms; they vary greatly in size, always symmetrically arranged with five curved arms.

Diameter 44–85 μ.

Have one or the other form from every State hitherto explored.

ST. PARADOXUM, Meyen. Plate XLII, figs. 36, 37.

Cells rough with minute granules; front view with elongated diverging processes which are bifid or trifid at the apices; end view triangular or quadrangular.

Diameter 40–60 μ.

Ponds, New York, Pennsylvania, New Jersey, Massachusetts. The figures represent an extraordinary form; usually the apices of the processes are more minutely trifid.

ST. ARACHNE, Ralfs. Plate XLII, figs. 38–42.

Semicells minutely granular, suborbicular, with elongated, slender, often incurved processes; end view with three to five linear rays; apices obtuse.

Diameter 40–50 μ.

Habitat same as that of the preceding. Distinguished from it by its more slender arms and obtuse apices.

ST. COMPTUM, Wolle. Plate XLII, figs. 43–46.

Small, granulate; semicells subfusiform, ends convex; arms more or less converging, separated by an elongated, cylindrical, somewhat swollen isthmus, ribbed in the centre; vertical view six radiate; rays straight, tricuspidate at the ends.

Diameter 30–40 μ.; length 40–50 μ.

Not rare in ponds, New Jersey.

St. elongatum, Barker. (*St. terebrans*, Nord.) Plate XLVI, figs. 11, 12.

Elongate; semicells subtriangular; base globosely inflated, produced into a cylindrical column inflated at the end, and drawn out into three arms somewhat reflexed at the ends; margins denticulate-undulate above, and spinous below; apices with three or four small spines. Inflated base with three transverse series of small papillae; end view triangular, sides concave, denticulate.

Diameter 43–45 μ.; length 60–75 μ.

Ponds, Pennsylvania.

Var. tetragonum, Wolle. Plate LI, fig. 31.

Separated from the typical form in having in end view, four rays instead of three; in having the rays horizontal, not reflexed, and terminating with three or four strong teeth; the ends of the cells are rough with spine-like granules; the base of the semicells inflated, corrugated and denticulate.

Diameter 38 μ.; length 58 μ.

Pond, Brown's Mills, N. J.

St. scabrum, Breb. Plate XLI, figs. 29, 30.

Semicells elliptic, scabrous; end view triangular, fringed with minute emarginate spines; sides straight, angles obtuse.

Diameter 25–28 μ.

Occasional in ponds, trenches and ditches, Pennsylvania and New Jersey.

St. fasciculoides, Wolle. Plate XLII, figs. 54, 55.

Small, somewhat longer than broad, granular, sheaf-form, slightly constricted and notched in the middle, furnished with a small protuberance on each side the notch (front view), apex 2–4 cuspidate. Ends convex, angles drawn out, each into a horizontal, short, stout, tapering process, apex dentate. End view triangular, sides slightly convex, angles dentate with two or three acute, conical teeth.

Diameter 27–30 μ.; length 38 μ.

Wet rocks, Lehigh Valley, Pennsylvania.

St. pusillum, Wolle. Plate XLII, figs. 47–50.

Very small, oblong, rectilinear, constriction indistinct;

angles produced into diverging horn-like processes; end view quadrangular, angles drawn out into four diverging processes, ends obtuse; membrane granular.

Diameter 8 μ.; length 14 μ. without the processes; about twice the measure with them. Larger form has with processes, a diameter of 25 μ.

Not rare in ponds, Pennsylvania, New Jersey.

St. FRANCONICUM, Reinsch. (*St. divaricatum*, Wolle.) Plate XLVI, fig. 22.

This species is separated from the preceding (*St. pusillum*) by its somewhat larger size and by having in end view, five processes with bifid apices, not obtuse. The typical plant is described by the author, "membrana glabra, (aut cornua verruculosa)." Our forms are always granular.

Diameter about 30 μ. with processes.

This, and the preceding, not common, but they appear in many widely separated localities in New Jersey and Pennsylvania.

St. HAABOELIENSE, Wille. Plate XLII, figs. 51–53.

Small, about one-third more in breadth than length; contriction in the middle forms a wide sinus; semicells in front view sub-elliptic, ends bicuspidate, margins dentate; in vertical view triangular or rarely quadrangular, sides sinuate. Membrane granulate.

Diameter 24 μ.; length, 18 μ.

Found this form several times in ponds, New Jersey; it differs slightly from *St. tricorne* except in the apices, which are not obtuse but bicuspidate.

St. BOTROPHILUM, Wolle. Plate XLII, figs. 11–13.

Somewhat longer than broad, distinctly granular; granules arranged in concentric series; semicells, front view, subtriangular, with ends broadly truncate, sides moderately convex or nearly straight, converging, basal angles rounded; end view triangular, angles rounded, sides slightly convex or straight; lateral view, sub-elliptic.

Diameter 36–38 μ.

Collected in marsh ditches near Bethlehem, Pa. In front view it has the appearance of a *Cosmarium*, like some form of *Botrytis*, but in side and end view it is a *Staurastrum*.

St. Pringlei, Wolle. Plate L, figs. 25.

Cytioderm granular; of equal length and breadth; constriction not deep, sinus wide; semicells subtriangular, sides rounded, end concave with a central inflation, angles acute. End view triangular, sides concave, angles acute. Membrane rough with fine granules. Surrounded by a thick gelatinous sheath.

Diameter 28–33 μ.

Found by C. G. Pringle, Nebraska Notch, Vt.

St. Donnellii, Wolle. Plate LII, fig. 20.

Small, twice as long as wide, oblong-quadrate; cytioderm punctate and sulcate; semicells quadrangular with basal angles rounded, sides crenulate; superior angles (four) produced into short, obtuse, diverging processes; end view quadrangular.

Diameter 15 μ.

Collected by J. Donnell Smith in Florida.

This species is nearest *St. pusillum*, but unlike it in the proportionately longer cell, the almost smooth and sulcate membrane, and the crenulate sides.

St. incisum, Wolle. Plate XLI, figs. 12–14.

Cytioderm granulate, margins serrately toothed; semicells in front view, cuneate, base broad, sides diverging to a convex top; the upper portion on each side produced into short, obtuse, tapering processes; end view, five or six radiate; rays with broad base, somewhat tapering to the obtuse apices; sides serrately toothed; the rays separated at their broad base by an acute-angled, or linear incision.

Diameter 36–40 μ.

Principally from Splitrock and other ponds of New Jersey.

St. pulchrum and *St. distentum* have a leading feature of this species—the incision, or notch between the bases of the rays, but they are separated by the smooth membrane and differently formed notch.

St. Meriani, Reinsch. Plate XLVI, figs. 17–19.

Cells in front view subrectangular, roughly granulate, slightly constricted in the middle; semicells somewhat enlarged in the upper portion; sometimes slightly constricted

near the end; apex rounded; end view usually pentagonal, but varies, more rarely, from four to six angular.

Diameter 16–24 μ.; length about one-half more.

Have found this species in various ponds of New Jersey and Pennsylvania.

St. Helenianum, Wolle. Plate XLIV, figs. 6, 7.

Small, finely granular; granules arranged in transverse rows; semicells, front view, narrow, elliptic, ends slightly emarginate; angles somewhat produced, and apices furcate; vertical view triradiate, with large central inflation, rays short, stout, tumid at base and furcate at apices; basal inflation furnished on each side with a small bicuspidate prominence.

Diameter 30–36 μ.

Frequent in Splitrock pond, New Jersey.

There is a trace of similarity between this desmid and *St. vestitum*, Ralfs, but, while the latter has two or more slender forked spines in the middle of each side, mine has stouter forked prominences on the inflated base of each ray; the sides, moreover, are not concave, but undulate convex; size of plant much smaller.

St. cerastes, Lund. Plate XLIII, figs. 6, 7.

Rather broader than long; semicells in front view, ends lunate, drawn out in the middle of the concave side into a subconical column; the lateral horns are robust, short, incurved, apices obtuse; the exterior margin coarsely granulate and often very rough with large emarginate, bifid, verrucae; the interior margin nude; end view quadrangular, angles produced into stout, straight horns, apices tridentate; margins and areas variously roughened, with larger and smaller granules and often dentate with large conical, or emarginate-bifid verrucae.

Diameter 60–70 μ.

Not abundant, nevertheless a cosmopolite.

The figures represent a smoother specimen.

St. gracile, Ralfs. Plate XLIII, figs. 16, 17.

Semicells rough, elongated on each side into a slender process which is terminated by minute spines; end view triradiate.

Diameter 40–50 μ.; length about one-third this measure.

Ponds, pools, ditches from Vermont to Florida, and westward as far as explorations have been made.

St. Ophiura, Lund. Plate XLIII, figs. 10, 11.

Large, slightly constricted in the middle; semicells somewhat obovate, end convex and ornate with bifid papillae; superior angles produced laterally with elongated, thin, almost colorless, straight, or lightly incurved rays, with margins more or less denticulate, and apices dentate. Viewed from the vertex seven (rarely six or eight) rayed; rays attenuated, long, apices tridentate, margins serrate-dentate; centre ornate with a crown composed of seven (rarely six or eight) four-parted papillæ.

Diameter 140–150 μ.; length 65–80 μ.

More abundant in the waters of New Jersey, than of Pennsylvania; found specimens also in ponds, Massachusetts.

Var. tetracerum, Wolle. Plate XLIV, figs. 1, 2.

Var. pentacerum, Wolle. Plate XLIV, fig. 3.

The one four-armed, and the other five-armed; the crown papillæ correspond in number with the arms; in other details they are not unlike the typical form; the serrate-dentate margins vary greatly in different specimens.

These varieties I collected only in Denmark pond, Passaic County, N. J., where they occurred frequently.

St. macrocerum, Wolle. Plate XLIII, figs. 3, 4, 5.

Very large, granularly rough; semicells, front view, subcuneate, truncate base and rounded top; upper angles laterally produced into long, slightly tapering, straight or lightly incurved arms, margins serrate, ends bifid; end view six radiate.

Separated from the preceding partly by the less number of arms, the less, central elevation (front view) and the absence of the crown of papillæ.

Diameter 150–180 μ.

Not rare in New Jersey waters.

St. odontatum, Wolle. Plate XLIII, figs. 8, 9.

Of equal length and breadth; semicells in front view subquadrangular, end convex, upper angles drawn out laterally into straight or lightly incurved arms, as long as the breadth of the body of the cell; margins serrate, apices furcate; the

lightly rounded inferior angles, each armed with a strong, short, aculeus. End view quadrangular, four rayed.

Diameter 62–75 μ.; length 45 μ.

Splitrock pond, Passaic County, N. J.

St. Rotula, Nord. Plate XLIV, figs. 13, 14.

Large, punctate, profoundly constricted; semicells subhexagonal, top truncate and furnished with a few teeth; angles produced laterally into long, straight rays, margins with three (or four?) tooth-like prominences; end view circular with seven to nine straight rays, margins tri-dentate-crenate, apices trifid; at the base of each ray a large granule, area between, punctate.

Diameter 88–125 μ.

Denmark, Splitrock, and other ponds, Passaic County, N. J. Very rare in Pennsylvania.

St. coronulatum, Wolle. Plate XLIV, figs. 11, 12.

Twice as wide as long; semicells obovate; sides produced into somewhat tapering, incurved arms, margins dentate; ends convex bearing six oblong teeth arranged in crown-form; viewed from the vertex, six radiate, margins delicately serrate-dentate, apices tridentate.

Diameter 75–85 μ.

Denmark pond, Passaic County, and pond near Malaga, New Jersey.

This species has the crown teeth of *St. Rotula*, but not the size, number of arms, nor the serration.

Var. Floridense, Wolle. Plate XLIII, figs. 12, 13, 14.

This form has points in common with the present species, with *St. Ophiura*, and with *St. pentacladum;* but the form recognized under the latter name is very slender and usually smaller; *St. Ophiura* has seven arms, long, and coarsely dentate-serrate. Size, relative length of arms and breadth of body, and the marginal serration and crown papillæ or teeth, make it appear most nearly allied to the present species.

Diameter 75–85 μ.; exceptions 50 μ.

Frequent in pond water, Florida.

St. PENTACLADUM, Wolle. Plate XLIII, fig. 15; Plate XLIV, figs. 15, 16.

Of the same general type as the preceding. It has five rays, end view, but these are more slender, the body is smaller and the apices are more spreading.

Diameter 40–70 μ.

Gilder pond, Mt. Everett, Mass., and in waters scattered throughout New Jersey and Pennsylvania.

St. LEPTOCLADUM, Nord. Plate XLIV, figs. 4, 5.

Semicells subtrianglar, end broadly rounded, furnished with small rudimentary teeth; within the margin a small tumor; margins serrate-crenate; base truncate, superior angles produced laterally, each into a long, thin, incurved, granularly rough arm with a bi-tri-furcate apex; in vertical view, fusiform with an obtuse angled inflation in the middle.

Diameter 80–100 μ.; length about 25 μ.

The original, typical plant from Brazil, is described by the author, and figured by him with the arms strongly incurved, and body longer than our form. The plants identified as of this species, have the arms nearly horizontal, and often strongly recurved.

They occur frequently in ponds of New Jersey, Massachusetts, Minnesota, Pennsylvania, Florida and doubtless in many other States.

St. GRALLATORIUM, Nord. Plate XLIV, fig. 19.

Semicells subquadrangular, top somewhat produced with one, or two, small aculei at each angle; inferior angles rounded; sides produced, each into a long, thin, colorless ray, margins crenate-dentate, apex bi-tri-furcate; vertical view oval, produced on opposite sides into a long thin arm.

Diameter 100–125 μ.

Var. UNGULATUM, Wolle. Plate XLIV, figs. 17, 18.

Beside having the apices of the rays tipped with a single claw-like spine, they are usually shorter and stouter, varying as the figures.

This variety is from Florida; the typical forms from Denmark Pond, Passaic Co., New Jersey.

St. FUSIFORME, Wolle. Plate XLIV, figs. 20, 21.

Semicells in front view, narrow fusiform, lateral angles drawn out into long, colorless arms, margins crenate-dentate, apices bifurcate; back or end broadly rounded or straight, crenate; end view fusiform.

Diameter 125–138 μ.; length 38 μ.

This species appears to be related to the preceding two, but varies from both in form of cell; from *St. leptocladum*, in the longer, stouter, and straighter arms, and from *St. grallatorium*, in the absence of the produced back and the aculei.

Denmark Pond, New Jersey.

St. IOTANUM, Wolle. Plate LI, figs. 5–7.

Very minute; semicells quadranglar, angles drawn out into thin, diverging, granular rays, each about as long as the diameter of the body; apices obtuse; end view triradiate.

Diameter including the rays 15–20 μ.

The rays are so minute, they appear like a single series of fine granules.

Found this very small variety quite numerous at Ocean Beach and at Malaga, N. J.

St. ANKYROIDES, Wolle. Plate LI, fig. 4 and variety fig. 3.

About as long as wide, granularly rough; semicell cylindrical with enlargement towards the convex end; sides produced laterally into narrow, elongate, slightly tapering, incurved arms, margins granulate-crenate, apices bifurcate; end view quadrangular, four-rayed.

Diameter 82 μ.; length 75 μ.

The only water which hitherto furnished this new species is a pond near Malaga, N. Jersey.

Var. HEXACERUM, Wolle. Plate LI, fig. 3.

Somewhat stouter than the typical form and furnished with six arms.

Ponds, northern Counties of New Jersey.

In the possession of six arms it bears some resemblance to *St. coronulatum*, but with nearly twice the length, and in the absence of the circle of large granules on the convex end, which suggested the name, it appears more nearly related to *St. ankyroides*.

St. NANUM, Wolle. Plate XLIV, figs. 8, 9, 10.

Very small, smooth, or granulate-punctate; semicells subcuneate, sides somewhat rounded, ends broadly convex; superior angles produced laterally into straight, slightly diverging arms, nearly as long as the diameter of the cell, ends forked; viewed from the end tri-radiate, sometimes twisted so that the arms of the lower half cell alternate with those of the upper half.

Diameter 20–25 μ.

Frequent in ponds, Mt. Everett, Mass.

This minute species is nearest *St. gracile*, Ralfs, but differs in its smaller size, more forked apices, and smoother membrane.

St. VESTITUM, Ralfs. Plate XLV, figs. 28, 29, 30.

Cells rough with minute granules; with this investment there are also minute emarginate spines; semicells fusiform in front view; seen from the vertex, triradiate, each side having two slender, forked spines in the middle, and often accompanied by other smaller ones.

Diameter 62–90 μ.

Has a home in many parts of the civilized world, so here also it is found widely scattered.

St. SEBALDI, (*Sancti Sebaldi*), Reinsch. Plate XLVI, figs. 1–6; 10.

One-fourth to one-half wider than long, coarsely granulate; margins in part granulate-crenate, and in part spinous. Semicells broad cuenate, base truncate, top convex, with sides more or less conically produced; apices bifid or trifid; near the top margin, a series of emarginate or tricuspidate spines, which come to view at one or the other end of the cell as it is more or less inclined from a horizontal position. End view triangular, angles slightly produced, apices tridentate; sides nearly straight, or slightly convex.

Diameter 75–95 μ.

A conspicuous species, large, stout and spinous; variable in the length of the lateral arms; in some cases short stumpy, in others more elongated; the spines are also variously prominent; in exact horizontal position they are often not noticeable; when somewhat turned they become prominent on one

end and indistinct on the other; the result of their being arranged not on the margin but within it.

The finest, largest and best developed forms, I found in small pools and ditches, Pennsylvania and New Jersey.

Var. SPINOSUM, Wolle. Plate XLVI, fig. 7.

The spine (process) protruding near each lateral margin of the semicell, is the peculiarity of this variety.

Collected near Minneapolis, Minn.

St. PSEUDOSEBALDI, Wille. Plate XLVI, figs. 8, 9.

Cells one-fifth part more in width than length, profoundly constricted; spines of the end of the semicells, bifurcate; rays nearly straight, granular, apices tricuspidate; vertical view, triangular, sides concave, furnished in the middle with short bifurcate spines.

Diameter about 75 μ.

Ponds, Pennsylvania and New Jersey.

St. ANATINUM, Cooke and Wills. Plate LI, figs. 1, 2.

Large, granularly rough, or spinous; semicells in front view oval with ends drawn out into diverging arms, apices trifid. End view triangular, sides slightly concave, with angles produced into straight arms; margins in both views ornate with large, emarginate-bifid, or papilliform verrucae.

Diameter 60–80 μ.; length about one-half the diameter.

Ponds, Mt. Everett, Mass.

This species differs from *St. Sebaldi*, in being more slender, not so turgid, arms more protracted, and more evenly clothed with large verrucae.

St. ARCUATUM, Nord. (Var.) Plate XLVI, figs. 13, 14.

In length and breadth about the same; constriction deep; sinus acute-angled, much ampliated; semicells elliptic, granularly rough, granules arranged in transverse series; base convex, top convex or straight, each end furnished with large diverging twinned aculei; end view triangular, centre smooth; arms short with granules in transverse series; sides furnished with four or more bicuspidate spines; angles with two aculei, only one of which is clearly visible in exact horizontal position of cell.

Diameter 30–36 μ., without the aculei.

Splitrock pond, Passaic Co., N. J.

Our species differs somewhat from the typical Norwegian form, but I adopt the name for our variety.

ST. SUBARCUATUM, Wolle. Plate XLVI, figs. 15, 16.

This species is allied to the preceding, *St. arcuatum;* I have separated it because it is smaller, the aculei at the terminal angles are not so long and the marginal granules are only rarely bifid. In end view, the papilla-like granules are arranged concentrically, often protruding on the margins.

Since naming this desmid, three years since, I came across varieties of *St. Avicula* coarsely granulate, which are very near to this form. A *variety of Avicula*, would have been equally appropriate.

SECTION III.

MEMBRANE PILOSE, SPINOUS OR ACULEATED.

ST. ACULEATUM, Erhb. Plate XLV, figs. 1, 2, 3.

Cells spinulose; semicells with sides somewhat drawn out, margined with smaller aculei, and terminated by larger ones; end view usually with three, but sometimes also with four angles.

Diameter without aculei about 50 μ.

Pond, near Minneapolis, Minn. Found no good specimens elsewhere.

Semicells are elliptic or fusiform, thickly spinulose, the spines usually simple, rarely divided at the apex; the semicells taper on each side into a short process tipped with three or four larger aculei.

This form agrees well with *St. Saxonicum*, Reinsch. Bulnheim has a different form with the same name which I have adopted in this monograph.

ST. TELIFERUM, Ralfs. Plate XLV, fig. 4.

Semicells more or less reniform, aculeated; the aculei larger and most densely set at the angles; end view triangular, sides concave, angles broadly rounded and bristly.

Diameter 33–38 μ.

Not rare in pond waters of New Jersey, Pennsylvania and Massachusetts.

St. Brebissonii, Arch. Plate XLV, figs. 5, 6.

Cells very near *St. teliferum*, but much larger; semicells more elliptic and aculei proportionately smaller.

Diameter 62 μ.

Florida, the only habitat hitherto found.

St. setigerum, Cleve. Plate XLV, figs. 26, 27.

Semicells broadly elliptic, bristly; the bristles, or more properly aculei, have a firm base and sting-like apex; they are arranged on the margins, with two longer, and stronger, diverging ones on each lateral angle.

Diameter with aculei 45 μ.; without aculei 25 μ.

Not north of Florida, as far as I could discover.

St. Saxonicum, Bulnh. (Not Reinsch's form). Plate XLV, figs. 33, 34.

Large, spinous; semicells elliptic, evenly aculeated over the whole membrane; end view triangular, sides straight or slightly concave.

Diameter 68–75 μ.

Budds Lake, N. J. Compare note, *St. aculeatum*.

St. echinatum, Breb. Plate XLV, figs. 31, 32.

Small, as long as broad, finely aculeated; semicells elliptic; end view triangular, angles broadly rounded, sides straight or lightly convex; whole membrane except the centre of the semicells, aculeated; 7–10 aculei to a side, end view.

Diameter 27–30 μ.

Not infrequent in pools and ponds, New Jersey, Pennsylvania and other States.

St. pecten, Perty. Plate XLV, figs. 35, 36.

This looks like and probably is a depauperated variety of the last, *St. echinatum*.

Diameter 20 μ.

Denmark Pond, Passaic County, N. J.

St. hirsutum, (Ehrb.) Breb. Plate XLV, figs. 19–21.

About as long as broad, more or less densely covered with thin, short, even, hair-like spines; semicells elliptic or sub-

semiorbicular; end view triangular, angles obtusely rounded, sides straight or moderately convex.

Diameter 40–60 μ.

A common species.

St. SOCIATUM, Wolle. Plate XLV, figs. 22, 23.

Separated from the last two, mainly by the arrangement of the spines which are sociated, or twinned.

Diameter without spines 28–30 μ., with spines 40–45 μ.

This species has some resemblance to *St. geminatum*, Nord, but the twinned spines are smaller, and the number twice as large.

St. TRIDENTIFERUM, Wolle. Plate XLV, figs. 9, 10.

Very small, smooth, sinus ample; semicells elliptic, ends more or less convex, angles furnished with three, firm, diverging aculei; end view triangular, sides retuse, angles with three large aculei.

Diameter 17–20 μ., without spines; with them 25–28 μ.

Sluggish waters, Pennsylvania.

St. CRUCIATUM, Wolle. Plate XLV, figs. 11–13.

Small, smooth, front view cruciform, lobes short linear, ends rounded; sinuses wide, rectangular; end view three or four lobed, slightly tapering, ends rounded and furnished with a number of more or less diverging setae, which are as long as the lobes.

Diameter 25 μ., without setae.

Ponds, Northampton Co., Pa.

St. CERBERUS, Bailey. Plate XLV, figs. 7, 8.

"Cells small, deeply constricted, semicells three-lobed; lobes with four teeth, two of which project upwards and two downwards, at each truncate angle."

Diameter 25–30 μ.

This species is reported by Bailey, from lakes in Florida.

St. HYSTRIX, Ralfs. Plate XLV, figs. 14–16.

Semicells in front view subquadrate, extremities somewhat rounded, end margins nearly straight, furnished with a few scattered, subulate, acute spines, chiefly confined to the lateral

extremities; end view with three or four broadly rounded angles, the spines scattered, chiefly confined to the lateral extremities, sides concave.

Diameter 22–25 μ.

Rhode Island, (S. T. Olney) Thwaites.

St. Ravenelii, Wood. Plate XLV, figs. 17, 18. Plate LII, figs. 7, 8.

A little longer than broad; semicells from the front, elliptical or oval, not semiorbicular; from the vertex triangular, with the sides convex or slightly retuse, and the angles rounded; connecting isthmus obsolete, broad sinus acute-angled; cytioderm armed with numerous acute robust spines.

Diameter 25–30 μ.; length 35–38 μ.

Still water, Aiken, South Carolina, collected by H. W. Ravenel.

Although in frequent correspondence with Mr. Ravenel, and having examined hundreds of specimens gathered by him the past years, I was not so fortunate as to find this desmid until December, 1883. The specimens were dried, and more or less collapsed and shrivelled in consequence, but I was delighted to be able to identify ten to fifteen good specimens. A peculiarity is the somewhat irregular arrangement of the conical granules. The drawing, front view, of the semicells (fig. 18) is singularly incorrect; the inferior angles should be rounded so as to form a wide, acute-angled sinus. See Plate LII, fig. 8.

St. controversum, Breb. Plate XLV, figs. 24, 25.

Cells spinulose; semicells with a short irregular process on each side terminated by minute spines; end view with three or four distorted rays.

Diameter 38–65 μ.; length 75 μ. more or less.

Marsh pool, Minneapolis, Minn.

A variable species in size, in distortions, and in arrangement and size of spines. The lateral angles of the semicells are often much incurved and tipped with minute subulate spines. In both views, the semi-cells show numerous conspicuous spines which are either subulate or forked at the end.

St. aspinosum, Wolle. Plate LI, figs. 22, 23.

Semicells smooth, in front view oval, with each end pro-

tracted into a colorless arm about three times as long as the breadth of the body, diverging, apices tricuspidate, margins rough with minute, firm, perpendicular, irregularly placed aculei; end view triradiate.

Spread of the arm 58–63 μ.

Pond, Brown's Mills, N. J.

The vertical spines, like the thorns of a rose, give this plant a distinctive character.

St. QUATERNIUM, Wolle. Plate LII, figs. 17, 18, 19.

Small, smooth, quadrangular in front view; deeply constricted; sinus acute-angled, much ampliated; semicells oblong, sides rounded, end truncate, each angle furnished with four firm aculei; end view triangular, sides concave, angles broadly rounded and furnished with four aculei, two on the margin, somewhat separated, and two within the margin, one on each side of the cell, and projecting between the other two. By turning the cells two smaller aculei may be detected near the margins of the sides.

Diameter of body 25 μ.; including aculei 40–50 μ.

Ponds, near Malaga, N. J., and near Wilkesbarre, Pa.

St. FORFICULATUM, Lund. Plate LI, figs. 16–19.

Cells rather broader than long; deeply constricted; sinus wide; semicells subtrapezoid, end truncately rounded; base convex, sides somewhat produced and divided into two large diverging mucros; margins ornate with large emarginate verrucæ, or more or less conspicuous prominences; in vertical aspect three, or more rarely, four or five angled; angles produced and divided, and sides furnished with spines as in front view.

Diameter including aculei 70–80 μ.

Bamber Pond, New Jersey.

The form of the semicells is more elliptic than trapezoid, but in other points it is a good representative of Landell's Swedish plant.

St. MONTICULOSUM, Breb. Var. *bifarium*, Nord. Plate LI, figs. 24–26.

Semicells with a forked spine at each lateral angle, and at the end, two twinned, stout, acute, or furcate prominences;

vertical view usually triangular, angles acute or bifid as the cell is in a horizontal position, or somewhat turned; sides with four single or two bifid prominences.

Diameter 38 μ.; length 33–35 μ.

Spring Lake, New Jersey.

The form I found is not the typical plant, but answers the description of Nordstedt's Norway variety, *bifarium*.

St. TRICORNUTUM, Wolle. Plate XLVII, figs. 1, 2.

Large, as long as wide, smooth, semicells broad-elliptic with angles terminated by three long, stout, colorless, diverging, subulate spines; vertical view triangular, sides somewhat concave, or sometimes slightly convex, angles terminated with three subulate spines.

Diameter of body 90–100 μ.; with the spines 175–200 μ.

Frequent in Hammonton and other ponds of southern New Jersey.

St. NOVÆ CÆSAREÆ, Wolle. Plate XLVII, figs. 3, 4.

Cells as long as broad, or somewhat longer, coarsely granulate; semicells in front view elliptic, margins crenulate, angles produced into two long subulate, divergent spines; vertical view quadrangular, at angles somewhat constricted often producing a mammiform appearance, and drawn out into two, long, subulate spines.

Diameter without spines 36–40 μ.; with spines 62–70 μ.

The hitherto only locality for this distinct form is a pond near Hammonton, N. J.

St. LONGISPINUM, Bailey. Plate XLI, fig. 7.

Large, smooth, triangular, with two long spines at each angle.

Diameter of body 75 μ.; with spines 150 μ.

Lakes in Florida (Bailey).

St. QUADRANGULARE, Breb. Plate XLI, figs. 1–4.

Cells smooth, nearly square, divided by a deep, linear constriction into rectangular-oblong semicells with a few marginal spines or teeth; end view quadrilateral, sides more or less concave, angles truncate and emarginate or dentate.

Diameter 23–30 μ.

Not infrequent in ponds of Pennsylvania, New Jersey, and Florida.

St. Brasiliense, Nord. Plate XLVIII, figs. 1, 2, 3.

Semicells short cuneate, top truncate or moderately rounded, angles terminating in three firm, diverging aculei; end view pentangular; each angle produced into three more or less elongated firm subulate diverging spines, sides concave; membrane punctate.

Diameter 87–130 μ. including the spines.

Three localities only have been developed for this species; Florida furnishes the smaller form figured; the other is from pond, Passaic County, New Jersey, and from vicinity of Mobile, Alabama. The original form from Brazil, is described by the author as usually quadrangular, and angles often furnished with four spines.

Section IV.—Cells furnished with numerous processes usually divided at the ends.

St. furcigerum, Breb. Plate XLVIII, figs. 12–14. Plate LII, figs. 23, 24.

Cells constricted at the middle, angular, with six processes to each semicell; in end view, triangular, one process at each angle and one within the angle, about half way between it and the centre of the triangle, Plate XLVIII, fig. 12, Plate LII, fig. 24; semicell in front view somewhat elliptic, Plate XLVIII, fig. 13, Plate LII, fig. 23; each end drawn out into a short process, margins serrate, ends furcate or toothed; three other processes are usually in view, two on the end margin, and one intermediate. Cytioderm granular; granules arranged in transverse lines.

Diameter 50–62 μ.

Occurs in many localities, Rhode Island and southward to South Carolina and Florida.

Foreign authors report a form, quadrangular in end view; such would have eight processes to a semicell.

I find considerable diversity in the specimens of this species, particularly in the arrangement of the processes on the tops or ends of the cells; typically they are attached away from the centre, and are directed towards the angles; a variety (Plate XLVIII, fig. 14,) has them coming from the centre and directed transversely, or at right angles with the sides.

St. eustephanum, (Ehrb.) Ralfs. Plate XLVIII, figs. 9–11.

Of nearly equal length and breadth, granular, margins more or less serrate; semicells elliptic (fig. 9) with angles produced, furcate; end view triangular, furnished with nine processes, counting the three somewhat produced, and bifurcate angles; the other six are on the upper surface, attached, usually, between the centre and the margins, ends elevated above the surface; the processes extend to margins, or slightly over them; in front view, these present themselves on the outer margin in two pairs; the third pair is either under the cell, or stands towards the eye, and is invisible.

Diameter varies from 50–75 μ.

Var. *a*. fig. 11 represents a form with more elongated processes.

Var. *b*. figs. 4–6 is another variety, very distinct; it is smaller in size and has spreading, swallowtail-like ends of processes.

The latter was collected in Minnesota; the others occur frequently in small ponds and ditches, New York, (Bailey; Ehrenberg); Pennsylvania, New Jersey, South Carolina, Massachusetts. Figs. 4–6 may represent a new species; it needs further verification.

St. senarium, (Ehrb.) Ralfs. Plate LII, fig. 1.

Smooth, each semicell furnished with fifteen processes; in end view triangular, each angle a process, two on each side, and six radiating, on the upper surface within the margins.

I have found no form to answer this description satisfactorily. Ehrenberg and Bailey report it from New York.

St. pseudofurcigerum, Reinsch. Plate LII, figs. 27, 28.

Cells smooth; semicells broadly elliptic, sides produced into a short, stout, process with margins smooth and apices bifurcate; end view triangular; one process at each angle, and two near the margin of each side, extending beyond it, making nine processes to each semicell.

Diameter 37–40 μ.

Minnesota.

I am aware that this name is usually applied to a different plant, which has a granular cytioderm and margins undulate-

serrate. Reinsch's figures indicate an absolutely smooth membrane, and in his description he writes *membrana glabra.* Satisfied I have Reinsch's prototype in size, and detail of construction, it is but just to retain the name given by him. The plants generally recorded for *pseudofurcigerum* would probably be better placed with *St. eustephanum.*

St. CUNEATUM, Wolle. Plate XLVIII, figs. 7, 8.

As long as wide, divided by a deep constriction into two broadly cuneate semicells; base convex, broad; sides, each with three to six sharp teeth, converge from the base to a concave-truncate end; superior angles somewhat produced, making a short process, apex bifid or trifid; end view triangular, sides slightly convex, angles bisected; on the top six processes radiating from the centre and extending to, or slightly over the margins.

Diameter 44–46 μ.

Ponds, Pennsylvania.

In front view, this form bears much similarity to a plant found on the Island of Spitzbergen and named *St. megalonotum,* Nord., but in end view it is entirely distinct.

St. SPONGIOSUM, Breb. Plate XLVII, figs. 5–8.

Thickly covered with short spines which are forked at the apex; semicells semiorbicular, spinulose; end view triangular, angles rounded; sides slightly convex and bordered with forked spines or short processes.

Diameter 45–50 μ.

This species appears to be sparsely but widely distributed. The specimens vary considerably in different localities; figs. 7, 8, represent the more frequent form; Naegeli supposed it to be a new species and named it *St. Griffitheanum.*

St. ARCTISCON, Ehrb. Plate XLVII, figs. 9, 10.

Cells about one-fourth longer than broad, moderately constricted, sinuses obtuse angled; semicells subglobose, slightly depressed, furnished in the middle with (usually) nine straight divergent processes; above these, another whorl consisting, usually, of six similar, but shorter processes, apices trifid. Membrane punctate.

Diameter 100–120 μ.

Wood describes *St. munitum*, as a new species, but evidently it is the same as *St. arctiscon*. He had it from New Hampshire; I found it frequently in Massachusetts, Pennsylvania, New Jersey. No doubt it will turn up in all parts of the United States. Ehrenberg had his specimens from New York.

St. Eloiseanum, Wolle. Plate XLI, figs. 17, 18.

Small, equal in length and breadth, smooth or finely punctate; sinus an acute angle; semicells subhexagonal, basal and superior angles produced into short, bifurcate processes; sometimes two, but oftener only one discernable at each angle; end view circular, margin furnished with (usually) nine, short processes, ends notched.

Diameter 22–30 μ.

This form has some resemblance to *St. spinosum*, Breb, but in front view, the processes are less conspicuous, the apices less distended; in end view, circular, not triangular.

St. duplex, Wolle. Plate LIII, figs. 6, 7.

Small, subquadrangular, constriction deep, sinus acute-angled; semicell, twice as broad as long, rectangular; angles truncate and furnished with two, short, stout processes with ends truncate granulate-spinous; end view triangular, sides straight or concave, angles truncate, divided and drawn out into two short, somewhat diverging processes, apices finely toothed.

Diameter 20–25 μ.

Numerous in small pools, on the banks of river, Bethlehem, Pennsylvania.

The end view has a resemblance to Nordstedt's *St. gemelliparum*, but front view is quite distinct.

St. distentum, Wolle. Plate XLI, figs. 15, 16.

Small, smooth; semicell obovate, end convex crenulate, sides in upper portion laterally produced into nearly straight elongated arms, margins smooth; apices, divided into three parts and distended; end view five or six radiate; rays taper from a broad base to a distended trifid end. Between each two of the bases is a deep linear sinus.

Diameter 40 μ. more or less.

Ponds, Denmark, Splitrock, Passaic County, N. J.

St. Kitchelii, Wolle. Plate XL, figs. 35, 36.

Cells smooth, about as long as wide; semicells subelliptic, bases more inflated than the ends, the angles produced into bifurcate processes; semicells furnished with three additional processes; end view triangular, angles produced, apices bisected; on the top surface three bifurcate processes, one extending over each of the three sides; membrane smooth or finely punctate.

Diameter 38–50 μ.

Collected by Rev. H. D. Kitchel, in Gilder Pond, Mount Everett, Mass.

St. spinosum, Ralfs, bears some similarity but is separated by having two or more spines on each side, beside the one terminating each angle. *St. furcatum*, Ehrb., also appears related, but is possessed of more spines.

St. furcatum, (Ehrb.) Breb. Plate XL, figs. 40, 41. Plate XLVIII, figs. 15, 16. Plate LII, fig. 34.

Cells smooth about as long as wide, sometimes shorter, furnished with numerous processes always more or less widely furcate at the apices; end view triangular, angles somewhat produced and furcate; sides each with two, or rarely three, furcate processes; normally a semicell has nine processes, one at each angle and two on each side between the angles; in front view, more or less broadly elliptic, angles drawn out and furcate; the end margin has usually four processes visible, projecting over the margin.

A variable form separated from *furcigerum, eustephanum* and others not only by the smooth, or punctate membrane, which is very striking in contrast with the granular surface, and serrate margins of the others, but by the processes, particularly evident in end view, which do not spring from the upper surface more less distant within the margin, but from the margin itself. This feature not evident in *St. pseudofurcigerum*, Reinsch, gives it a position for itself. The form Plate XLI, figs. 8, 9, from Minneapolis, Minn., is Ralfs' *St. spinosum*, now properly transferred to this "old name," has beside the marginal processes some smaller accessory ones within the margin, Plate LII, fig. 34. Plate LII, figs. 25, 26, is another variety from the same locality of unusual size and very marked in the wide-spreading forks of the processes; Ralfs admits of "sometimes three marginal-spines as seen in end view."

St. enorme, Ralfs. Plate XLI, figs. 19–25.

Cells irregular or quadrate, spinous; end view three or four lobed; lobes broad, more or less emarginate or bifid, and terminated by spines which are either simple or branched.

Ralfs, the author of this species, says of it, it "is by far the least symmetrical plant in this family, expecially in front view, and it is very difficult to trace any division into the cells."

Some of the forms, as figs. 24, 25, may properly belong to this genus, but the others would be better placed under *Polyedrium*.

These forms occur frequently in ponds of New Jersey, Pennsylvania, Massachusetts.

St. leptacanthum, Nord.

Var. tetroctocerum, Wolle. Plate LI, figs. 29, 30.

Cells about as long as broad; deeply constricted; semicells suborbicular furnished with eight long thin rays, deeply forked, or clawed at the ends; this whorl is rather below the middle, and another above it with four similar rays; end view octangular, each angle produced into a long, thin ray, deeply clawed at the end; between the margin and the centre four more similar rays go out; membrane smooth.

Diameter of body 25 μ.; including the processes 75–80 μ.

Pond near Malaga, N. J.

The only essential distinction between this form, and the typical, Brazil plant, is that it has *six* rays in the larger whorl, and ours has *eight*.

St. Pottsii, Wolle. Plate LI, figs. 8, 9.

Small, smooth, sinus gaping; semicells in front view broadly elliptic, furnished on each side with three divergent processes, whose apices are rounded, bearing two small diverging aculei; end view triangular, sides concave, angles broadly truncate and produced into two processes with a wide, rounded sinus between, a third process from a position somewhat back of the sinus, rising at an angle of about 40 degrees, projects between the other two, thus constituting three divergent processes at each of the angles of the triangle.

Diameter, including the aculei 30–38 μ.

Collected by Ed. Potts in Harvey Lake, near Wilkesbarre, Pa., where it appeared in numbers.

The three diverging, aculei-tipped processes at each angle make this form a distinct species.

Family, PROTOCOCCACEÆ.

Cells chlorophyllous, strictly unicellular, without terminal growth, either single, segregate or associated in families.

Propagation by means of gonidia, which are of two kinds, *macrogonidia* the larger kind, and *microgonidia* the smaller forms; they are ovate, the smaller, anterior end, somewhat protruding and colorless, is provided with two ciliae; the posterior end is broadly rounded and green.

This family is subdivided into a number of subfamilies, and these again into *genera*. There remains for us to treat merely of the subfamily *Pediastreae*, and genus *Pediastrum*. The features of the subfamily and of the genus being in this case, the same, therefore

Genus, PEDIASTRUM, Meyen.

Cells united into definite families, known as *coenobiums;* they are plane, discoid or stellate, swimming free. A *coenobium* is formed of cells in a single or rarely, in part, double stratum which is continuous or perforated. Cells are polygonal, with four or more sides; those of the centre entire or often emarginate, and those of the periphery often bilobed; the lobes cuneate, either simple or bidentate, often produced into short hair-like ends. Cell contents green, primarily homogeneous, then granular.

In the propagation of the species the granular chlorophyllous contents of the cells break up into small subspherical bodies; these constitute the macrogonidia, which break through the membrane. After a short period of motile life, they come to rest, then divide and redivide, and become invested with a gelatinous covering; the cells unite in a single layer, then gradually develop into the form of the matured, or mother plant.

P. SIMPLEX, Meyen. Plate LIII, figs. 17–20.

Coenobium variously composed of from one to three circles of subquadrilateral cells, those of the periphery with apex more or less conically produced, cuspidate.

Var. *a.* Composed of six simple cells radiately connected, fig. 17.

Var. *b.* (*P. Sturmii*, Reinsch.) Composed of six cells, with an open space in the centre, fig. 18.

Var. *c.* (*P. duodenarius*, Bailey.) fig. 20; composed of twelve cells in the periphery, and a circle of four cells in the middle, with open spaces between the two, and open centre.

Var. *d.* A new form, with three circles of cells, of fourteen, seven, and four; the four constitute the centre. The openings or lacunae first circle seven, second four.

The only good locality found for this species and varieties, is the Croton water supply of the City of New York. Bailey's specimens, collected more than thirty years ago, were from the same source.

P. MUTICUM, Kg. Plate LIII, fig. 36.

Coenobium circular or oval, composed of two to five circles of cells, entire, smooth, regular; peripheric cells emarginate or with two slight protuberances.

Pond waters, Pennsylvania, New Jersey.

P. ANGULOSUM, (Ehrb.) Menegh. Plate LIII, figs. 28, 37.

Minute, consisting of one or more circles of cells. Not perforated; marginal cells with angular lobes which are not extended into rays. A small form (fig. 37) has the centre open.

Frequent in ponds, New Jersey.

P. FORCIPATUM, (Corda.) A. Br. Plate LIII, figs. 21, 30, 31.

Coenobium orbicular, entire, marginal cells bilobed; lobules with apices acute, converging, leaving an oval sinus between; usually smooth or punctate, but sometimes coarsely granular, probably when in older condition.

Ponds, Pennsylvania, New Jersey.

P. BORYANUM, (Turpin). Menegh. Plate LIII, figs. 22, 29, 32.

Coenobium orbicular, oblong or elliptic, bright green, variable in size, composed of 8–16–128 cells. Marginal cells two lobed, each drawn out into a colorless horn-like process, short or long, rather obtuse, sometimes a little thickened at the ends. Cells closely united, four to six angled. Membrane punctate.

Sometimes the cells and the horns are distinctly granulate. These constitute the variety *granulatum*, Kg.

Frequent, Massachusetts to Florida.

P. PERTUSUM, Kg. Plate LIII, figs. 33, 34.

Coenobium, more or less orbicular, pierced with many lacunæ; variable in size; composed of 16–32–64 cells. All the cells more or less loosely connected; attached at the angles only, leaving an opening between the sides, and between the connecting end of one, and the base of the adjoining cells. Cells of the periphery deeply bilobed; lobes conical or horn-like, sometimes acute, sometimes obtuse or truncate.

Frequent in pools everwhere.

Var. BRACHYLOBUM, A. Br. Plate LIII, fig. 35.

Differs from the typical form in having the cells of the periphery emarginate, notched, or shortly two lobed, or lobes almost obsolete; cells of the disc perforated with smaller openings.

Var. CLATHRATUM, A. Br. Discs pierced with larger openings; the lacunæ being often as large as the cells.

P. EHRENBERGII, (Cordæ.) A. Br. Plate LIII, figs. 25–27.

Marginal cells closely united, bilobed, medianly deeply incised; each lobule with ends truncate and notched or incised. Coenobium not perforated, composed of 4–8–16–32 cells.

Var. CUSPIDATUM, A. Br. Plate LIII, fig. 25.

A small form, with lobes of cells finely, and often indistinctly bidentate.

Not so frequent as the preceding forms, but widely distributed.

P. TETRAS, Ehrb. Plate LIII, fig. 24.

Coenobium very small, four-celled, separated by colorless interstices which form a cross.

A. Braun. has a variety of *P. Ehrenbergii*, var. *truncatum*, very near this form, but differs in having the ends of the lobes notched—our form, as far as observed, is perfectly square, hence I retain the old name.

Occurs frequently from Rhode Island to Florida.

PEDIASTRUM SELENÆA, Kg.

Coenobium orbicular; cells cresent-shaped, arranged in one or more circles round one or two central cells.

A form reported by Bailey from Rhode Island.

P. CONSTRICTUM, Hass.

Conobium nearly orbicular, continuous, composed of 16–32 cells; cells of the periphery two lobed, or suddenly contracted into two short cylindrical, obtuse processes.

Bailey reports this species from South Carolina, Georgia and Rhode Island. It is very nearly allied to *Boryanum* and is probably a variety of that species.

ADDENDA.

Since the paragraph (page 16), regarding the motion of granules in the vacuoles of *Closterium* and other desmids, was put into print, I observe a notice of a somewhat novel view of the phenomenon, in the Journal of the Royal Microscopic Society of London, Feb. '84. I transfer it as of interest, without comment.

"The occurrence of crystals of calcium sulphate, endowed with a peculiar "dancing" motion, has long been known in the terminal vesicles of *Closterium* and in other desmids; the phenomenon has now been carefully investigated by A. Fischer. Their chemical constitution was clearly established by different tests. They are always quite isolated from one another, and occur in all parts of the cells, though in the greatest quantity in the terminal vesicles; they are either carried along passively by the currents of protoplasm, or they 'swarm' in the space filled with cell-sap between the cell-wall and the radiating chlorophyll-bodies; these vesicles are not true vacuoles, but portions of cell-sap space. The crystals are not formed, nor do they grow, in the vesicle, but reach it in a mature condition from some other part of the cell, being formed apparently in the furrows between the bands of the chlorophyll-bodies; from here they are carried to the terminal chambers by the protoplasmic currents.

Fisher found these crystals in all species of *Closterium* which he examined; also in various species of *Cosmarium* (though individuals are often entirely destitute of them), their form being the same as in *Closterium*. They occur in *Micrasterias*, *Euastrum*, in which genera also they are not invariable present, and always in *Pleurotaenium*, *Penium*, and *Tetmemoris*, but were absent from all the specimens examined of *Staurastrum*, *Desmidium* and *Hyalotheca*. They appear to be entirely confined to the Desmidieae, other fresh-water *Algæ* containing calcium oxalate, especially species of *Spirogyra* but not calcium sulphate."

For details the original paper must be consulted in Pringsheim's Jahrb. f. Wiss. Bot. XIV, (1883) pp. 133–184.

DOCIDIUM (PLEUROTAENIUM) BREVE, Wood. (Add to page 30).

Robust, 4–8 times longer than broad, distinctly constricted, but not undulate in the middle; slightly attenuated towards the ends; apex truncate and somewhat rounded; cytioderm very thick, densely minutely granulate; margins either straight or shortly undulate.

Diameter 20–24 μ.

Dr. Wood remarks, "this species was sent to me by Dr. Billings, who obtained it near Washington, D. C. The margins are sometimes straightish, but in other fronds there are three or more distinct, short, undulations or rounded projections in each half margin."

The shape of the semicell is very near Plate X, fig. 12, but only about half the size, not so undulate and not spinous.

CLOSTERIUM SUBTILE, Breb. Plate VII, fig. 2. (Add to page 40).

Cells very slender, acicular, slightly curved, narrow lanceolate, apices acute, cuspidate.

Diameter 3–4 μ.

Ponds, New Jersey, rather rare.

C. PSEUDOGRANATUM, Nord. Plate XVII, figs. 21–23. (Add to page 80).

This plant differs from *C. granatum*, Breb. in having a distinct central inflation as is evident in lateral and transverse views. Unlike *C. granatum*, and unlike the Brazil plant described by Nord., the sides of the semicells are not sinuate or straight, but somewhat convex. Membrane punctate.

Diameter 35 μ.; length 60 μ.

Pond, Northampton County, Pennsylvania.

COSMARIUM TURPINII, Breb. Plate XVII, figs. 24, 25. (Add to page 81).

Cells of equal length and breadth; constriction deep, forms a narrow linear or acute-angled sinus, outwardly ampliated; semicells triangular, lower angles rounded, apex truncately rounded; sides somewhat concave; central inflation granulate, and sometimes emarginate; cytioderm finely granulate or punctate.

Diameter 55–70 μ.

Not rare; frequently in large numbers in ponds, New Jersey, Pennsylvania and many other States.

As these last pages are preparing for the press (March, 1884) I received material collected by the Rev. H. D. Kitchel in a pond in the vicinity of Maitland, and near Sanford, Orange County, Florida. In it I find several specimens of special interest, which demand the following notes:

DESMIDIUM DIAGONUM, (*Aptogonum Diagonum*, Delp.) (Add to page 27).

Filaments compressed, perforated, twisted, not vaginate; cells in end view oblong-elliptic.

Diameter 32 μ.; thickness 14 μ.; length of cell about half the diameter.

Lake Jessup, five miles from Sanford, Florida.

This species described by Delponte in his "*Desmidiacearum Subalpinarum*," is, in front view, scarcely separable from *D. aptogonum*, but in lateral view it is distinct. The cells are oblong-elliptic in end view not triangular. The filaments are twisted, and being more than twice as wide as thick, present an irregular outline, parts showing the broad front, and parts the narrow sides of the filaments. The margins of cells are notched, and the ends excavated as in *D. aptogonum*.

SPHAEROZOSMA SPINULOSUM, Delp.

This species is noticed, page 31, with some feelings of doubt. The specimen referred to was more granular than spinous. In the Florida collection are numerous well-developed specimens, which agree with Delpont's diagnosis in being really spinous. They have the form of cell, the measure, and the arrangement of the spines, except perhaps that there are more frequently only two, than three spines, on the margin of each semicell. A fine and distinct species. If the granules of the figure (Plate IV, fig. 14) were drawn out into short spines, the typical plant would be well represented.

DOCIDIUM EHRENBERGII, Ralfs.

Var. FLORIDENSE, Wolle.

Differs from *D. Trabeculum*, Naeg., described, page 48, and from the typical form of *D. Ehrenbergii*, of Ralfs, Delponte,

and others in its more slender cell, and in the larger number of umbonations. Cell twenty or more times longer than broad, medianly distinctly constricted, without an evident suture or projecting rim. Semicells tapering slightly, in direct lines from the centre to the end, with not only one or two inflations (umbonations) at the base, but four, five or more, often extending in slight undulations to near the end; apex squarely truncate, bordered by three to five minute tubercles.

Diameter 16–20 μ.; length 300–400 μ.

EUASTRUM VENTRICOSUM, Lund. (Add to page 97).

Without a figure for illustration, this species may be most satisfactorily described by comparison with *E. crassum*, Kg., to which it is very nearly allied, and in front view scarcely separable except in size; it has only about half the length of a fully developed, large form; it is more squatty, less than twice as long as wide; in lateral view, however, it is quite distinct; semicells not ovate, with convex sides, narrow truncate end, and broad flat base, but subrectangular; end broad, flatly rounded; sides somewhat contracted near the apex, producing a lobule on each side; another lobule on each side between the base and the apex; each of the superior lateral lobes seen in front view, when seen from the side, show an obtusely rounded, conical point near the apex, not bifid as in *E. crassum*. The end view varies also; it is broadly elliptic, with four, or imperfectly, five swellings on each side, not three.

Diameter 50 μ.; length 88 μ.

Frequent with zygospores, which are orbicular, furnished with numerous, short, stout, obtusely pointed, conical tubercles; two, often converging, or diverging, the one to, or from the other.

A. INCUS, Hass. (Add to page 97).

A variety from lakes, Winter Park, Florida, which differs from the forms figured in having the ends of the semicells somewhat convex, the sides not rounded but gibbous near the base; sinus wide, internally rounded; spines converging.

M. QUADRATA, Bailey. (Add to page 117).

Found good specimens in collections made in lakes, Winter Park, Florida. Beside the typical form also a variety which has the ends of the basal lobes deeply bisected, to nearly half the length.

ST. NOYÆ CÆSARÆ, Wolle. (Add to page 145).

This species, hitherto found only in a pond near Hammonton, N. J., proves to have a home in Florida also. The plant differs somewhat from the more northern form, in having the subulate spines at the angles not so long, and the cell itself not quite so large.

ERRATA.

Page 22, 11th line from below read *H. dissiliens* instead of *disilliens*.

Page 47, 8th line from the top read *C. setaceum* instead *cetaceum*.

Page 48, 14th line from the top read XII instead of XI.

Page 94, 1st line read *anti* instead of *ante*.

Page 128, 8th line from the top read 14 instead of 13.

INDEX.

NAMES IN ITALICS ARE NEW SPECIES.

PLATES

AND

EXPLANATIONS.

PLATE I.

Figures magnified 500 diameters.

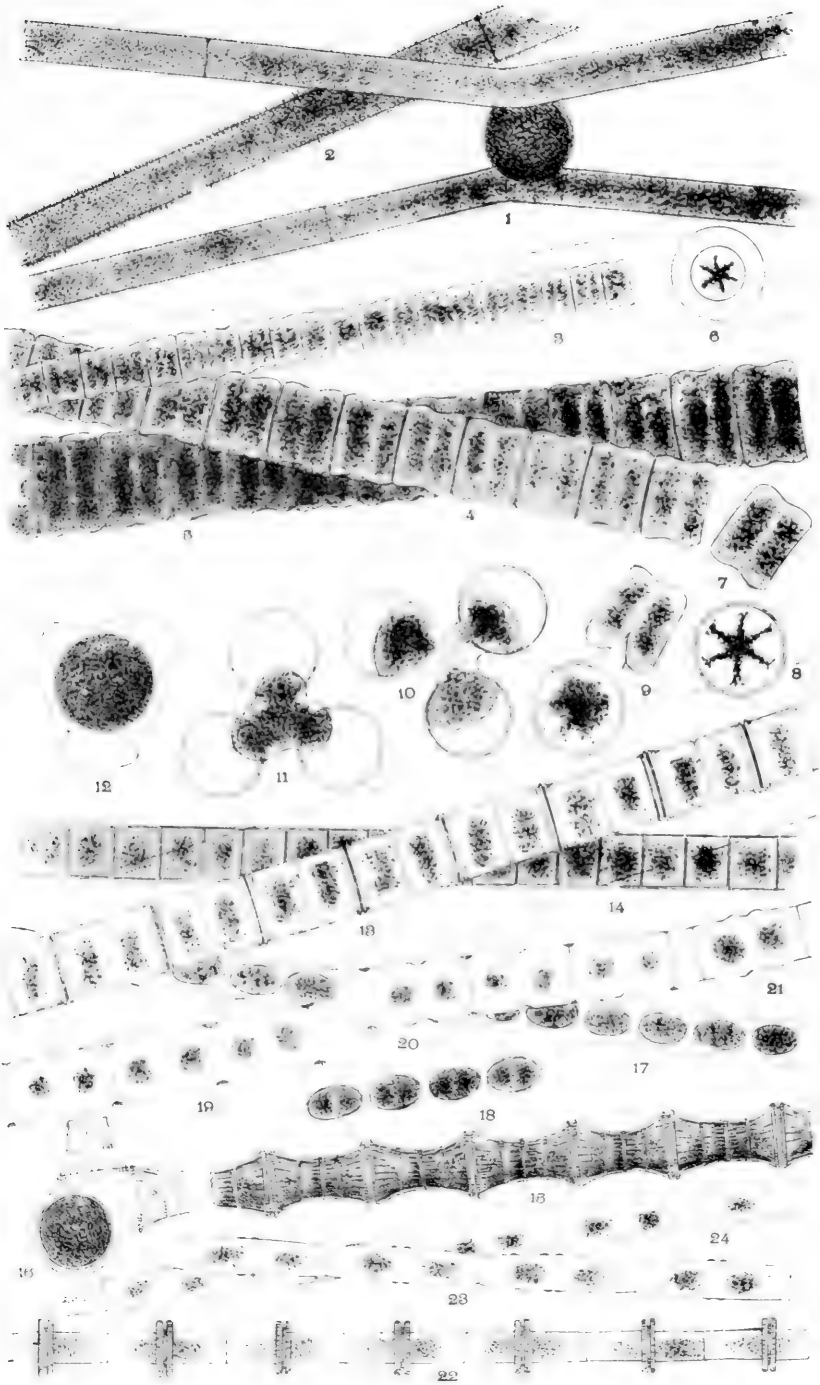
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PLATE II.

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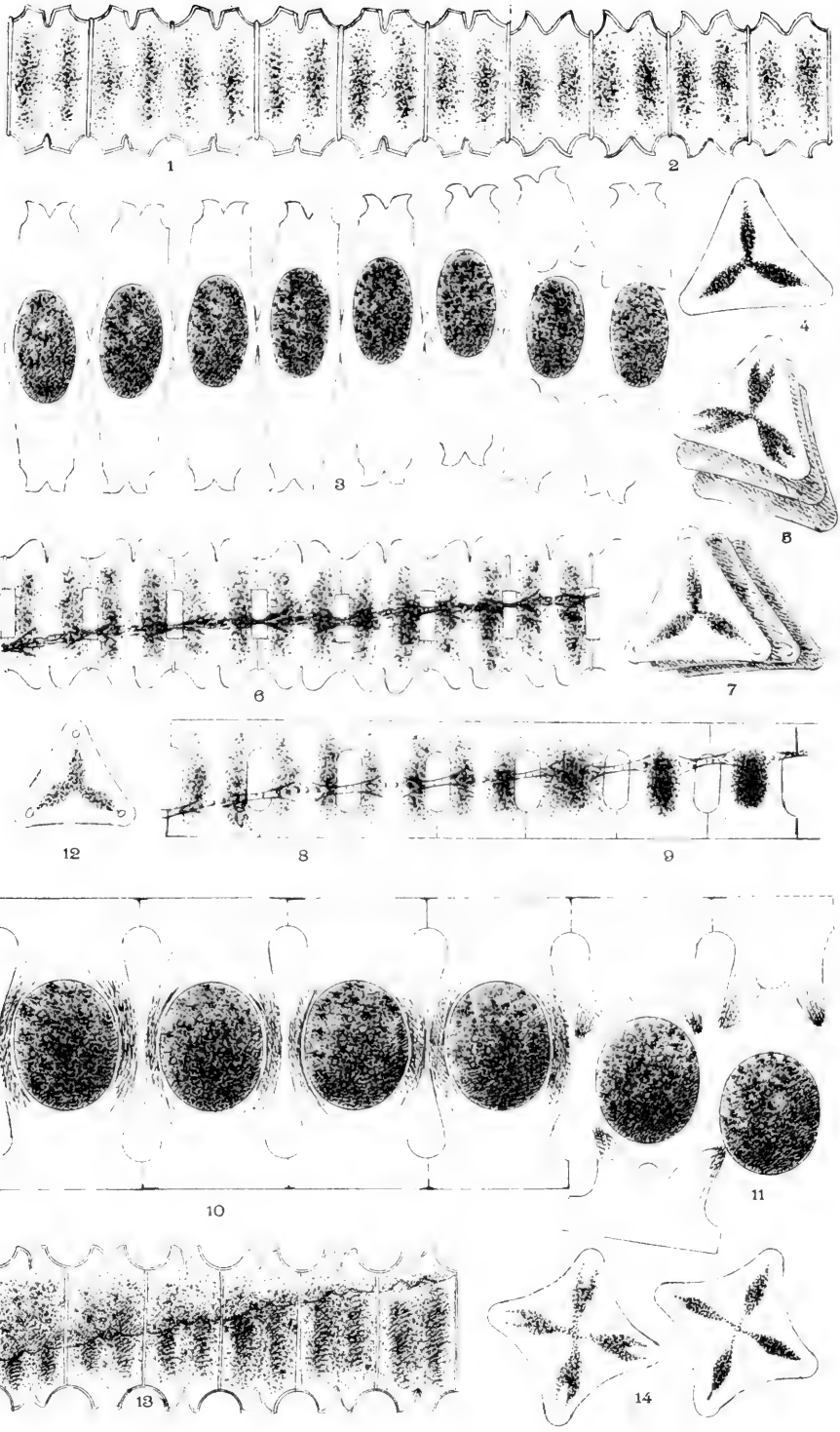
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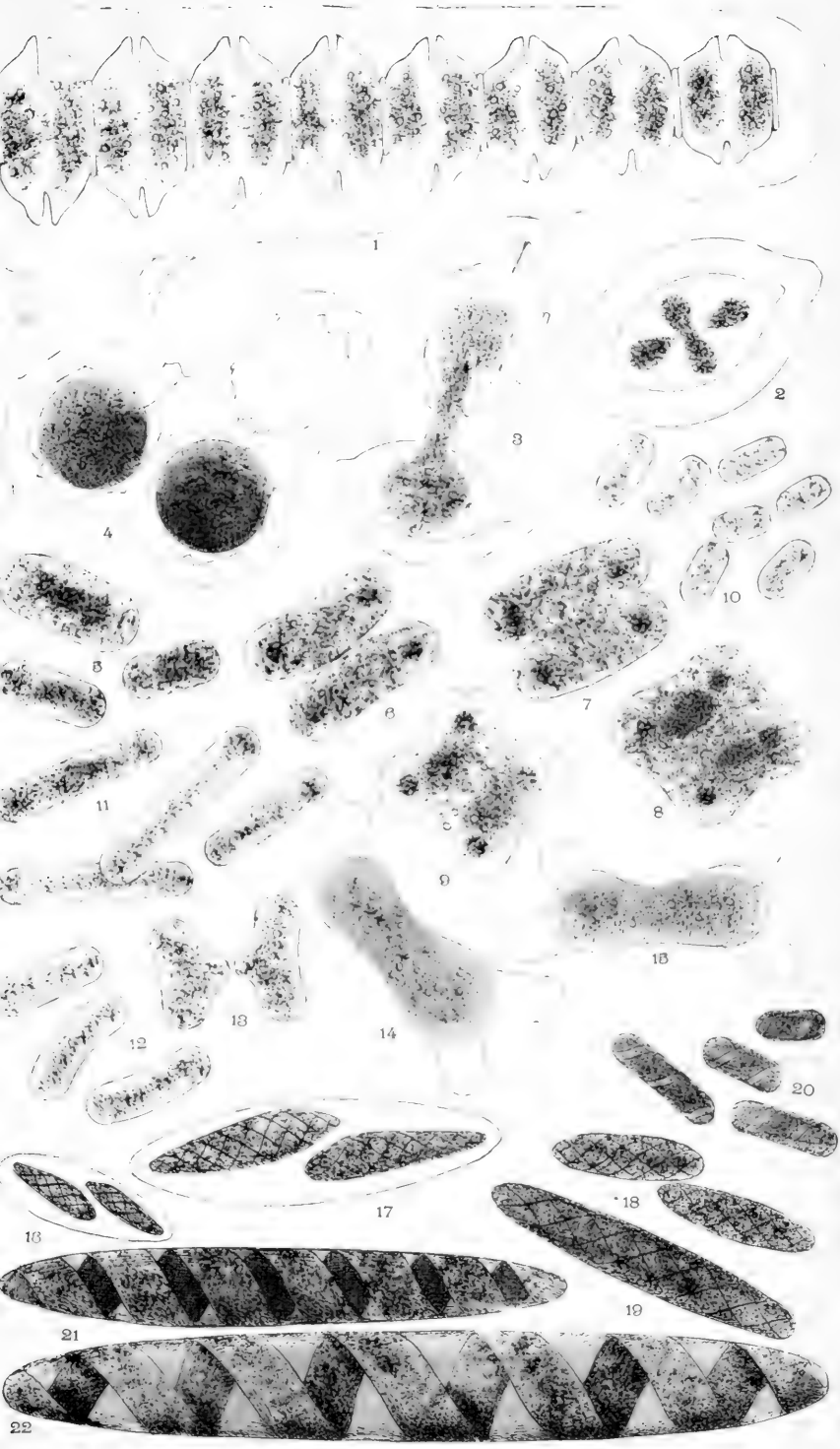
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Figures magnified 500 diameters.

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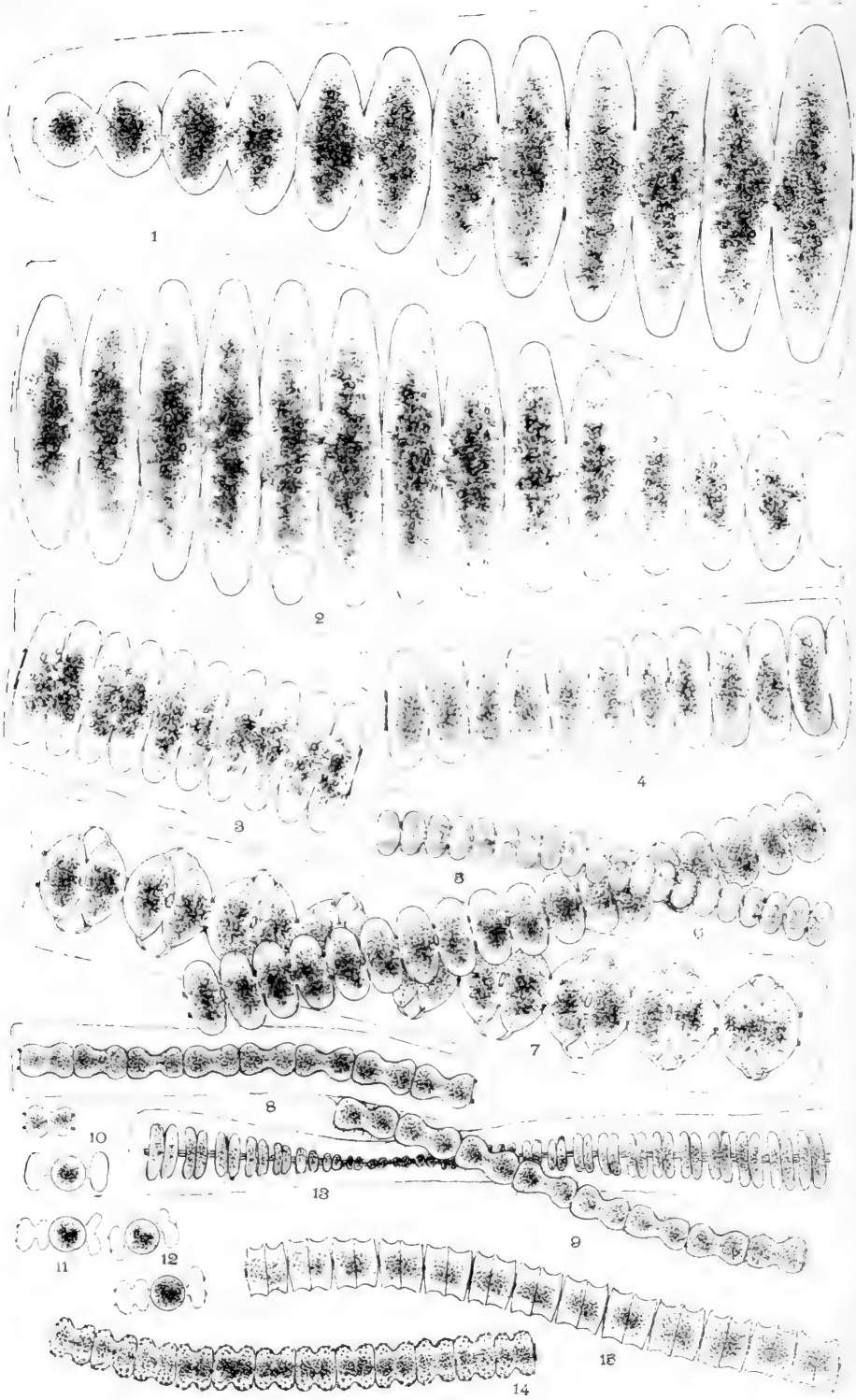
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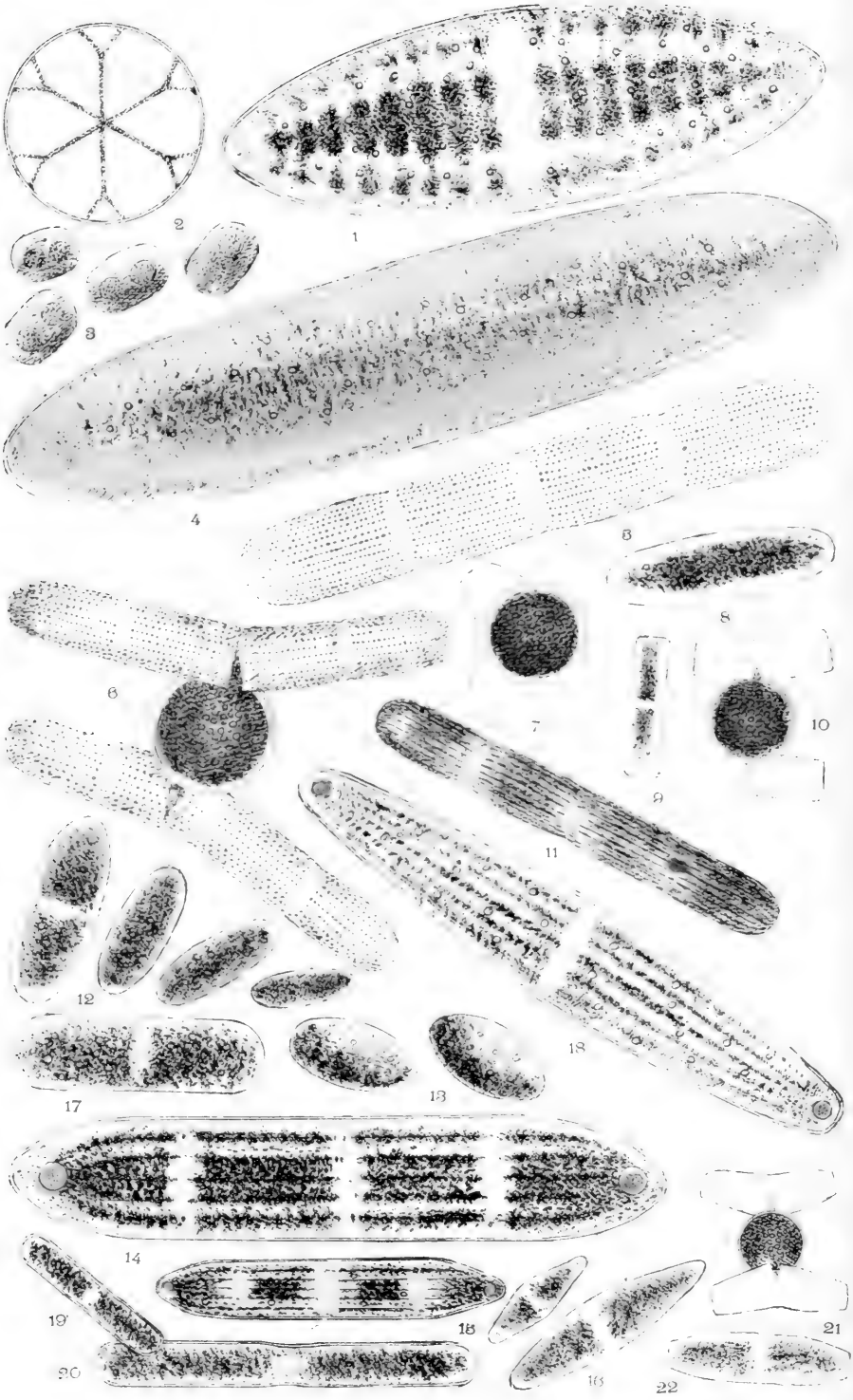
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PLATE VI.

Figures magnified 250 diameters.

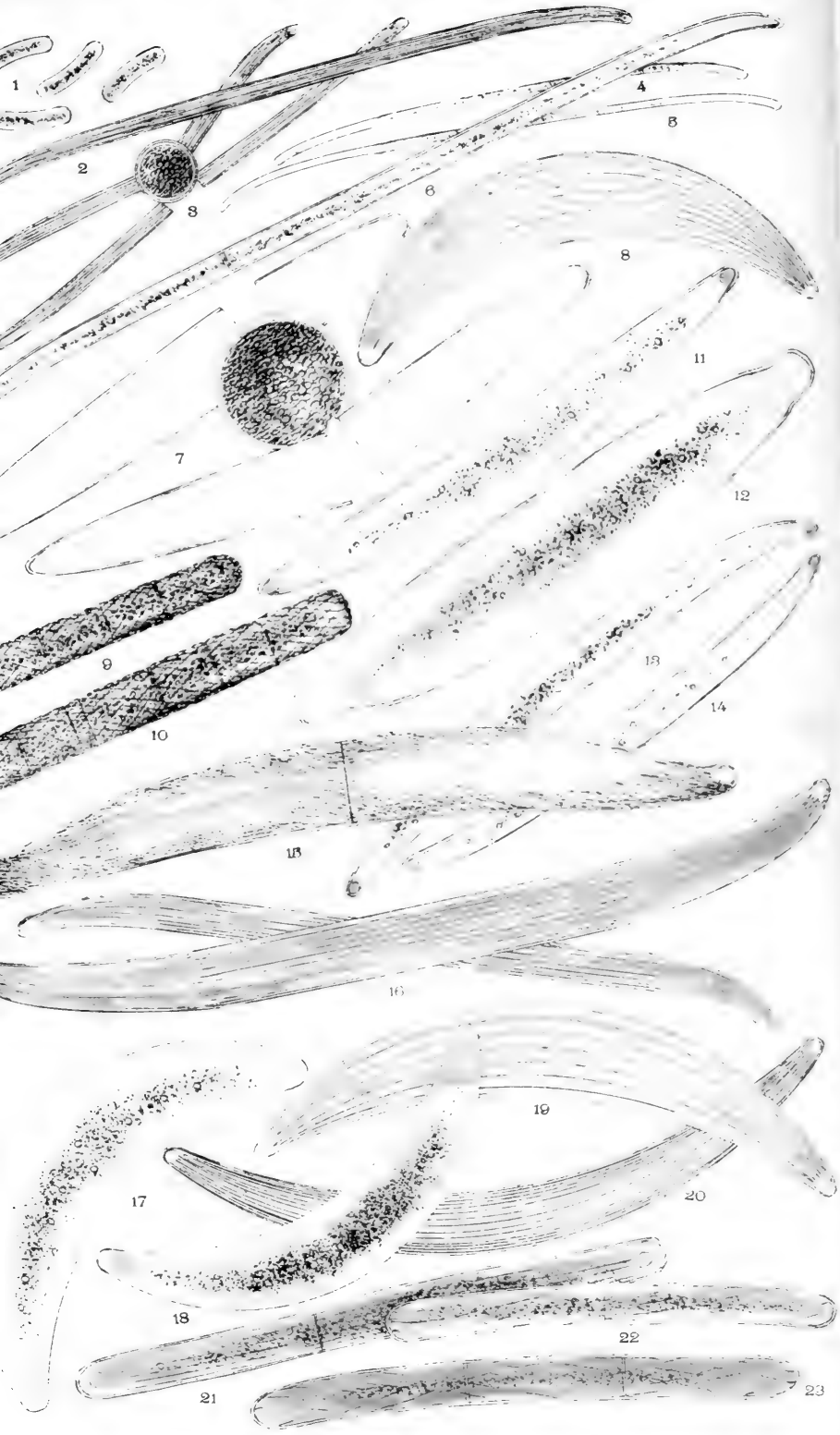
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PLATE VII.

Figures magnified 250 diameters.

PLATE VII.

PLATE VIII.

Figures magnified 250 diameters.

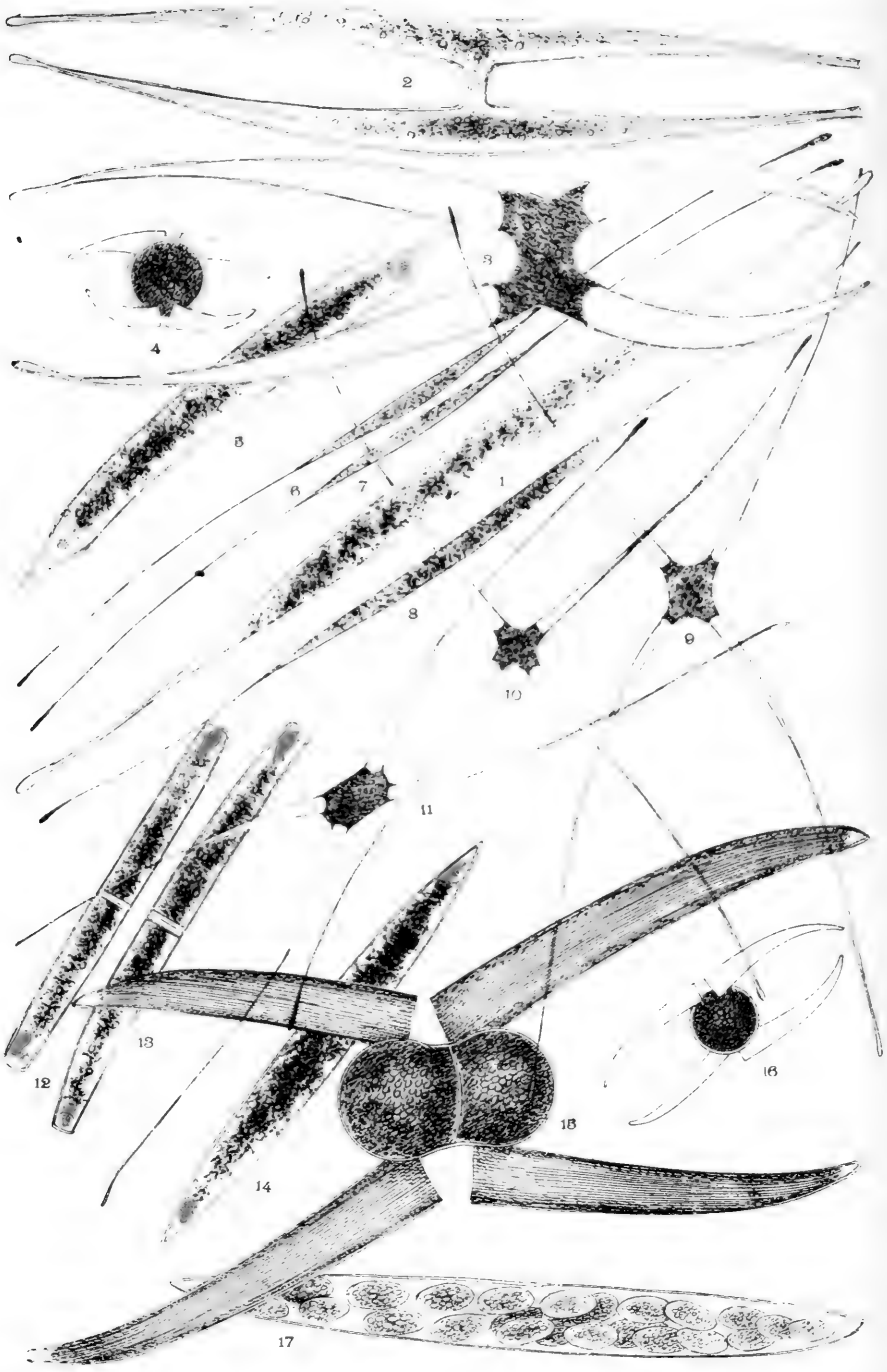
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PLATE IX.

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PLATE IX.

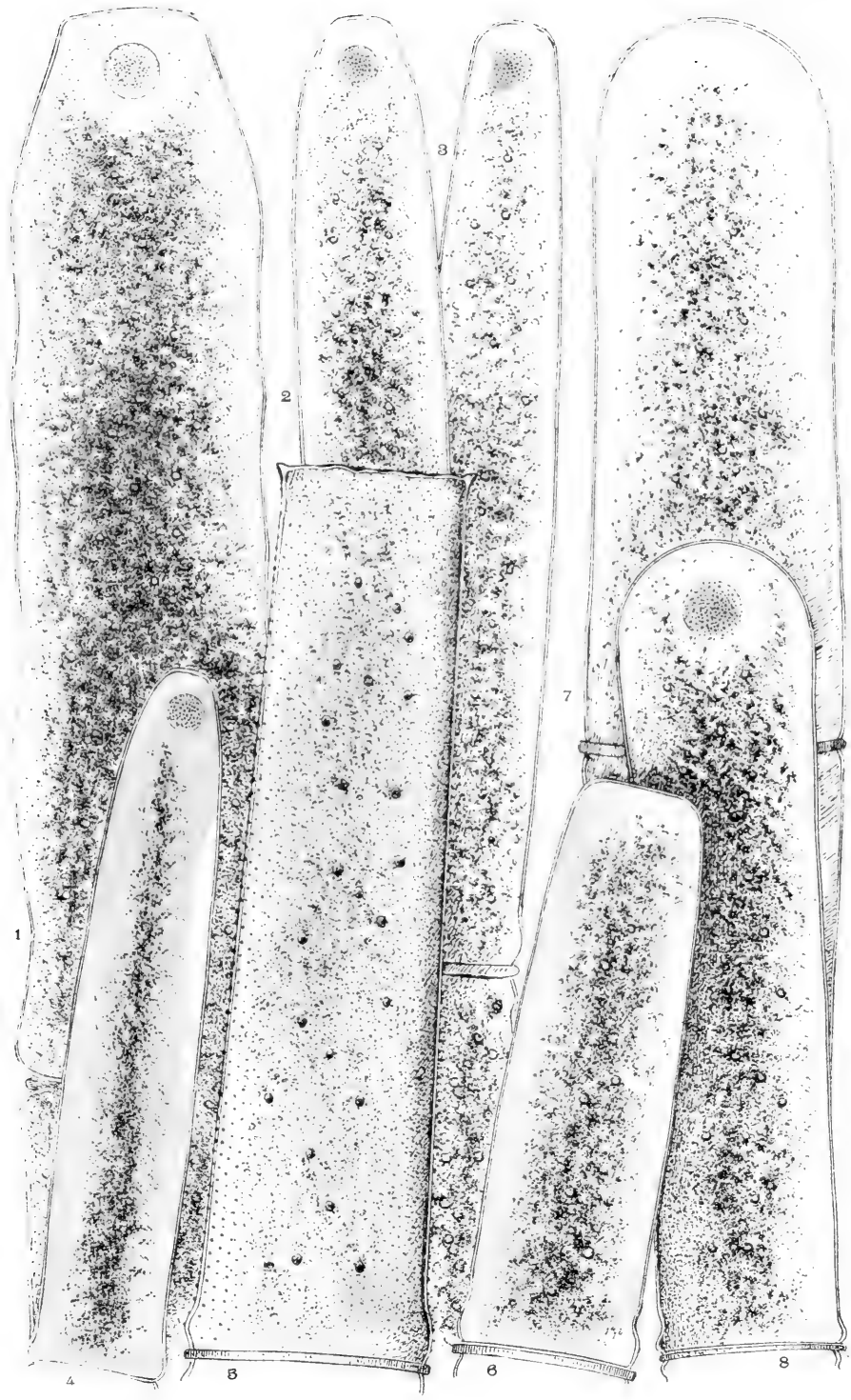

PLATE X.

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PLATE X.

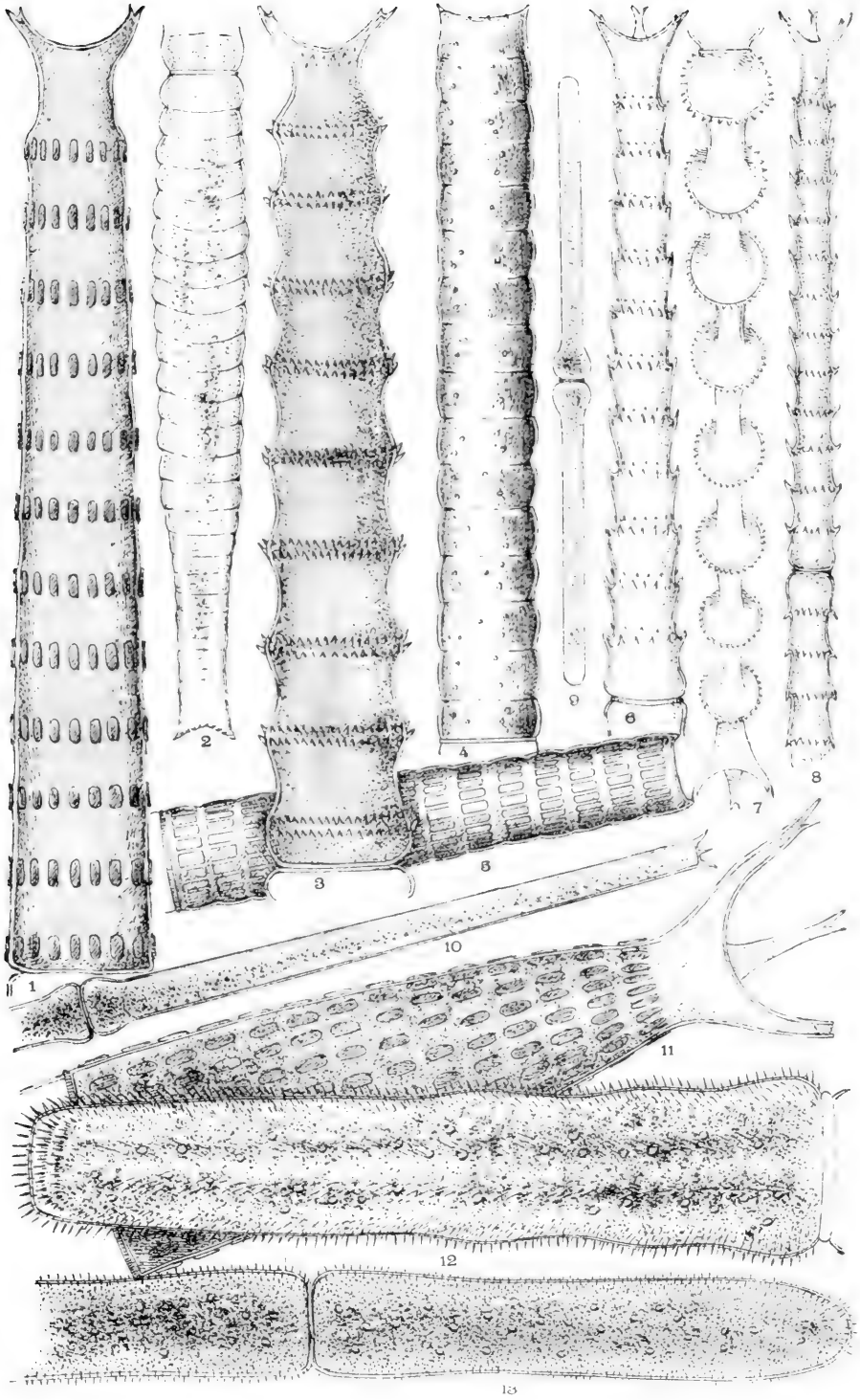

PLATE XI.

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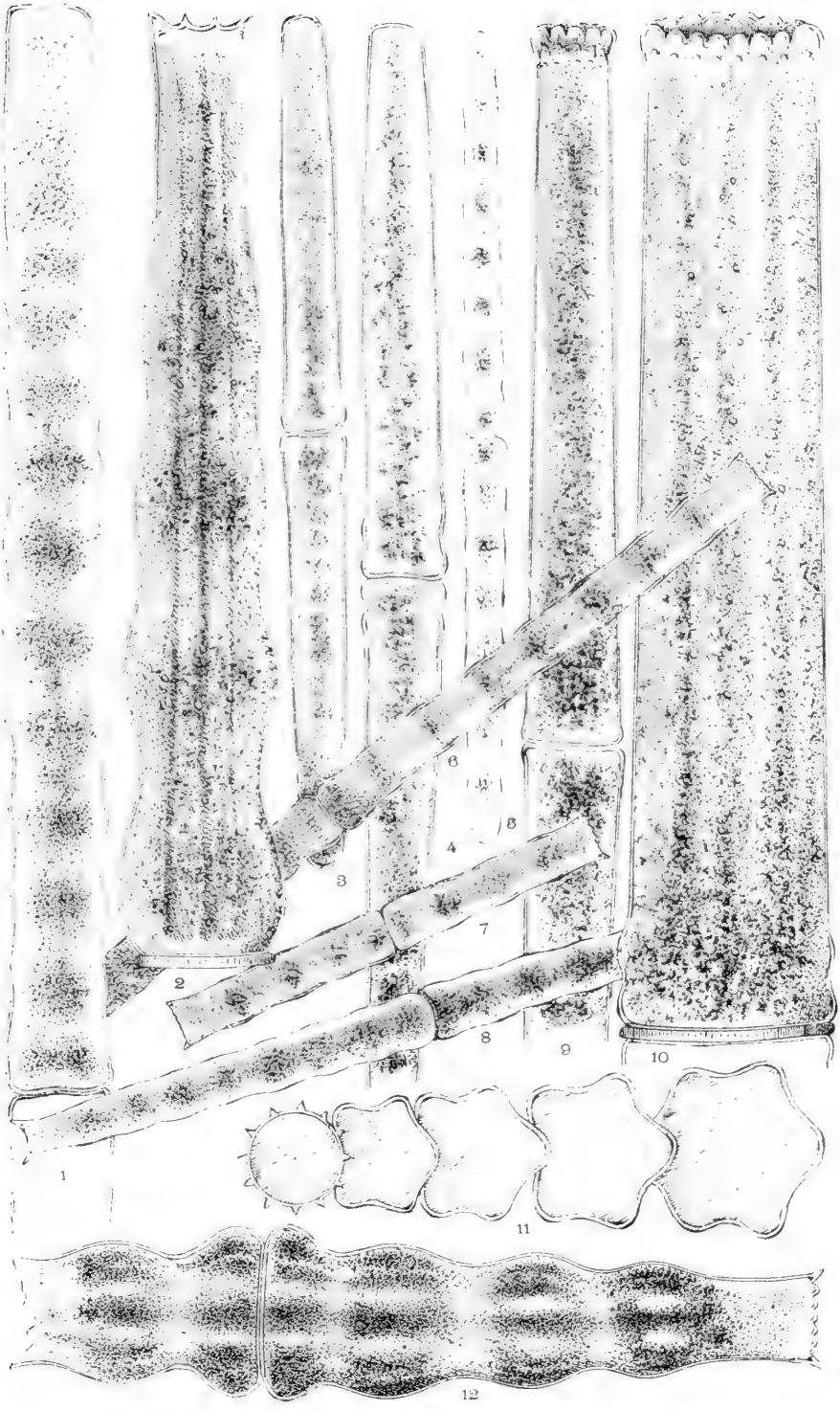
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PLATE XII.

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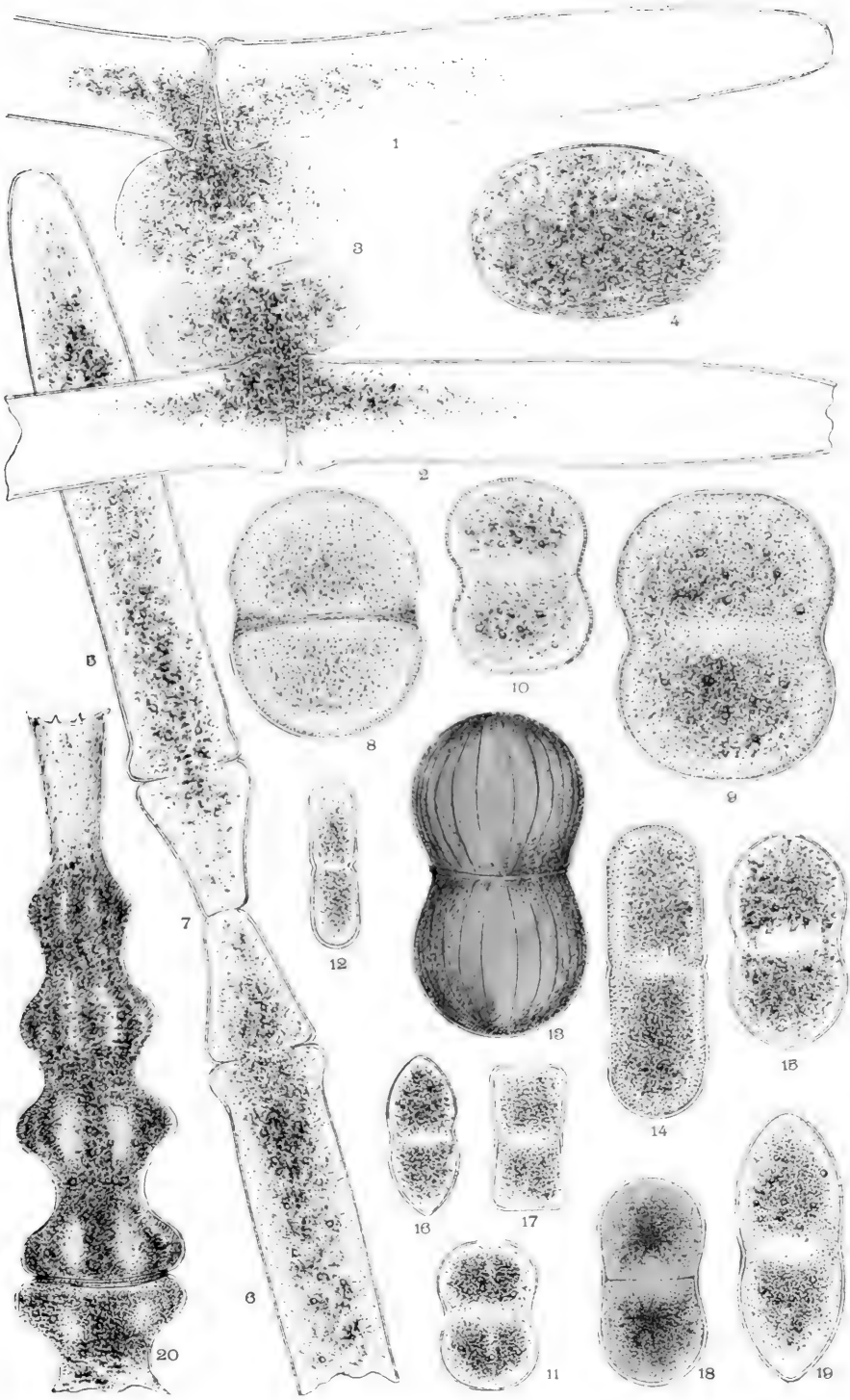
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PLATE XIII.

Figures magnified 500 diameters.

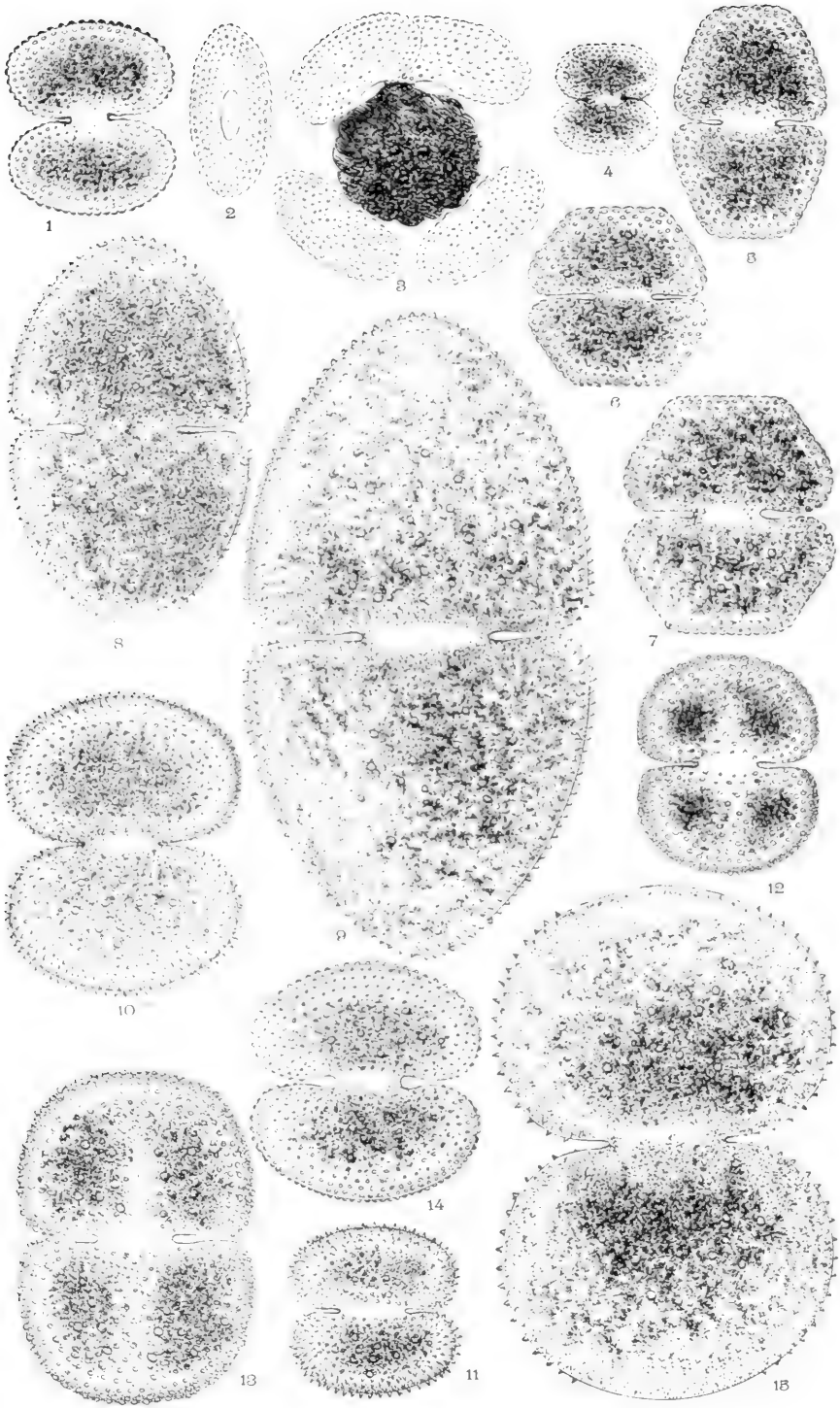
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PLATE XIV.

Figures magnified 500 diameters.

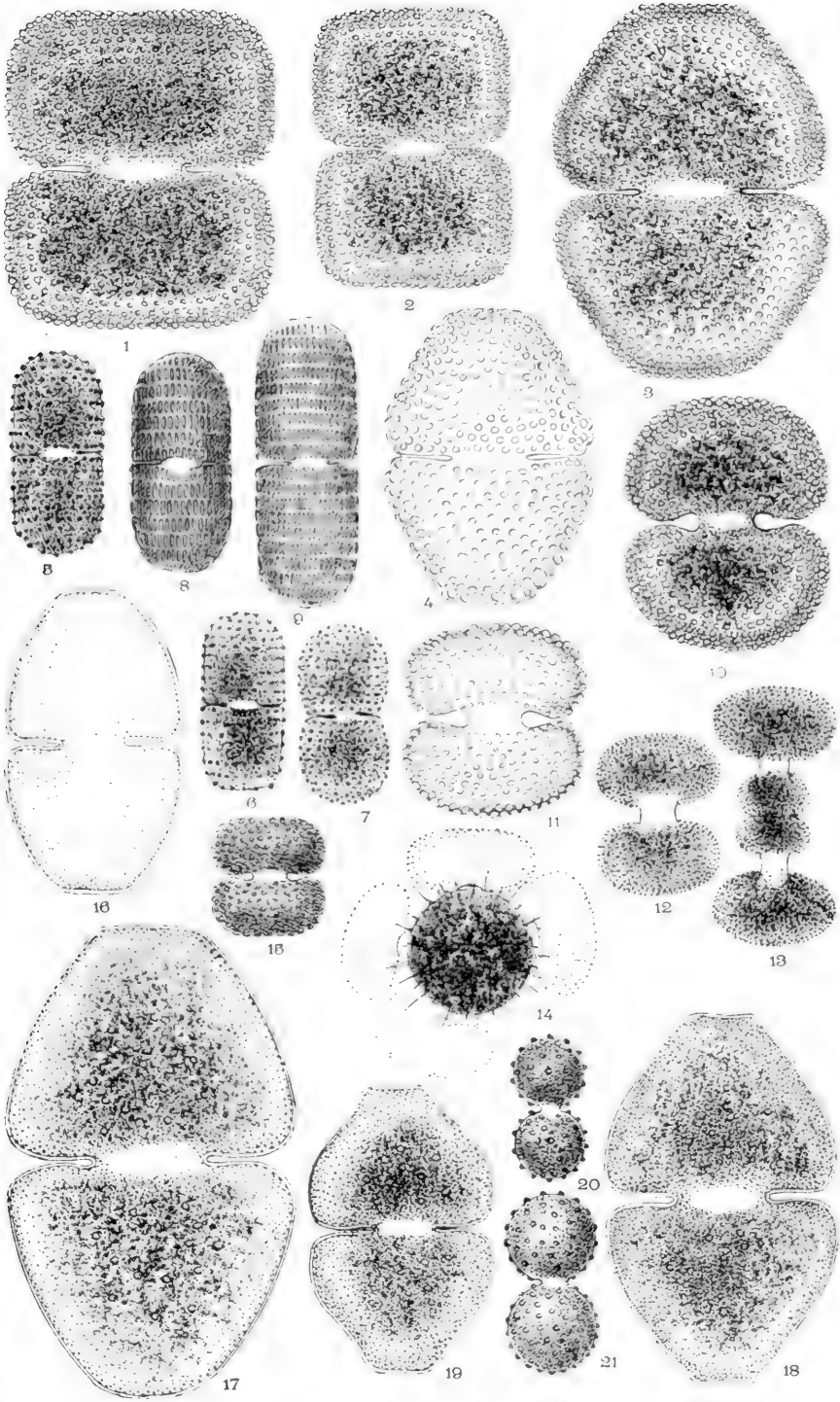
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PLATE XV.

Figures magnified 500 diameters.

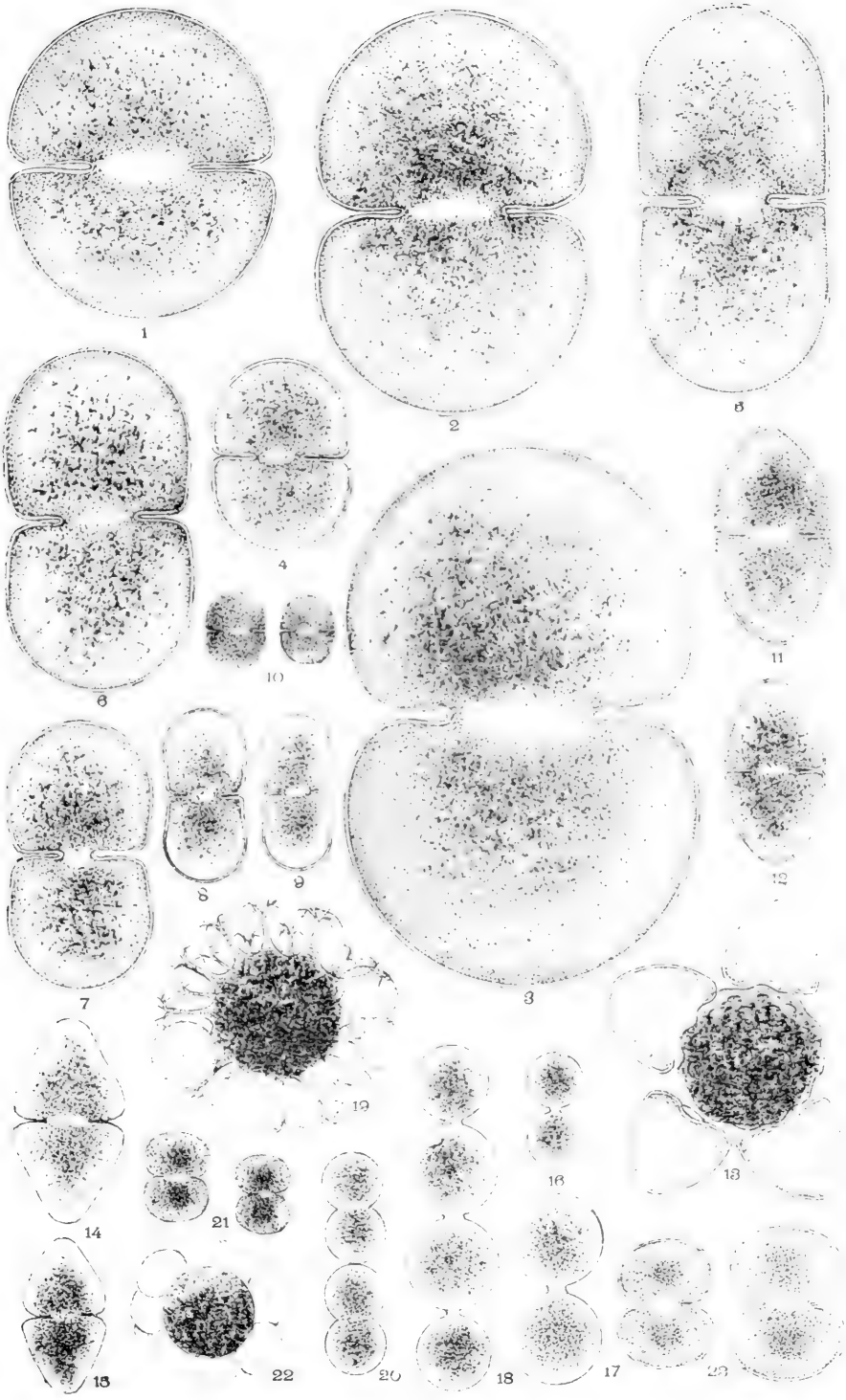
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PLATE XVI.

Figures magnified 500 diameters.

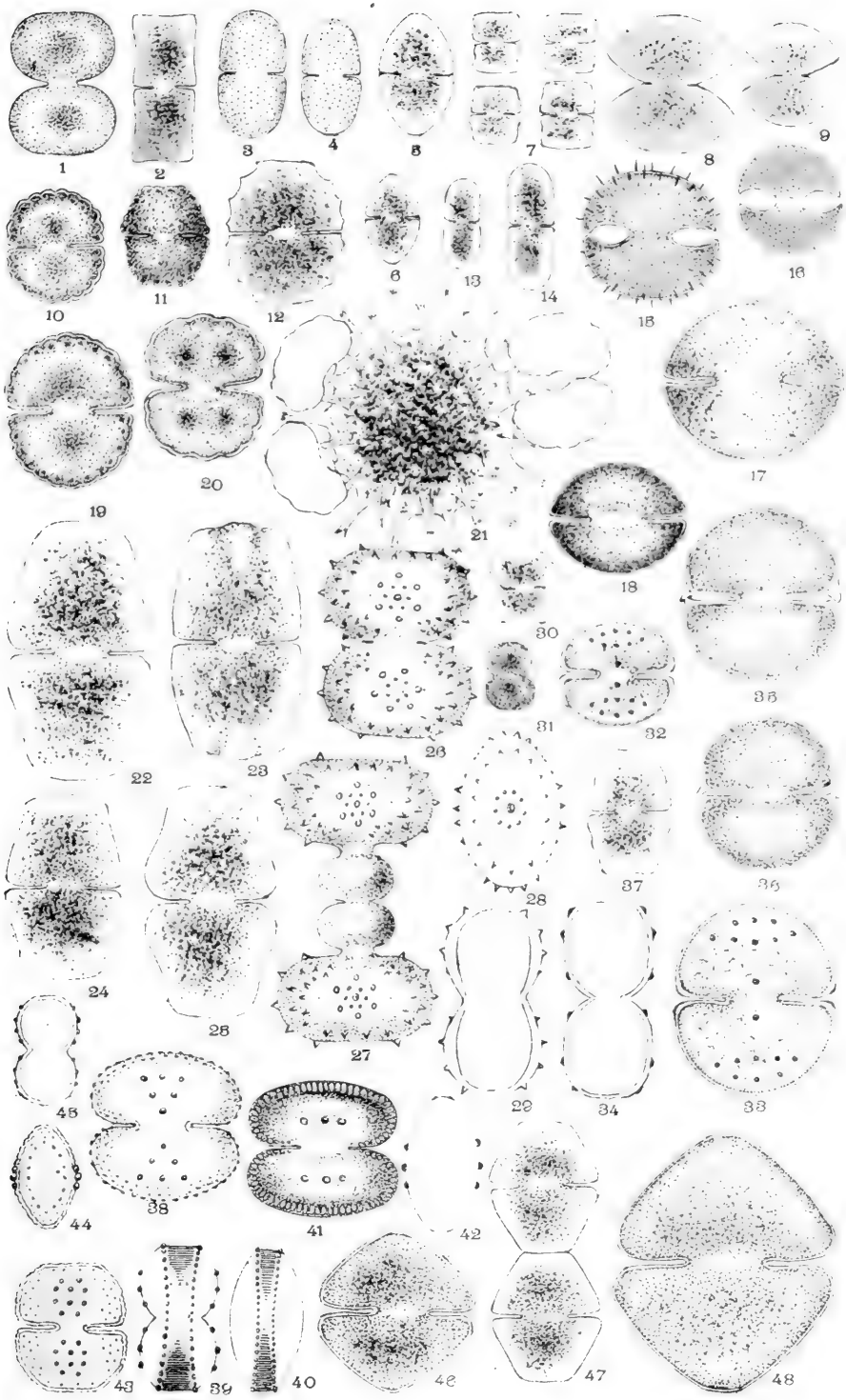
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PLATE XVII.

Figures magnified 500 diameters.

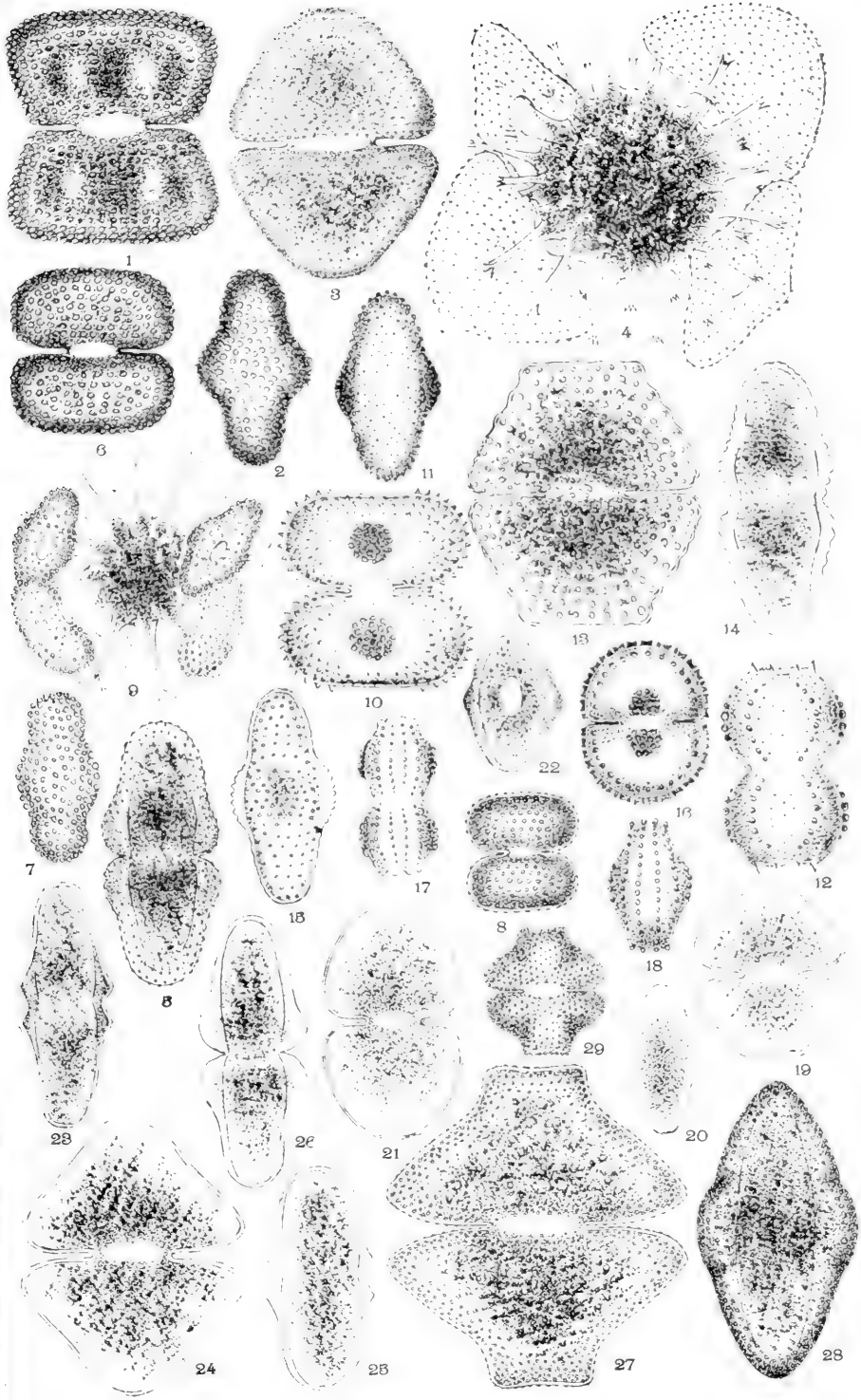
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PLATE XVIII.

Figures magnified 500 diameters.

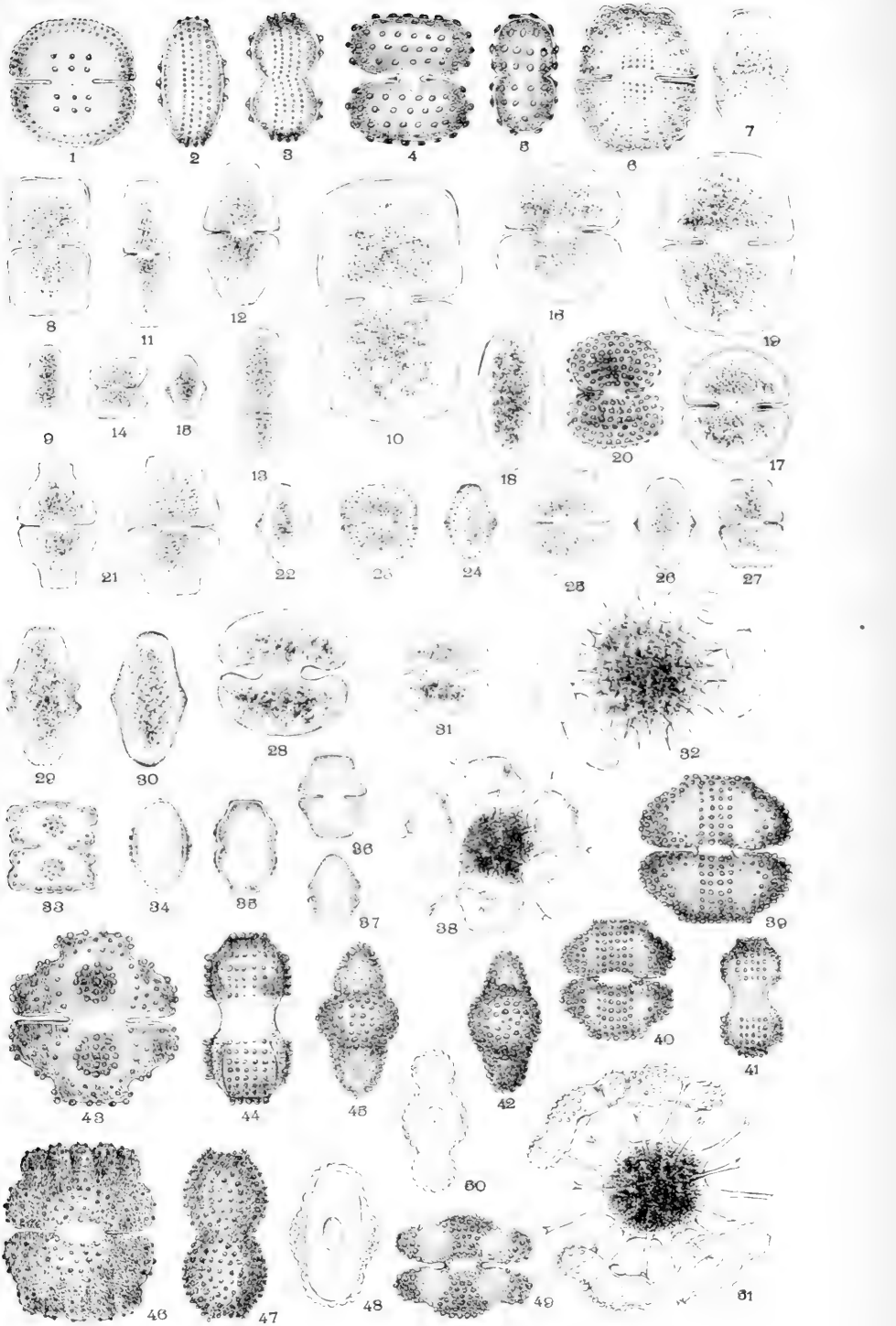
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PLATE XIX.

Figures magnified 500 diameters.

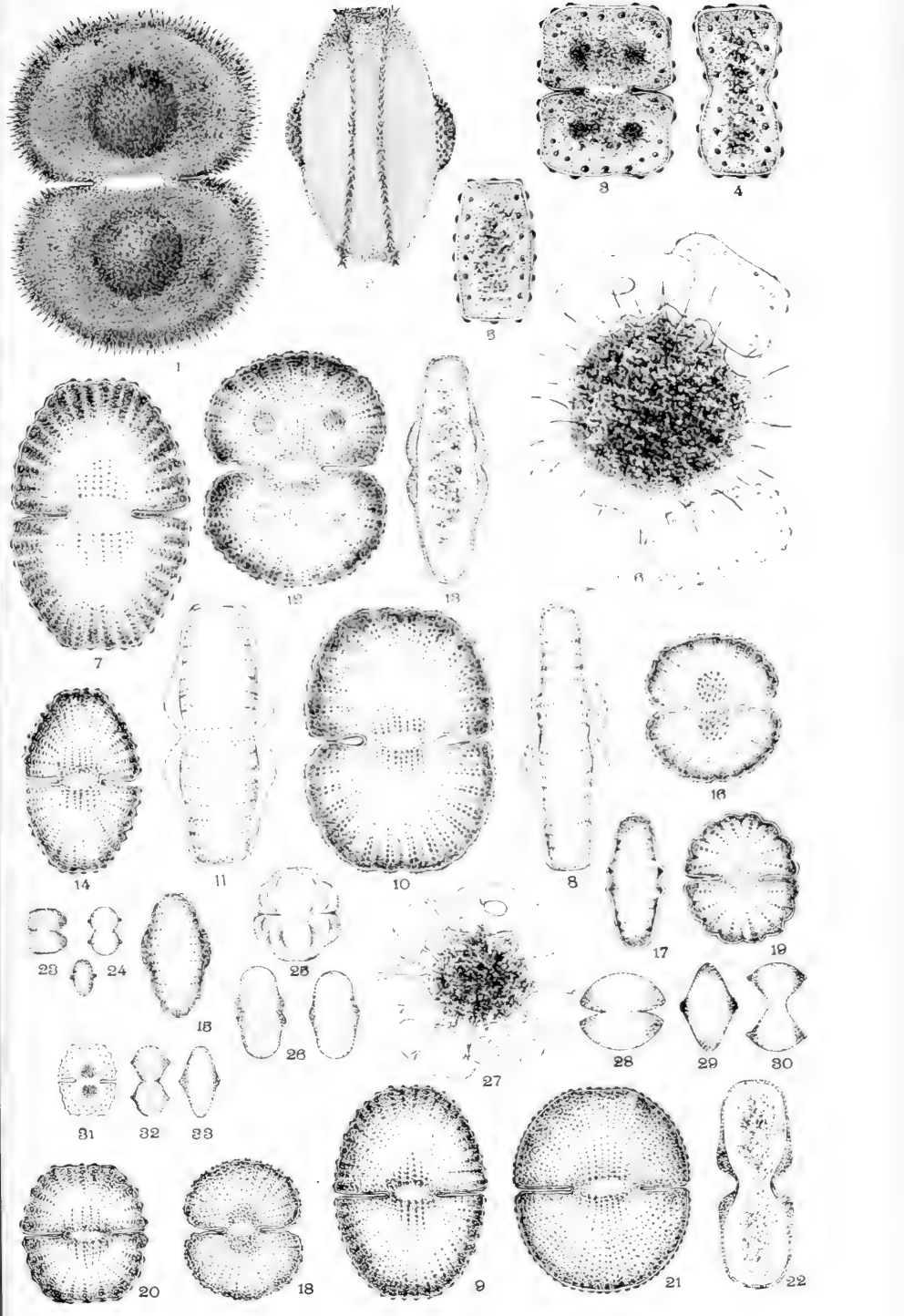
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PLATE XX.

Figures magnified 500 diameters.

PLATE XX.

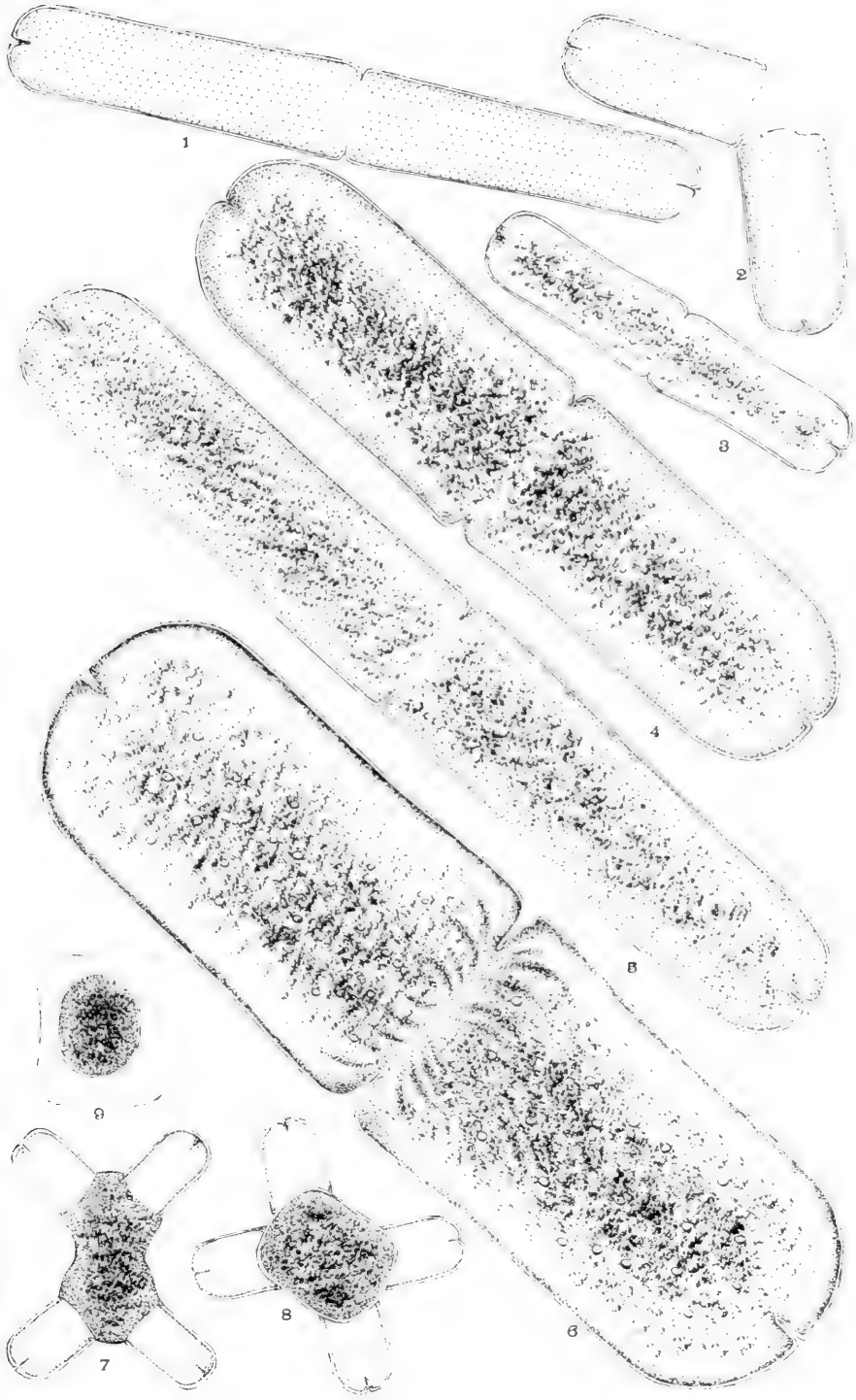

PLATE XXI.

Figures magnified 500 diameters.

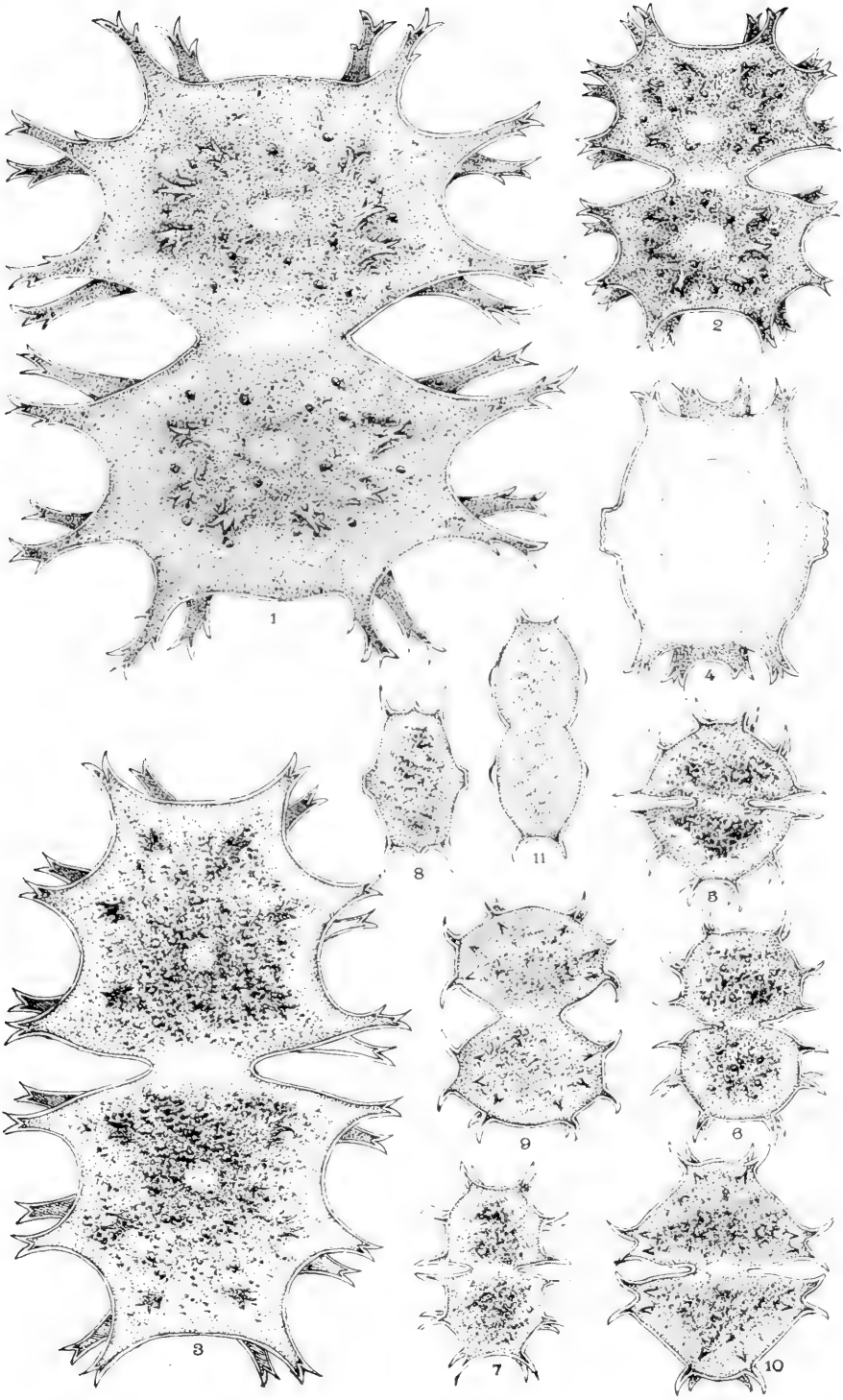
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PLATE XXII.

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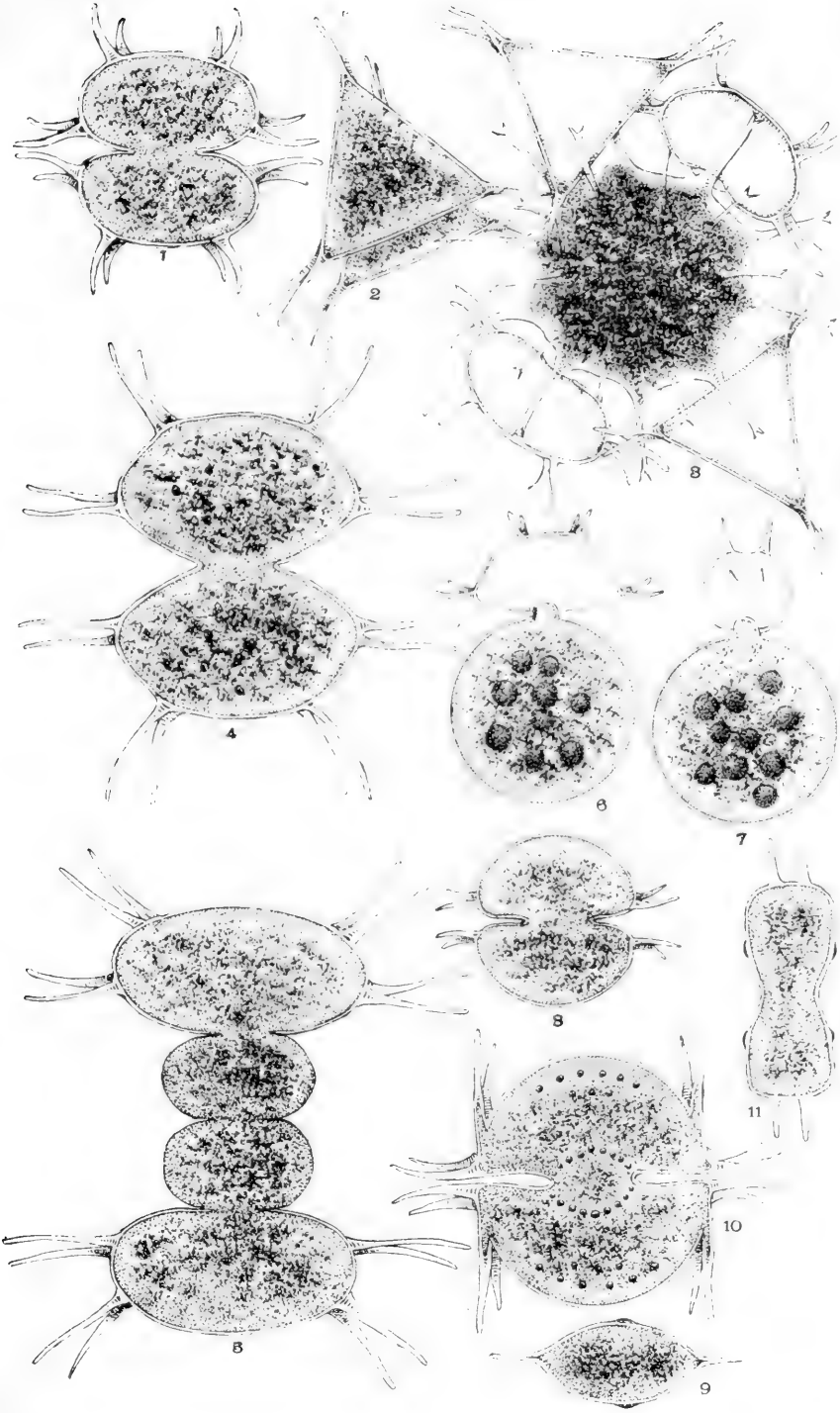
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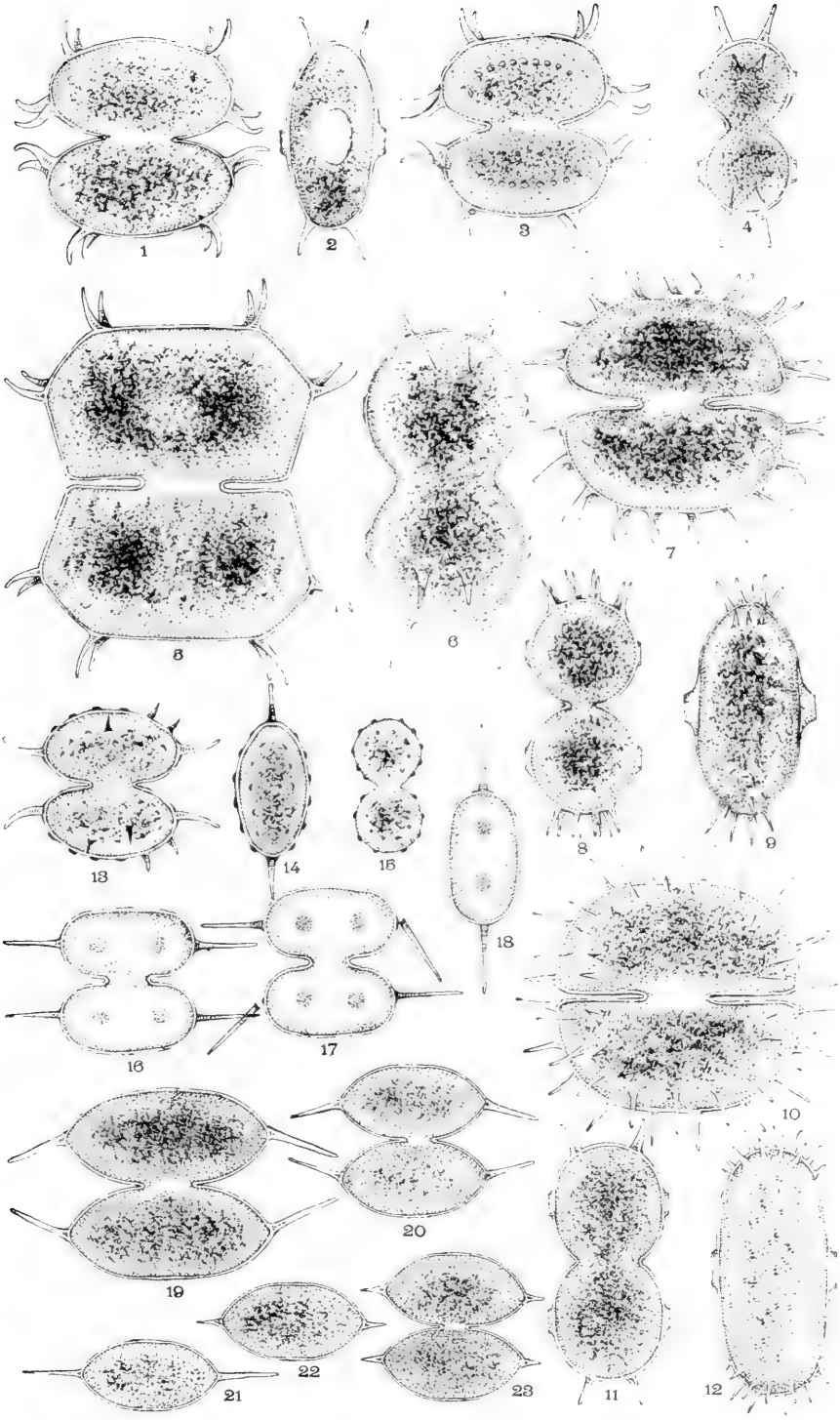
PLATE XXIII.

Figures magnified 500 diameters.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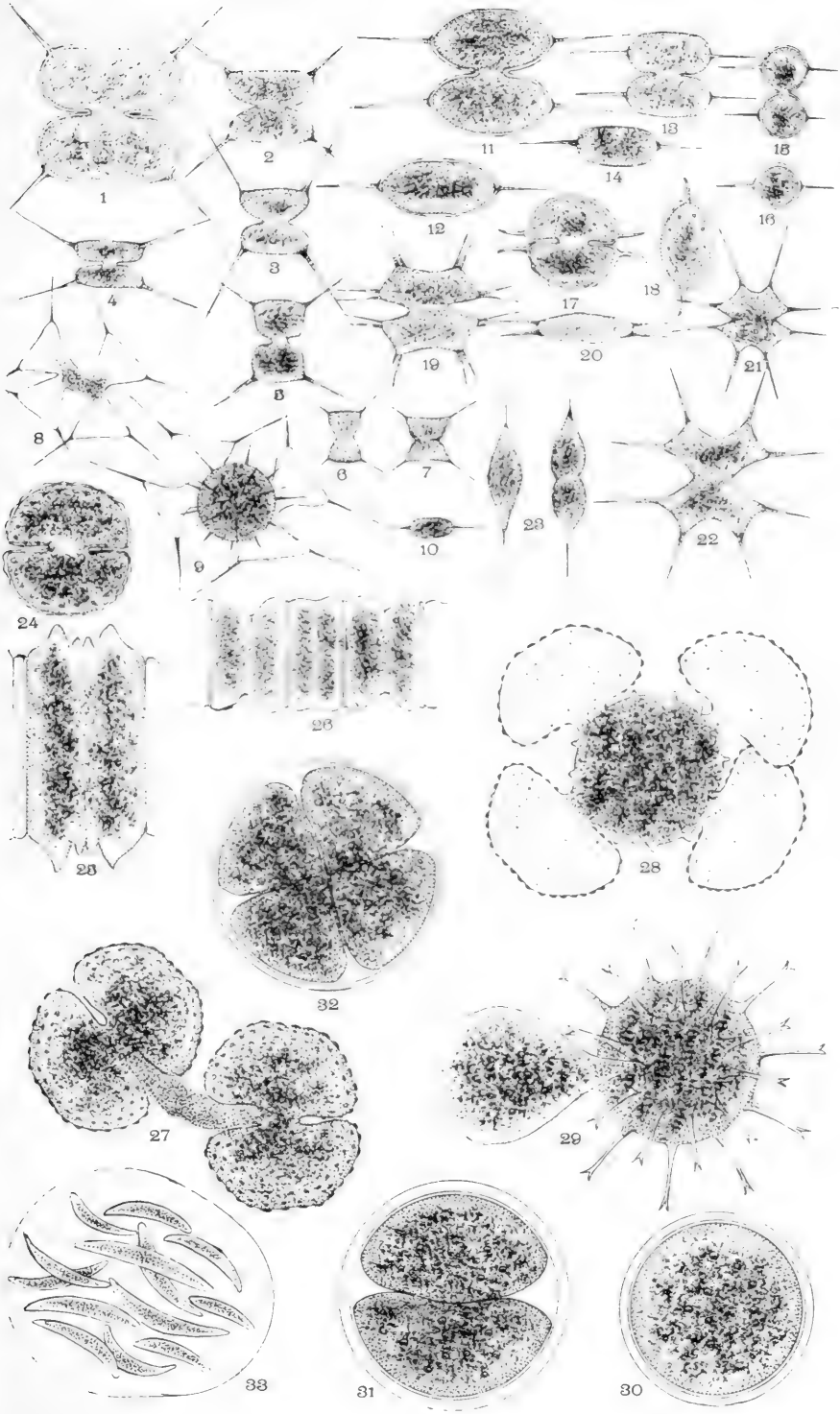
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PLATE XXV.

Figures 3, 7, 10, 12, 250 diameters: others 500 diameters.

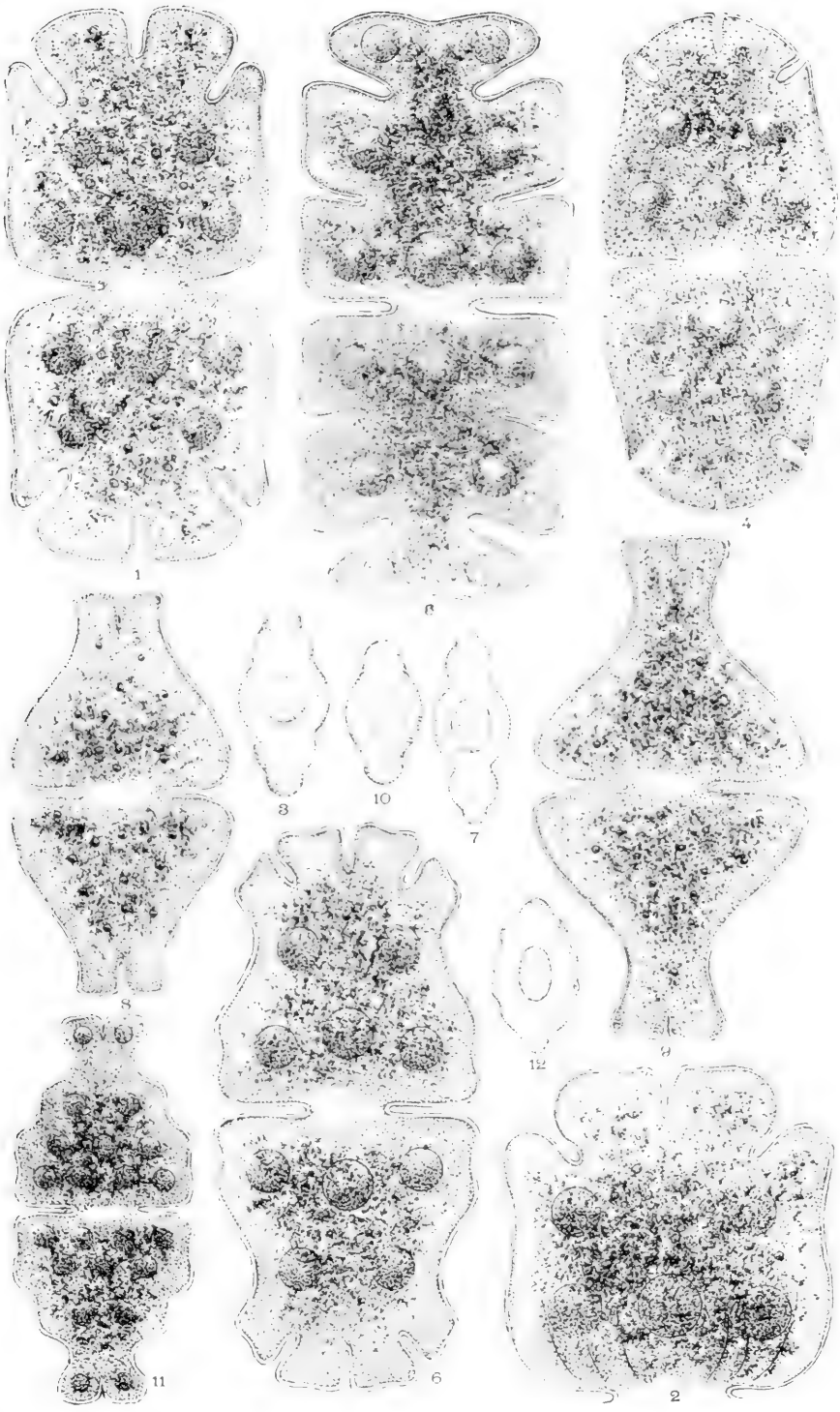
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PLATE XXVI.

Figures magnified 500 diameters.

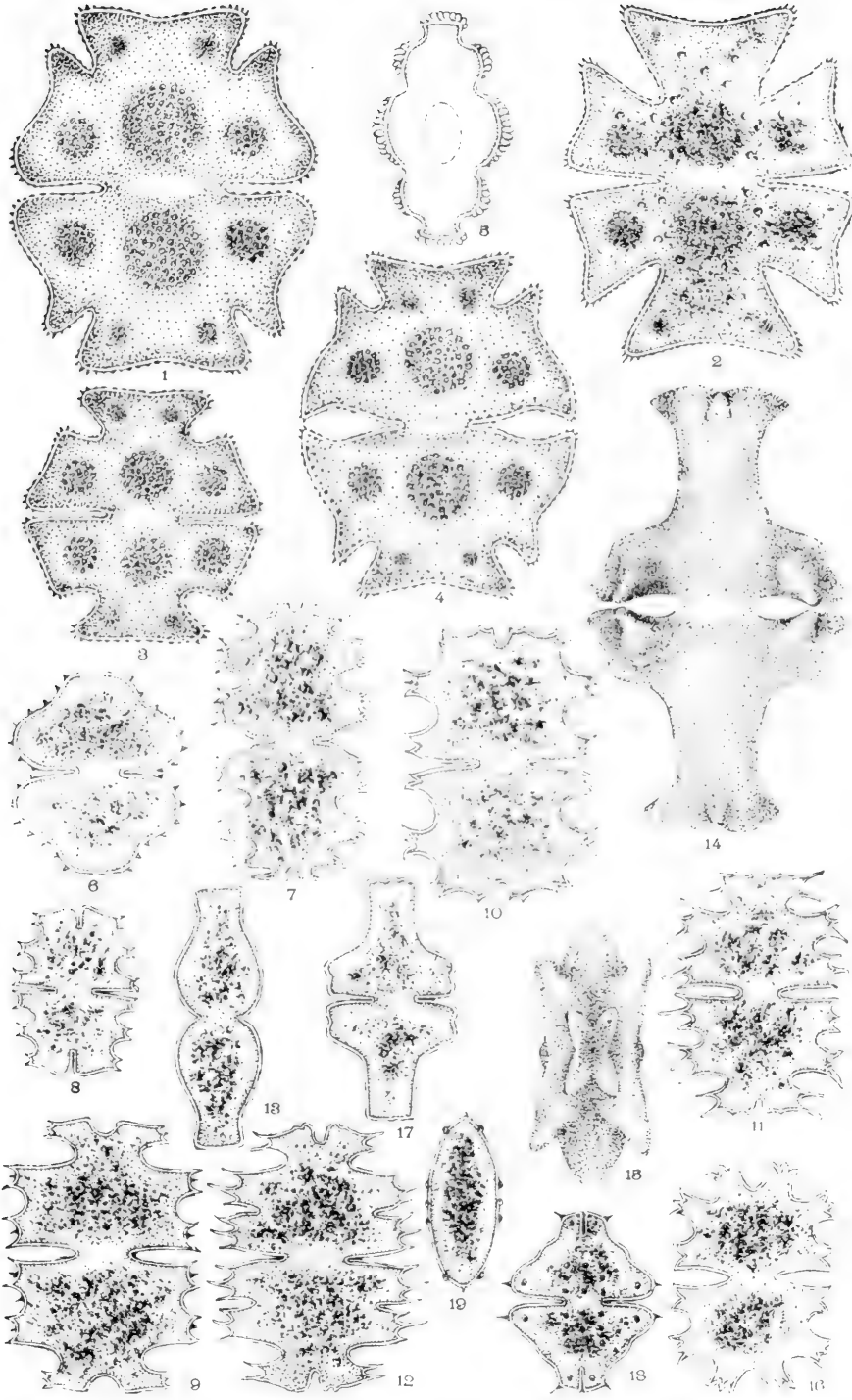
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PLATE XXVII.

Figures magnified 500 diameters.

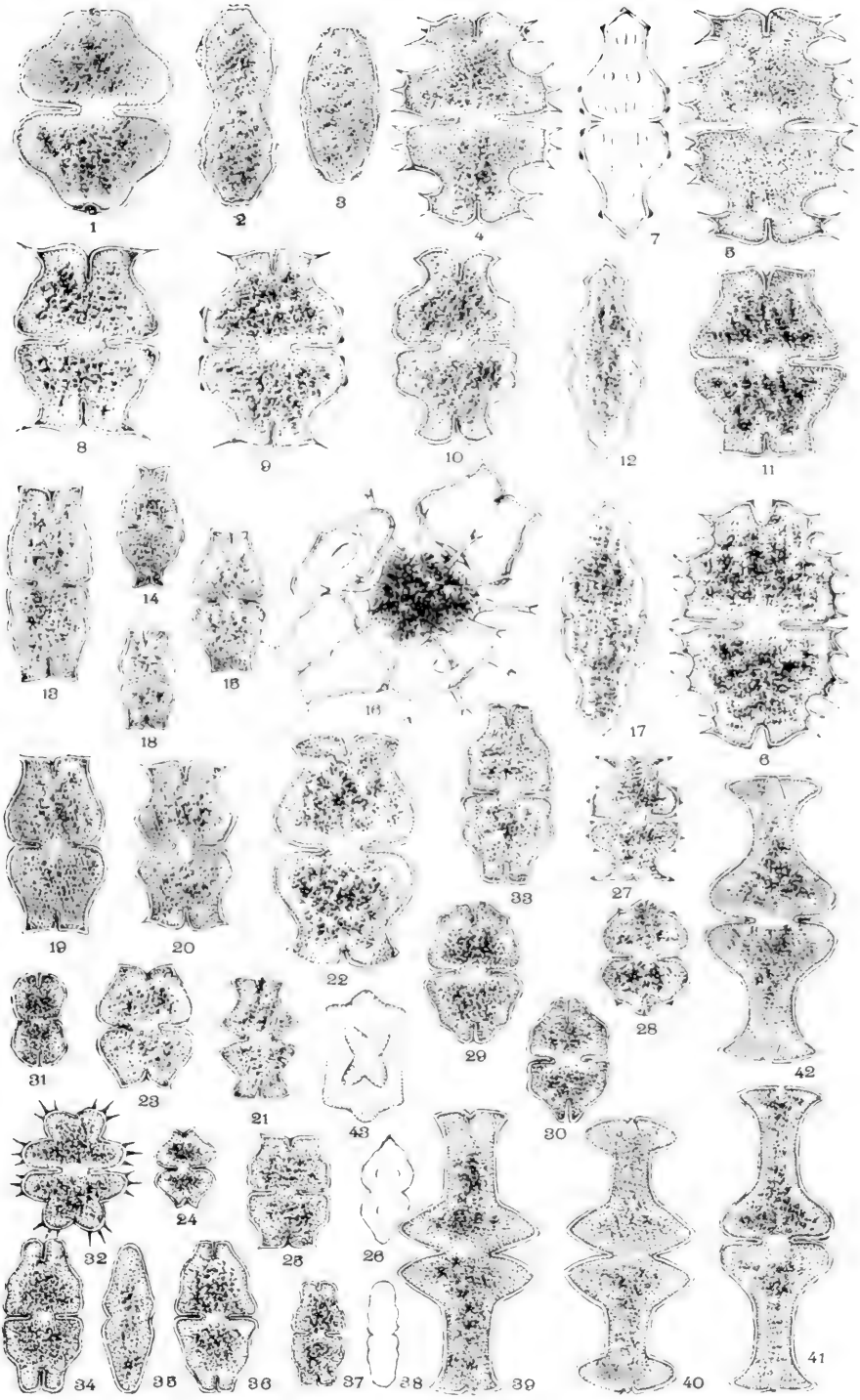
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PLATE XXVIII.

Figures magnified 500 diameters.

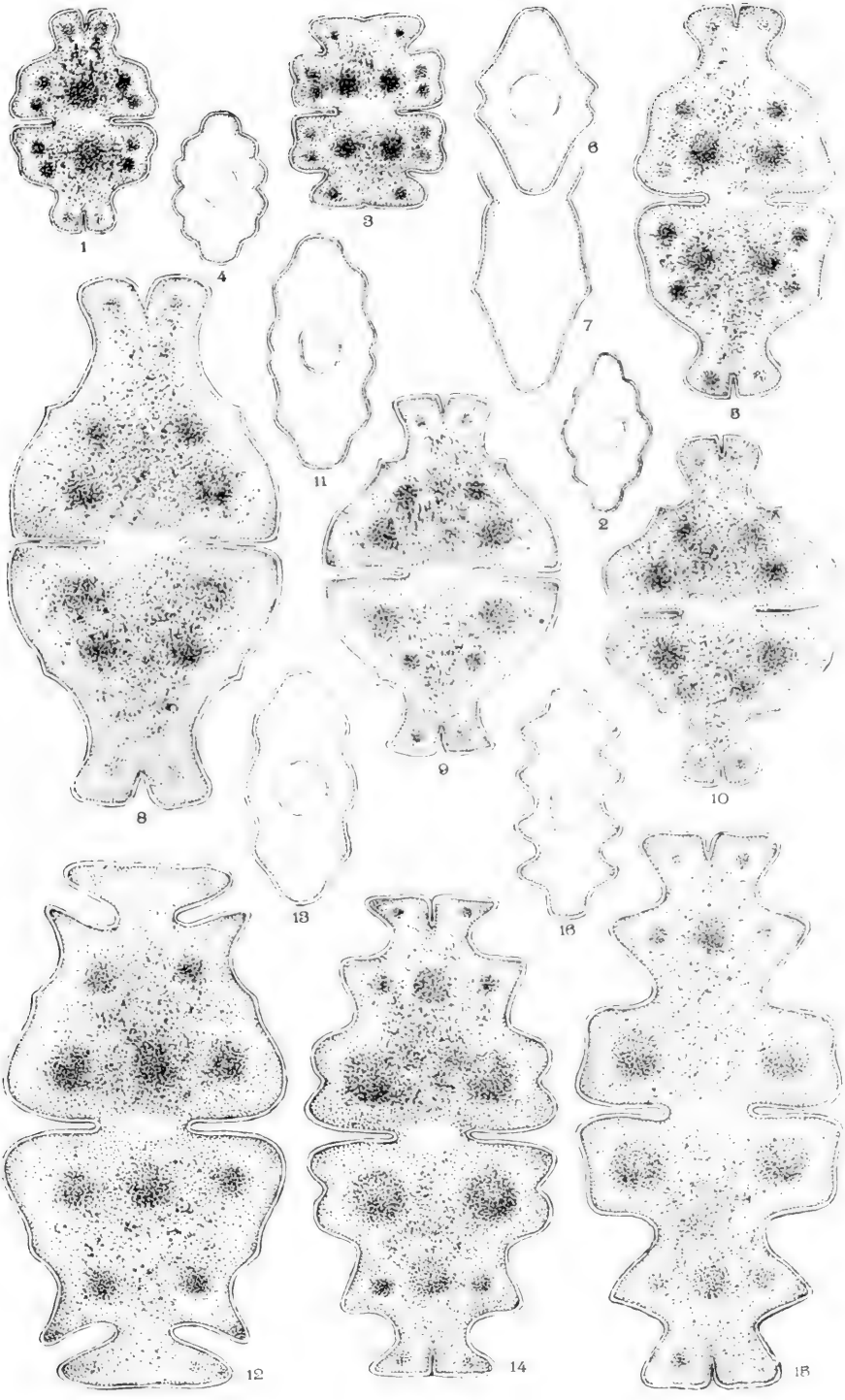
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PLATE XXIX.

Figures magnified 500 diameters.

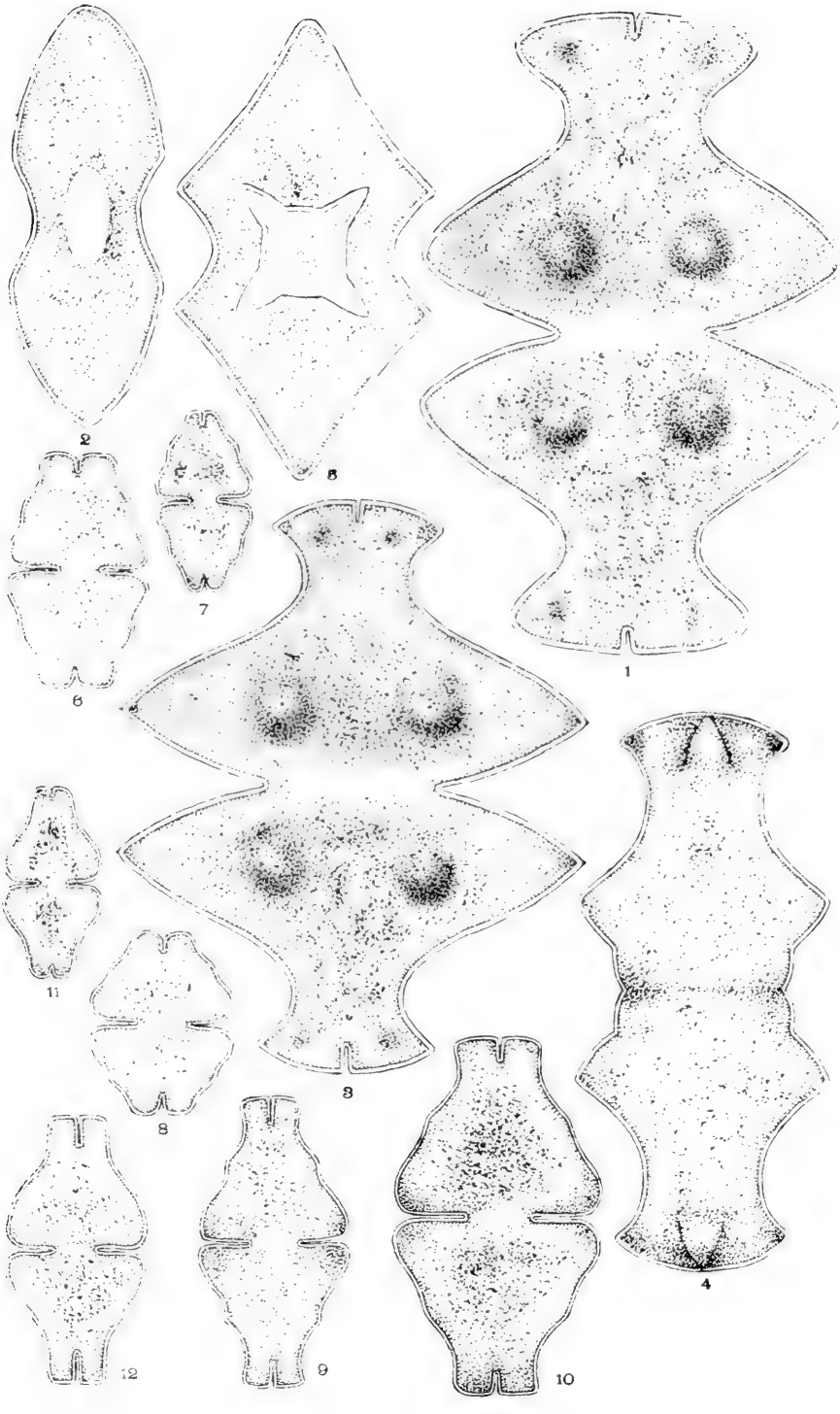
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PLATE XXX.

Figures magnified 375 diameters.

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Fig. 1–8. MICRASTERIAS TORREYI, in eight varieties, each represented by one-fourth of a cell. The varieties effected by the process of multiplication by division; two semicells of entirely different outline being in many cases united, as parts of the same plant, . 108

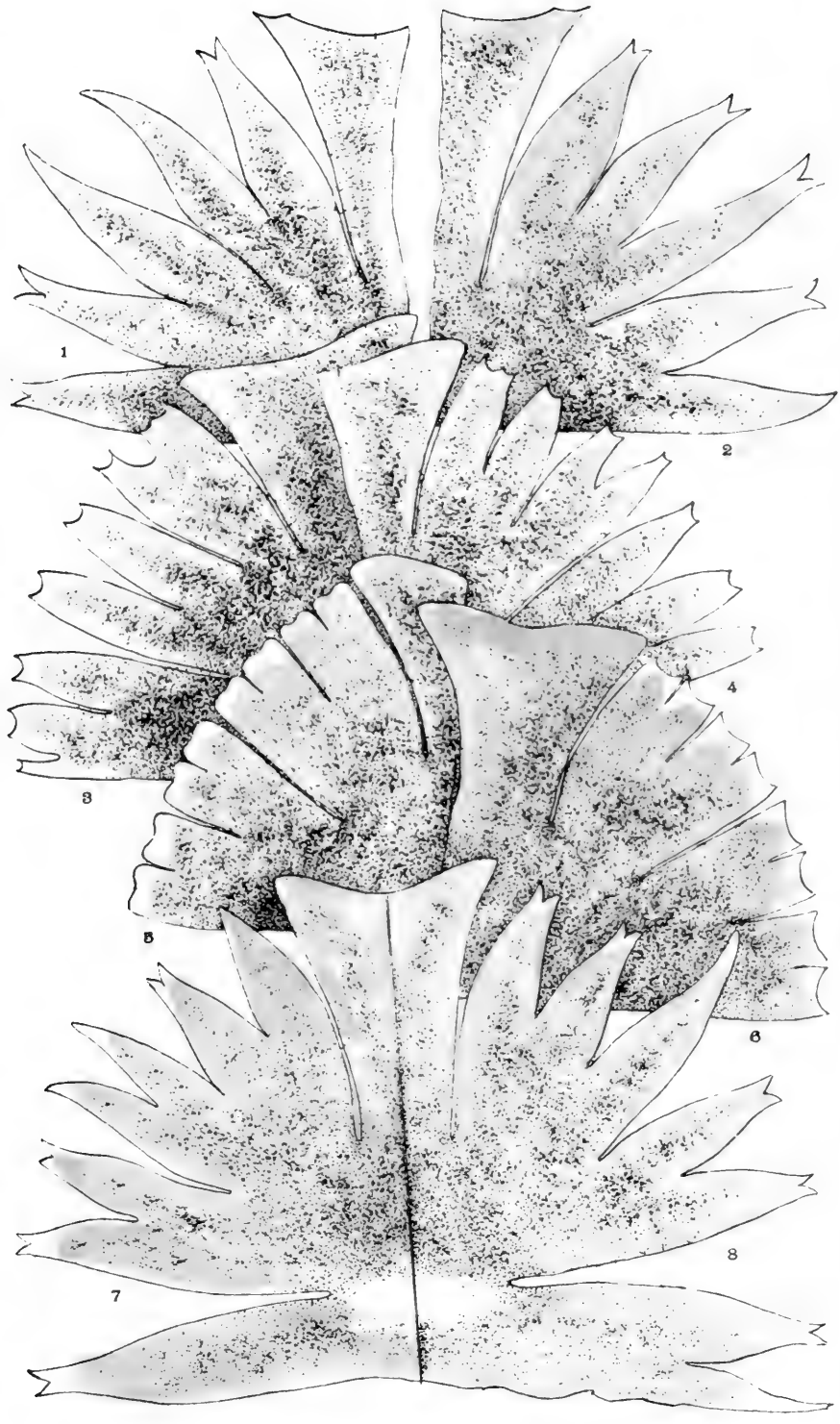
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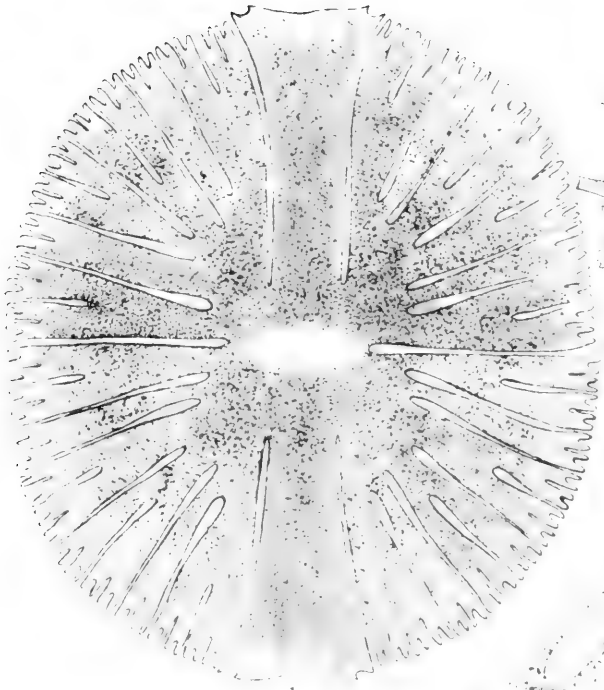
PLATE XXXI.

Figures magnified 375 diameters.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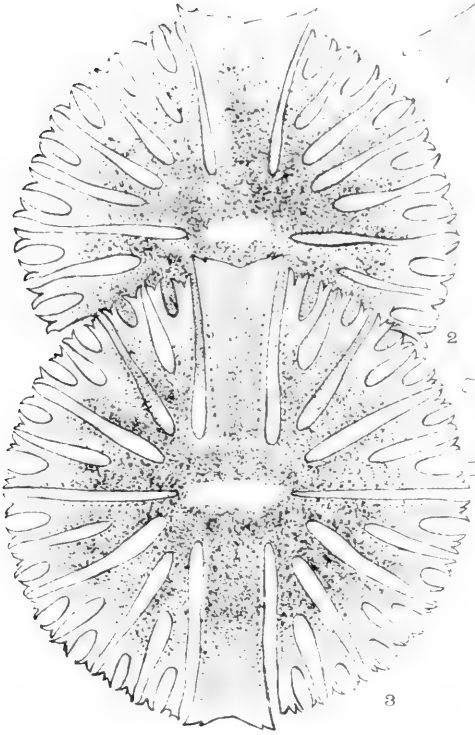
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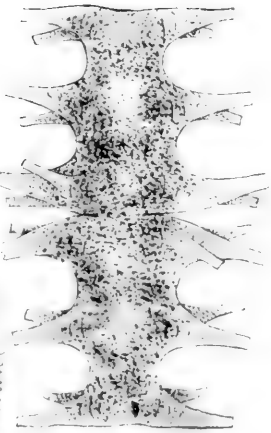
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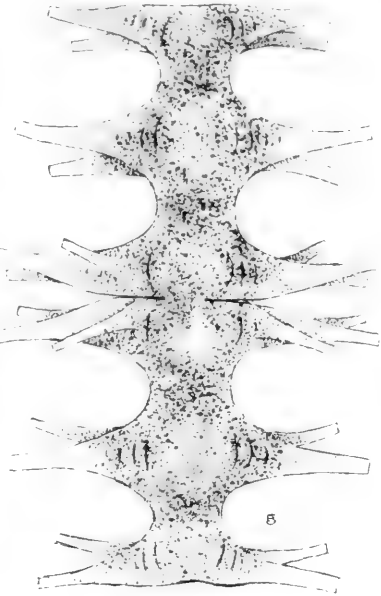
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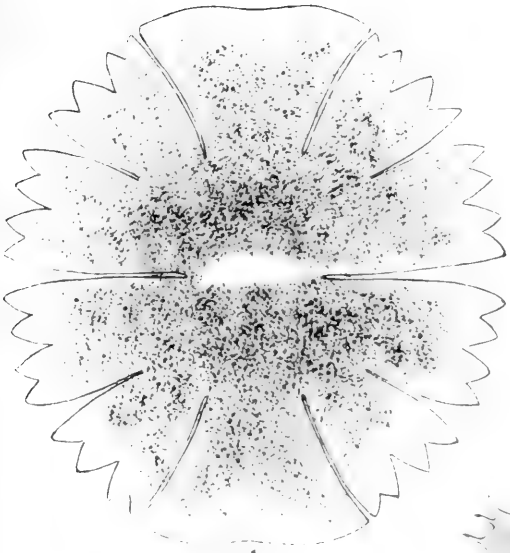
PLATE XXXII.

Figures magnified 375 diameters.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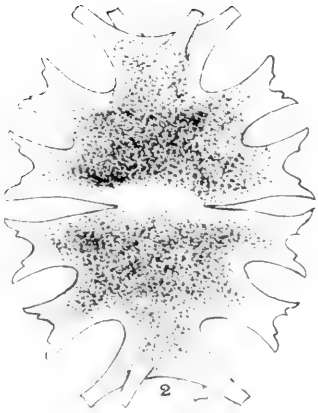
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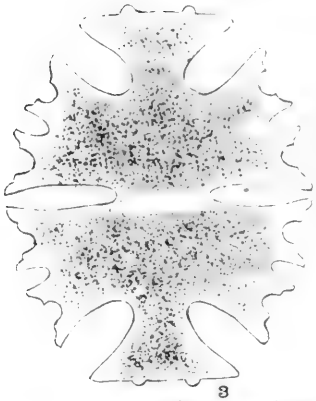
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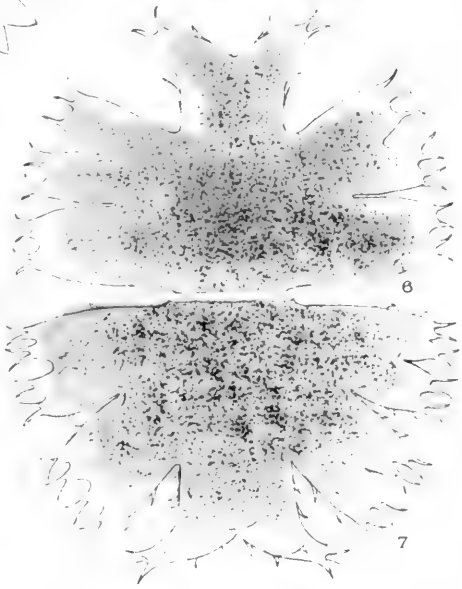
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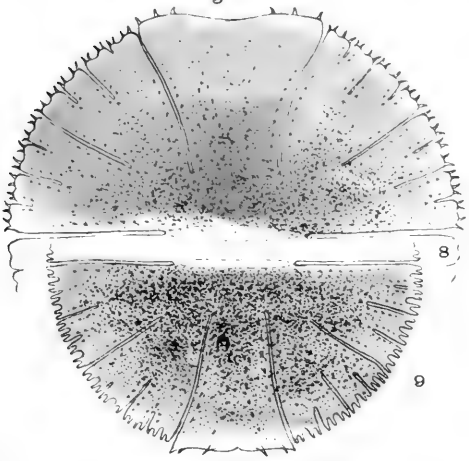
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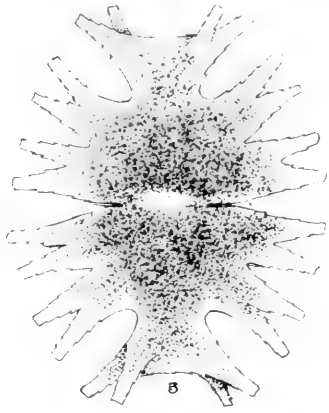
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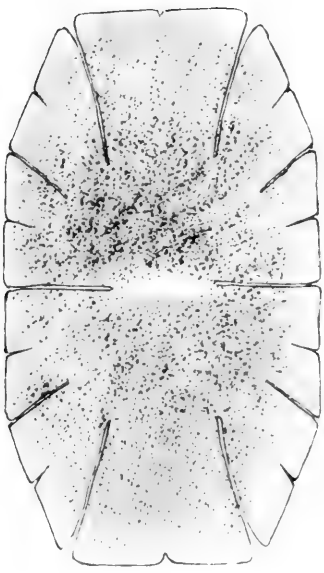
PLATE XXXIII.

Figures magnified 375 diameters.



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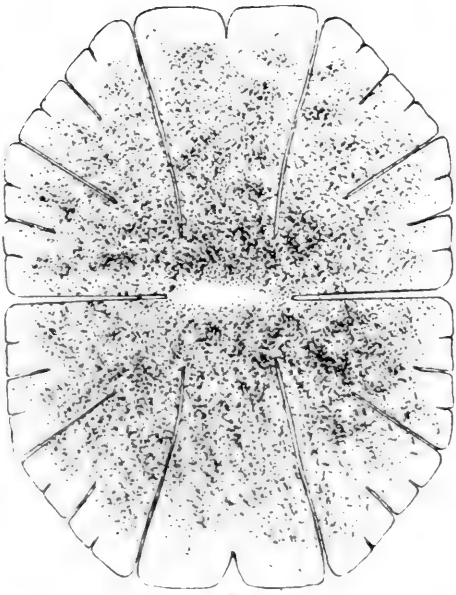

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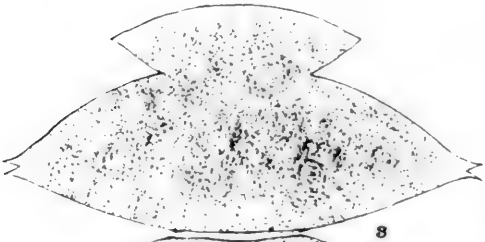

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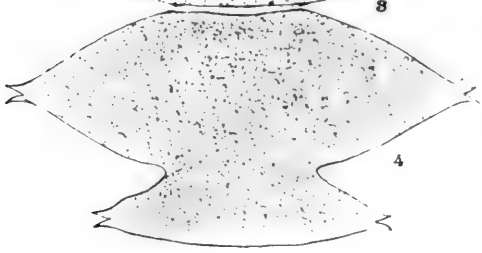

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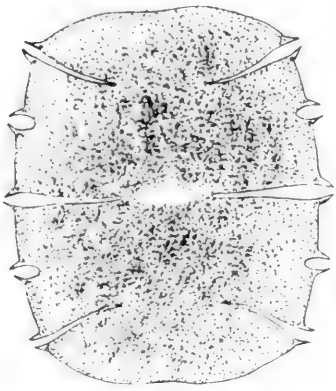

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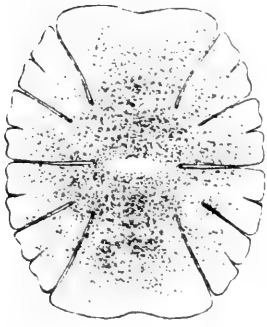

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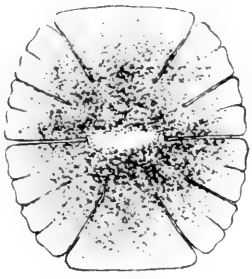

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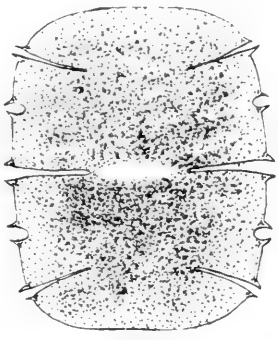

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PLATE XXXIV.

Figures magnified 375 diameters.

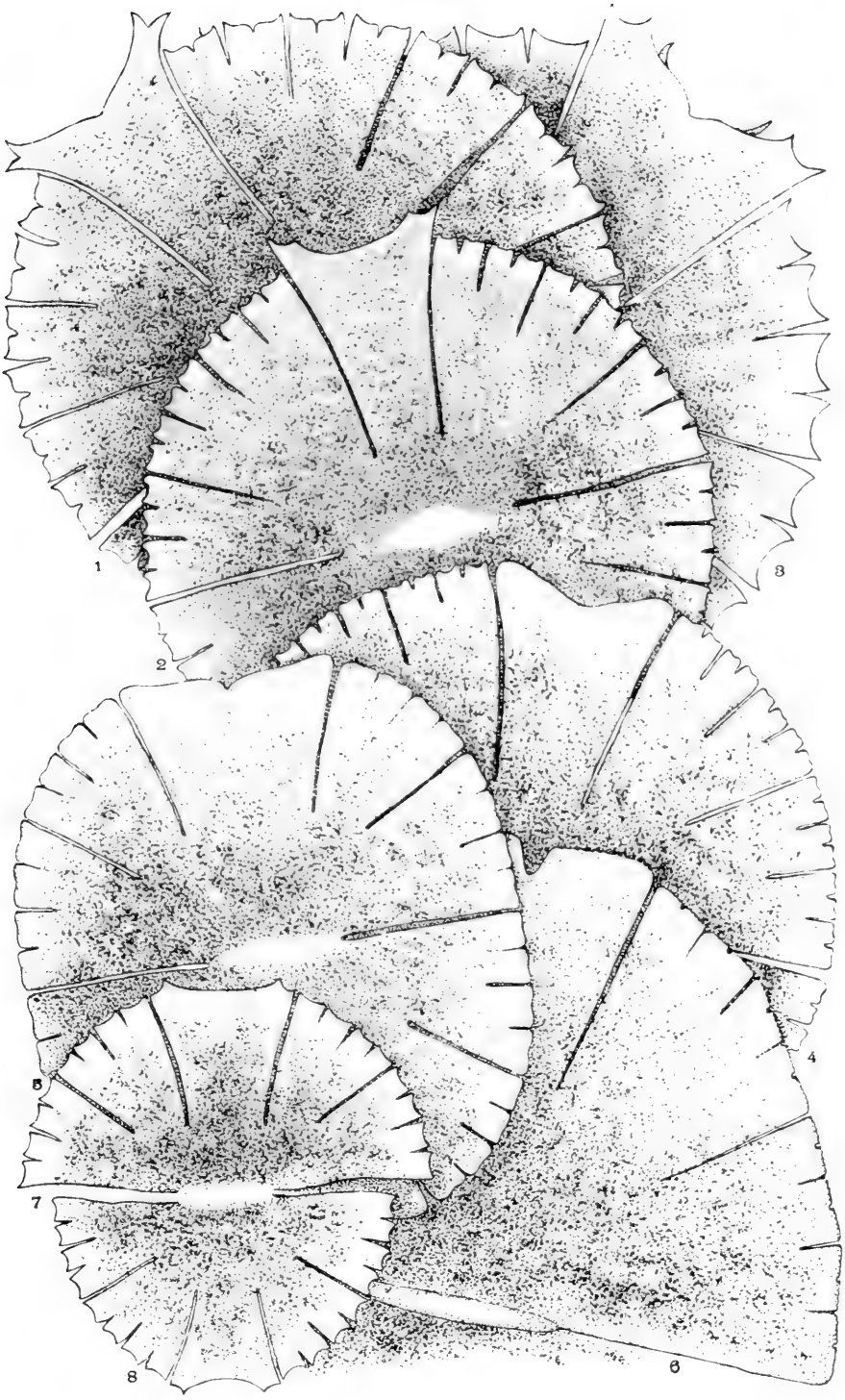
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PLATE XXXV.

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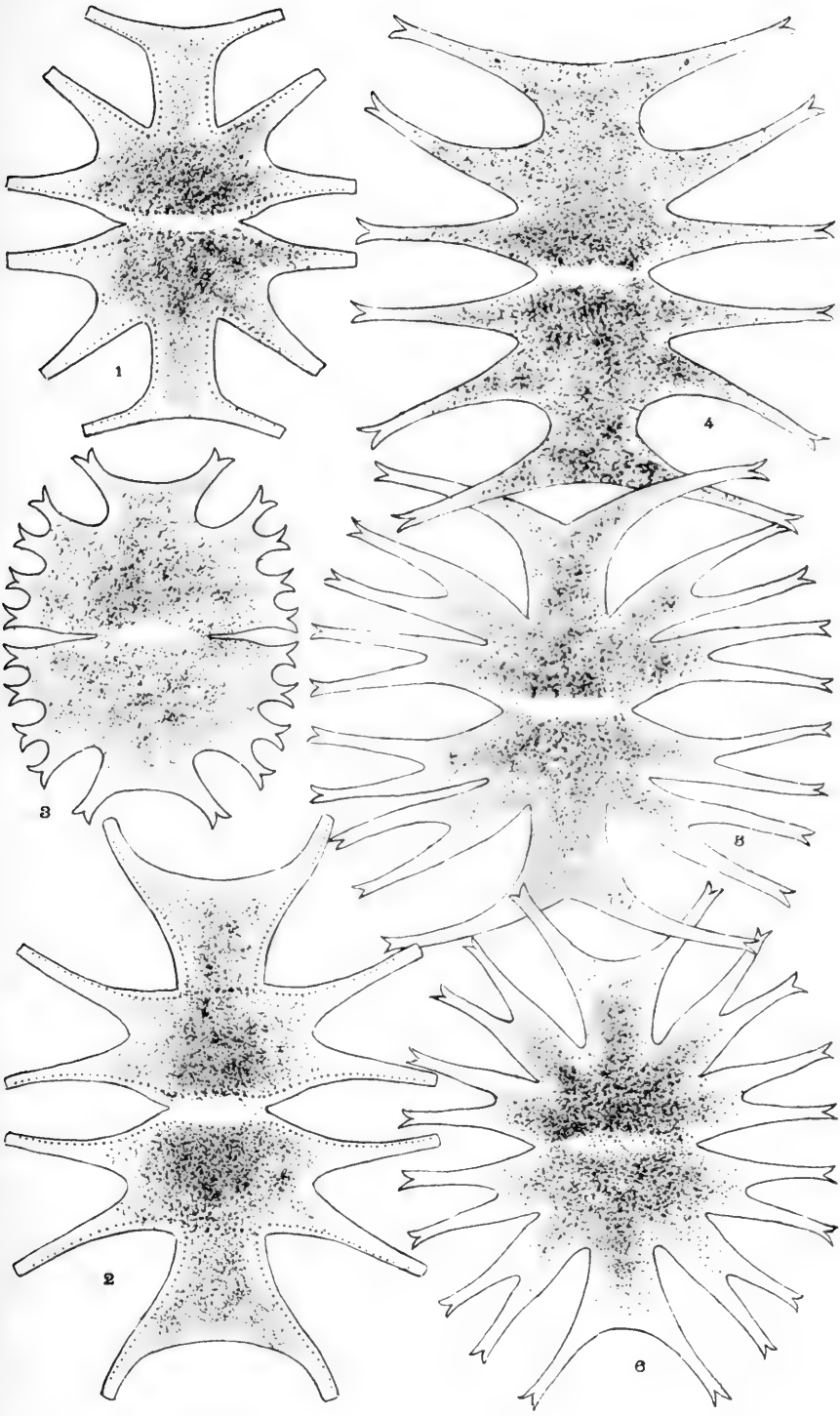
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PLATE XXXVI.

Figures magnified 375 diameters.

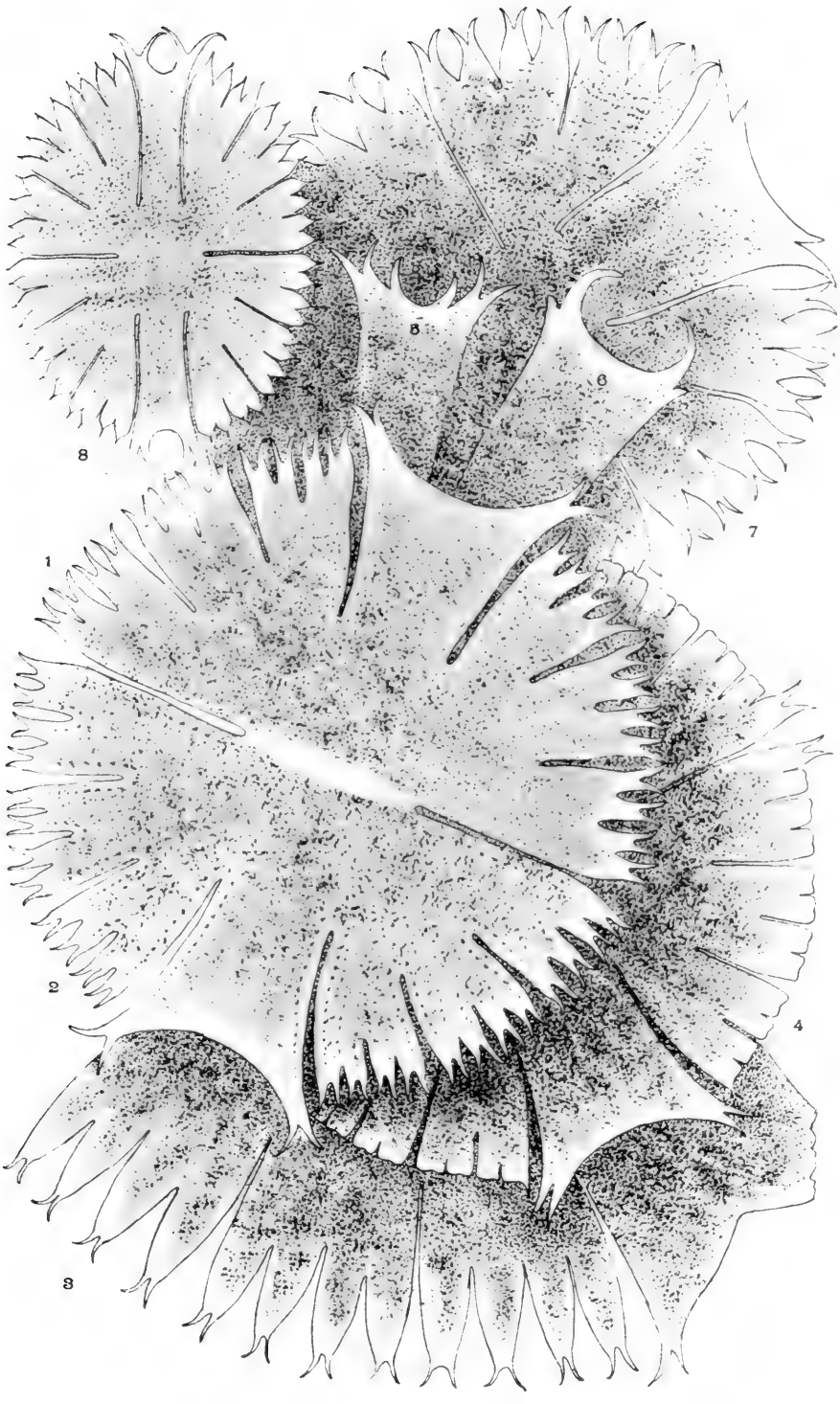
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PLATE XXXVII.

Figures magnified 375 diameters.

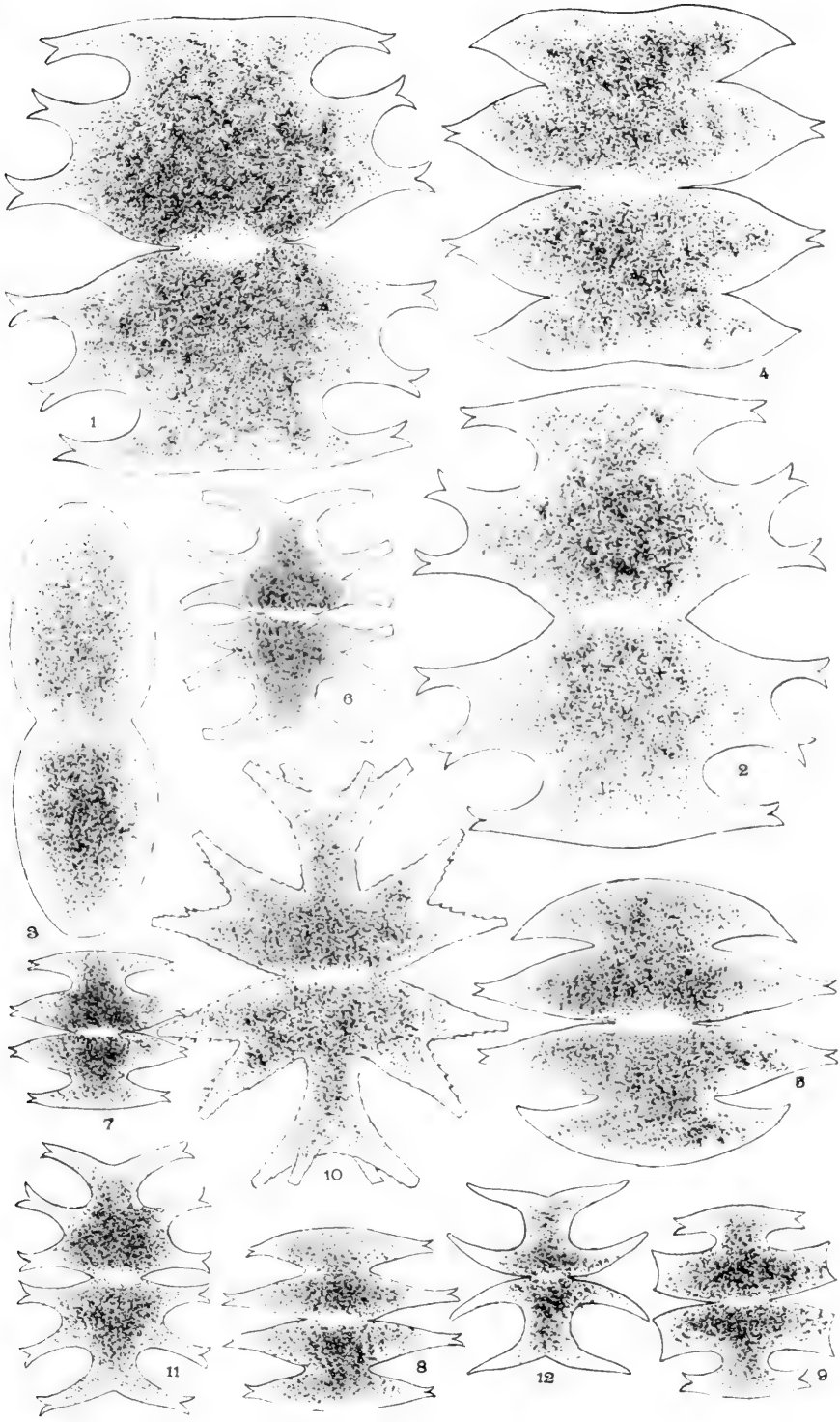
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PLATE XXXVIII.

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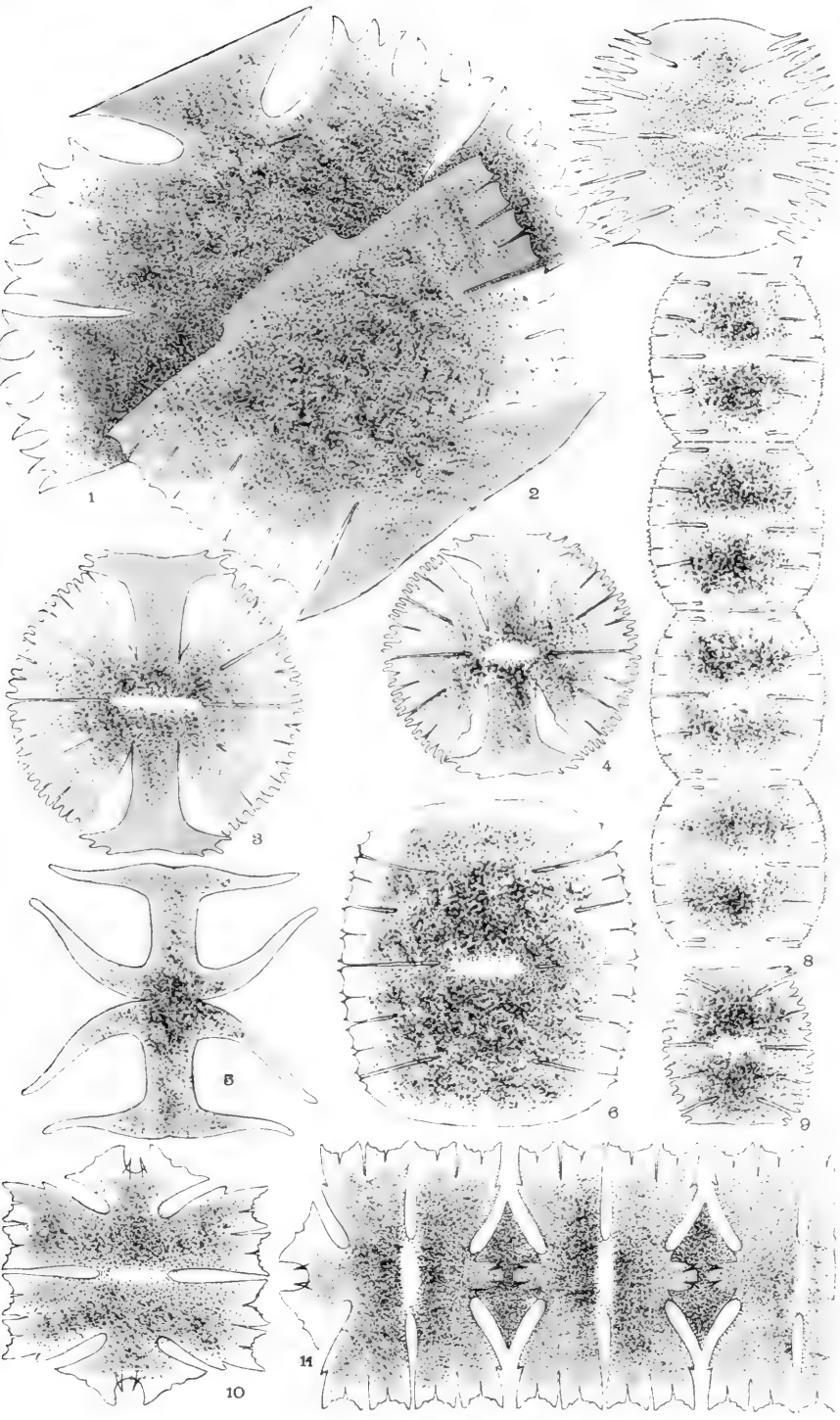
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PLATE XXXIX.

Figures magnified 500 diameters.

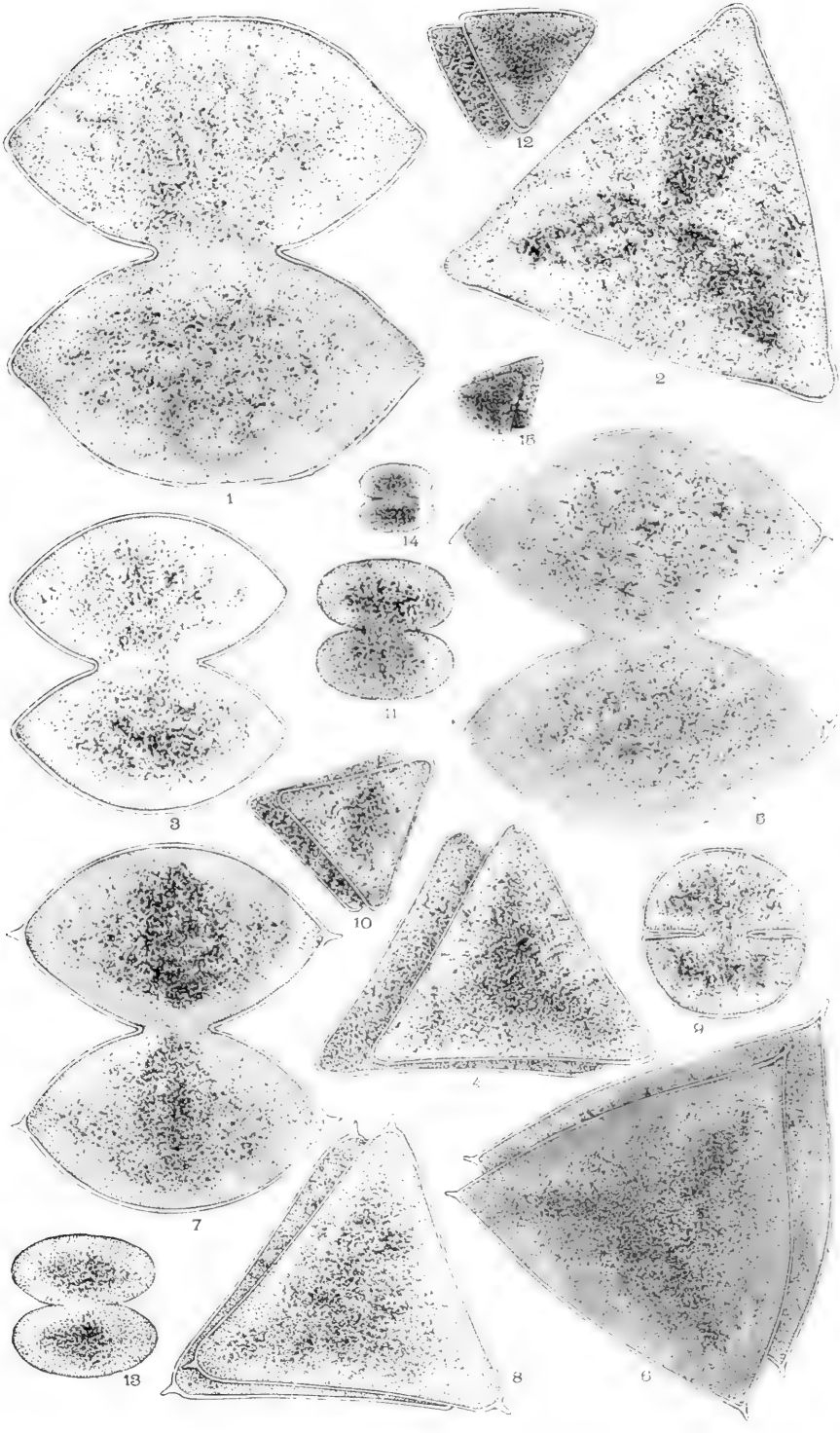
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PLATE XLI.

Figures magnified 500 diameters.

* Compare note under *St. incisum*, p. 132. This species from ponds, New Jersey, was described in the "Bull. Tor. Bot. Club, New York, 1880." Membrane smooth; end view five-rayed; apices of rays obtusely rounded, bases wide, separated by a rounded sinus,

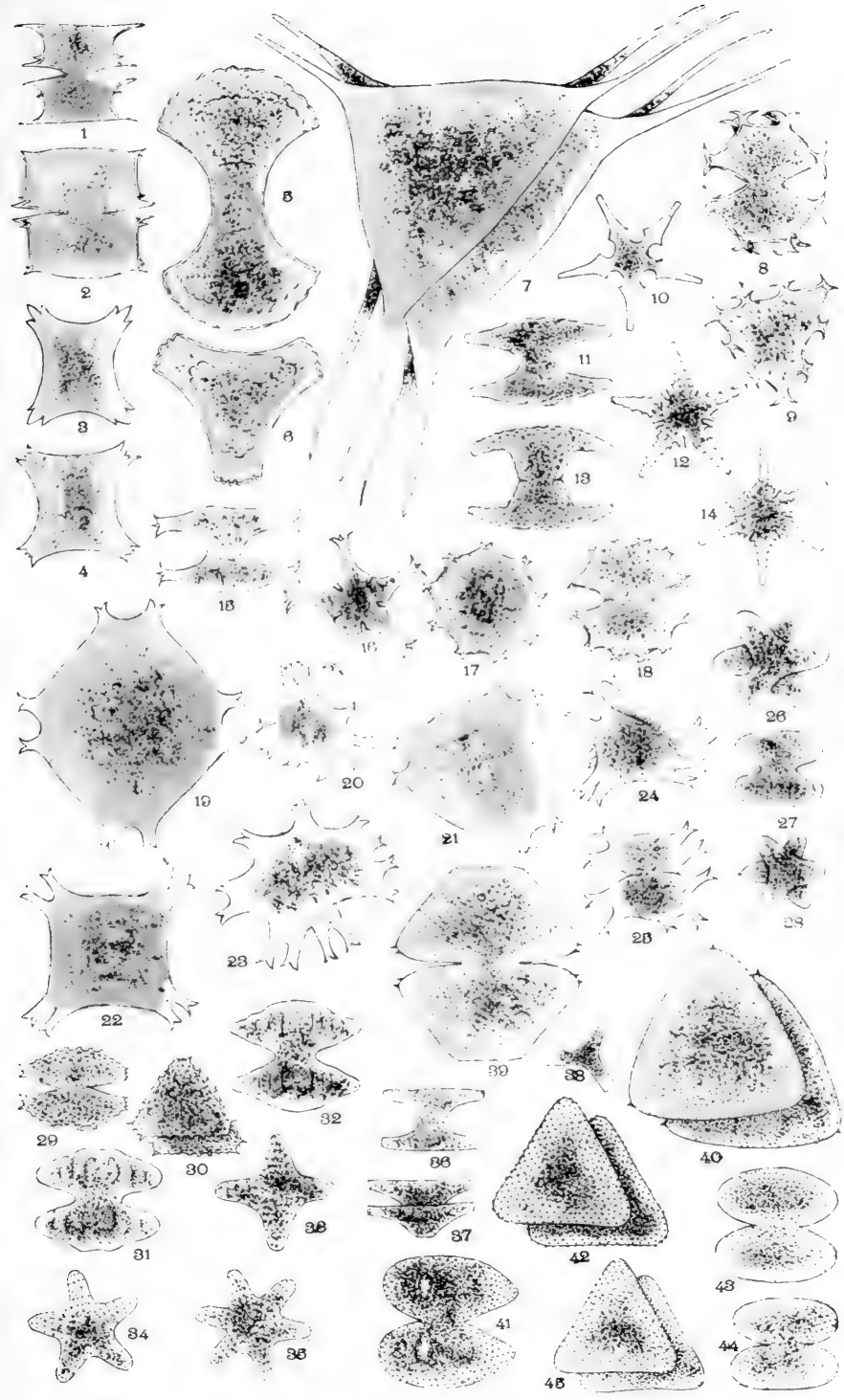
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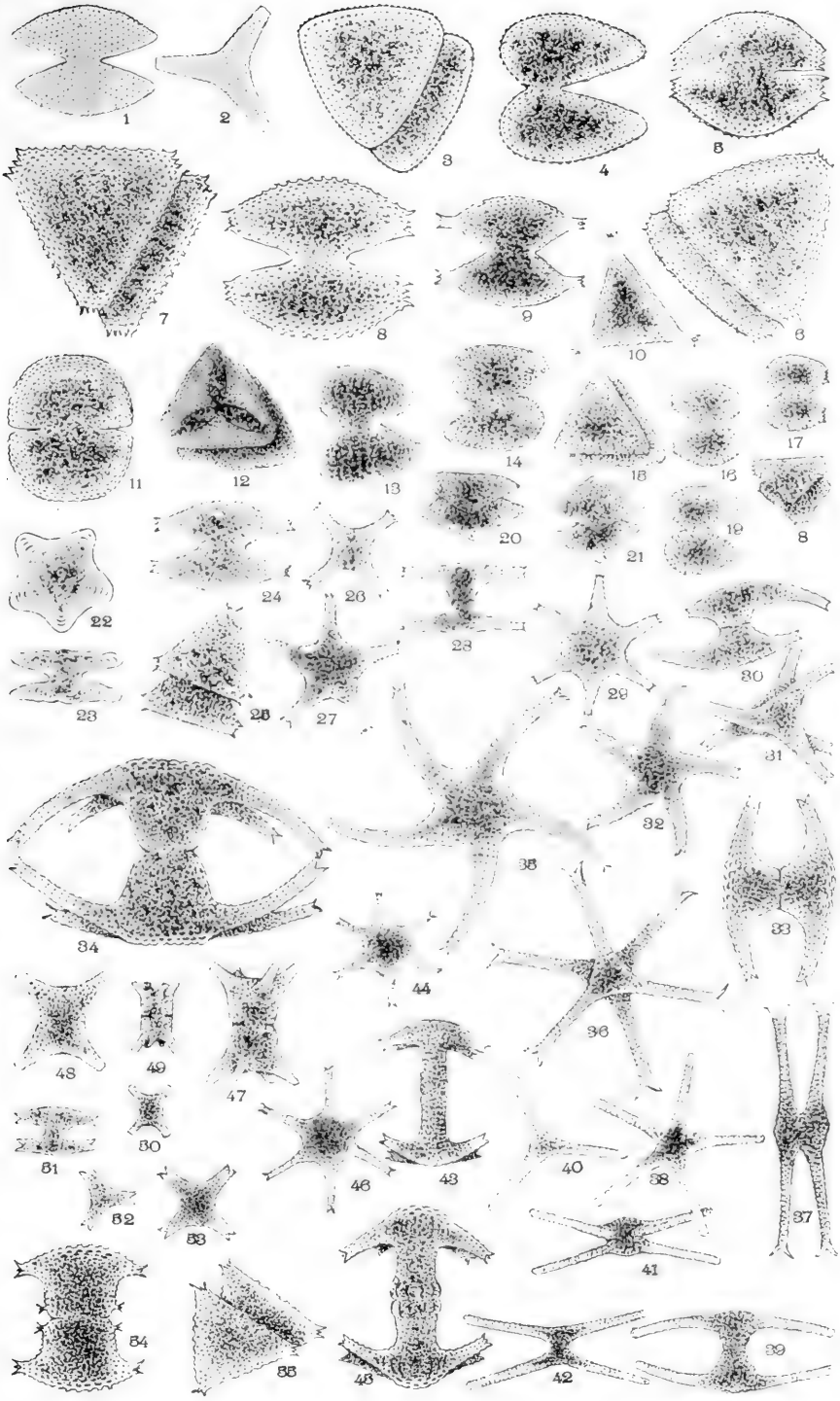
PLATE XLII.

Figures magnified 500 diameters.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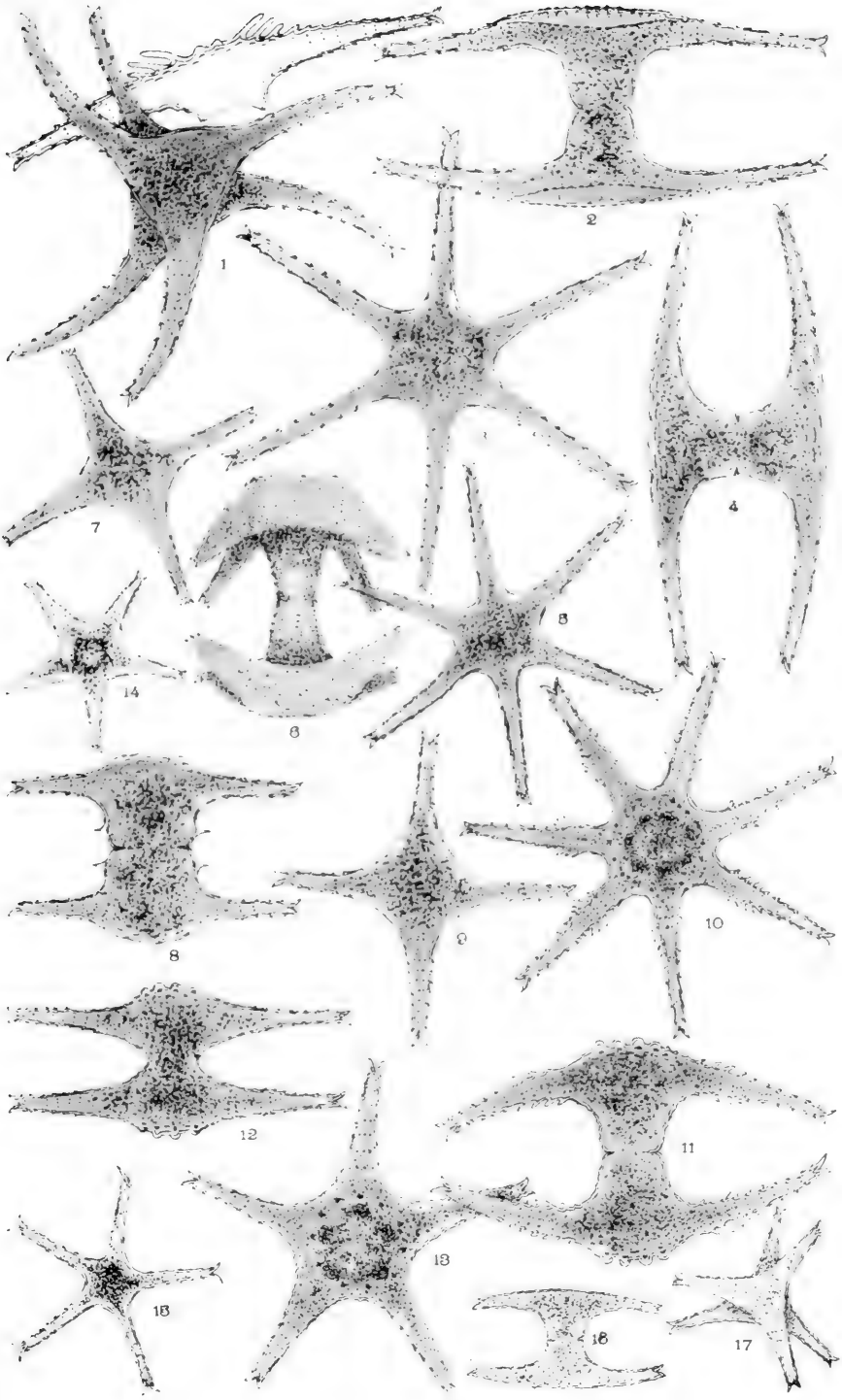
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PLATE XLIV.

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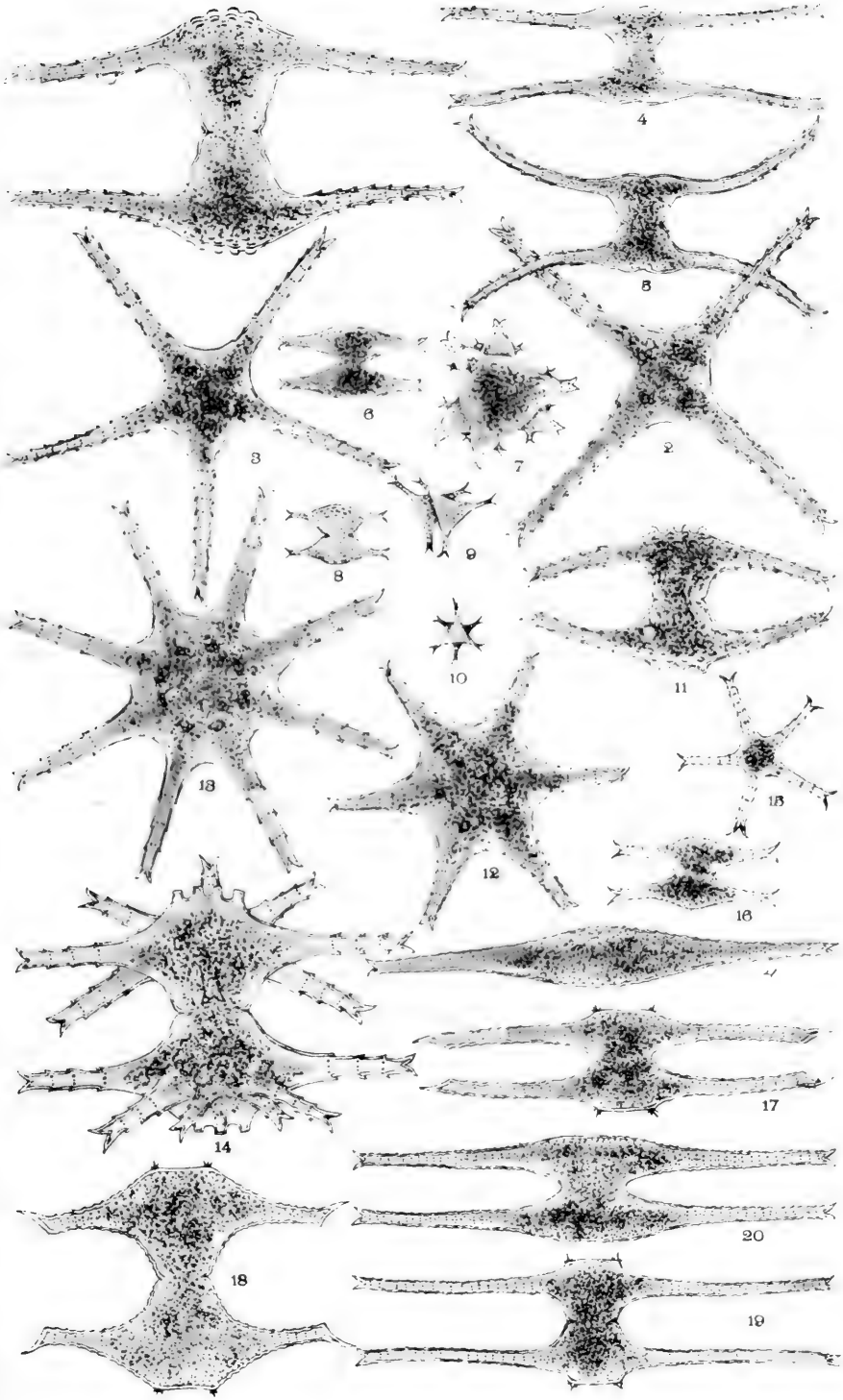
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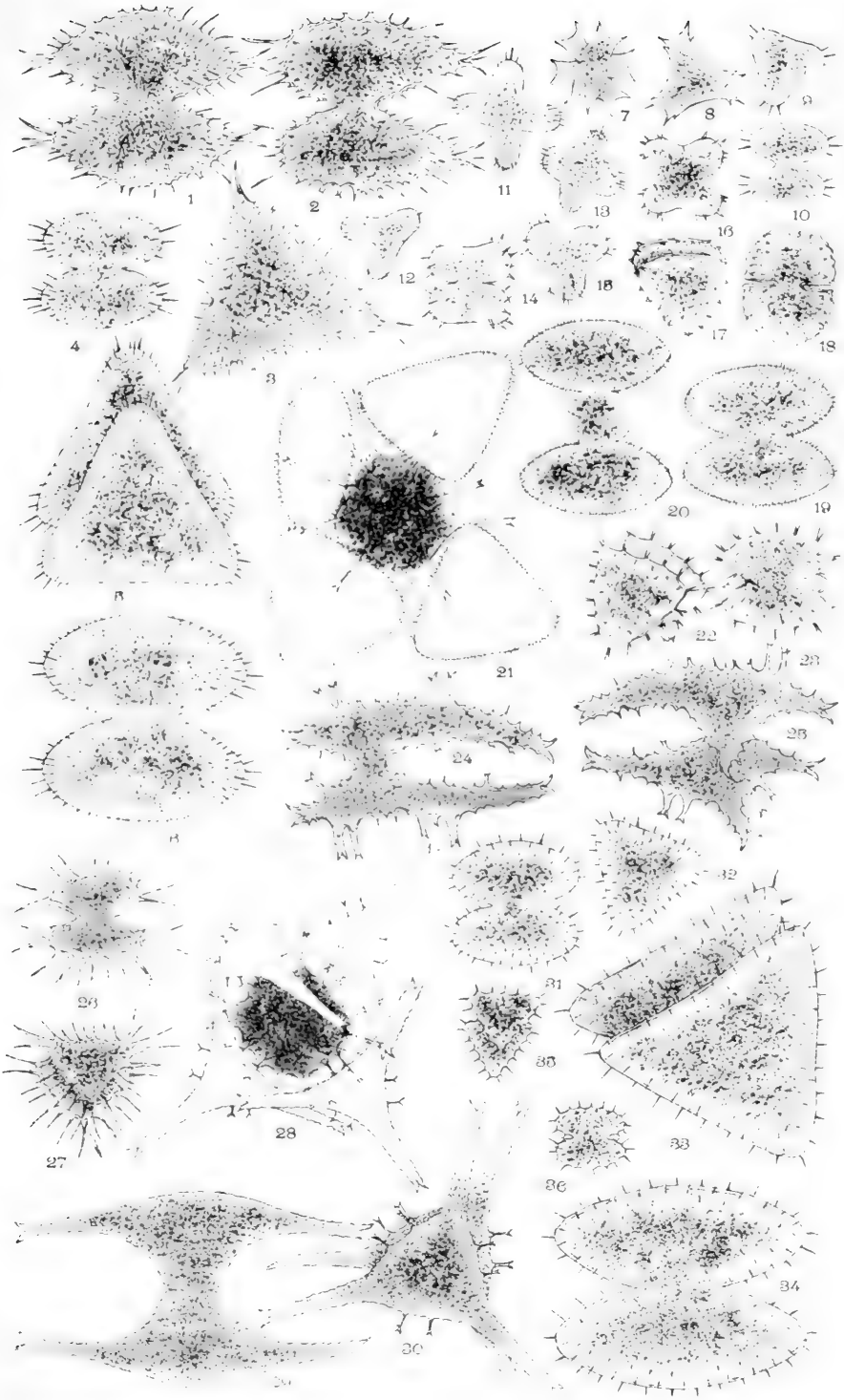
PLATE XLV.

Figures magnified 500 diameters.



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Figures magnified 500 diameters.

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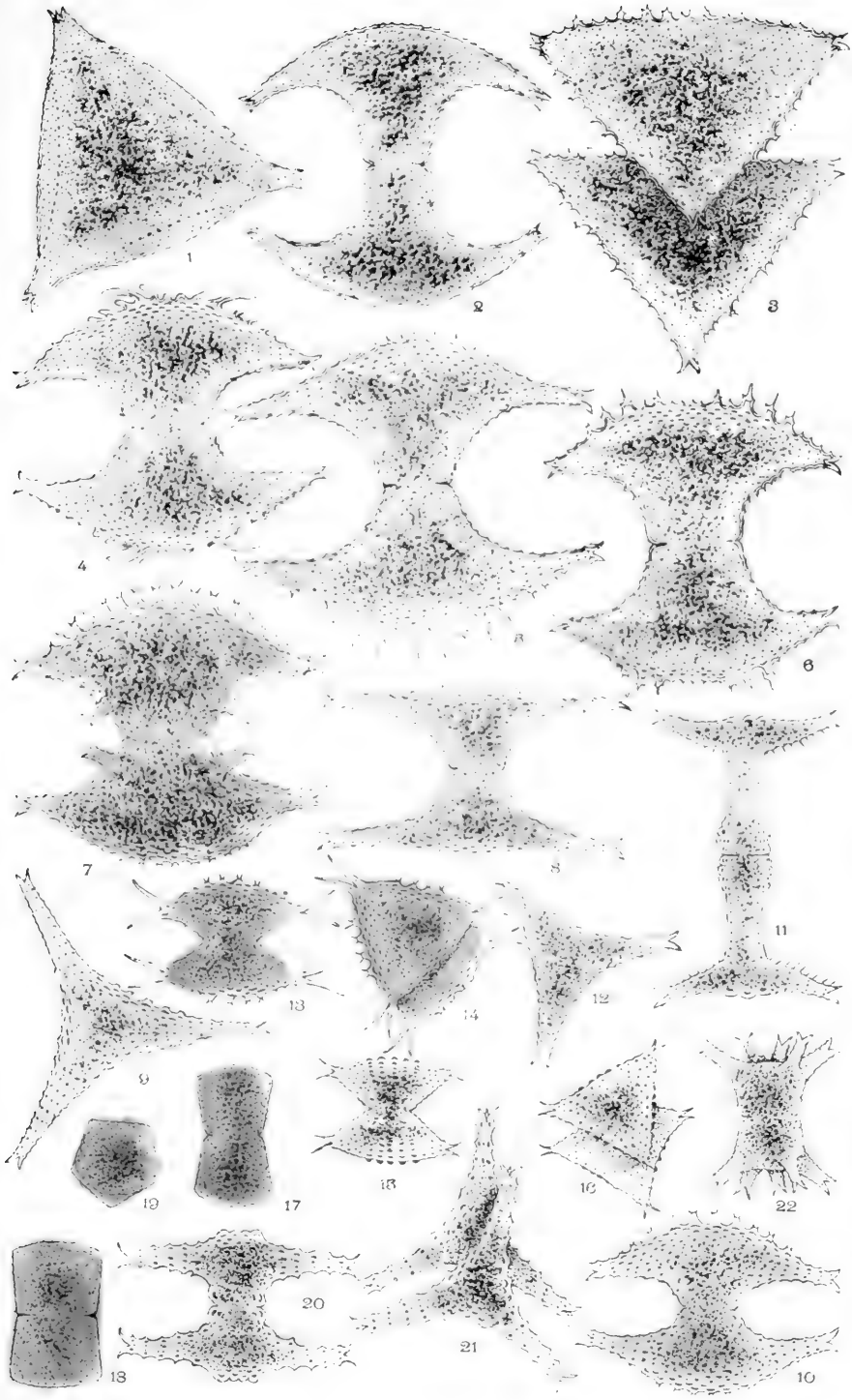
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PLATE XLVII.

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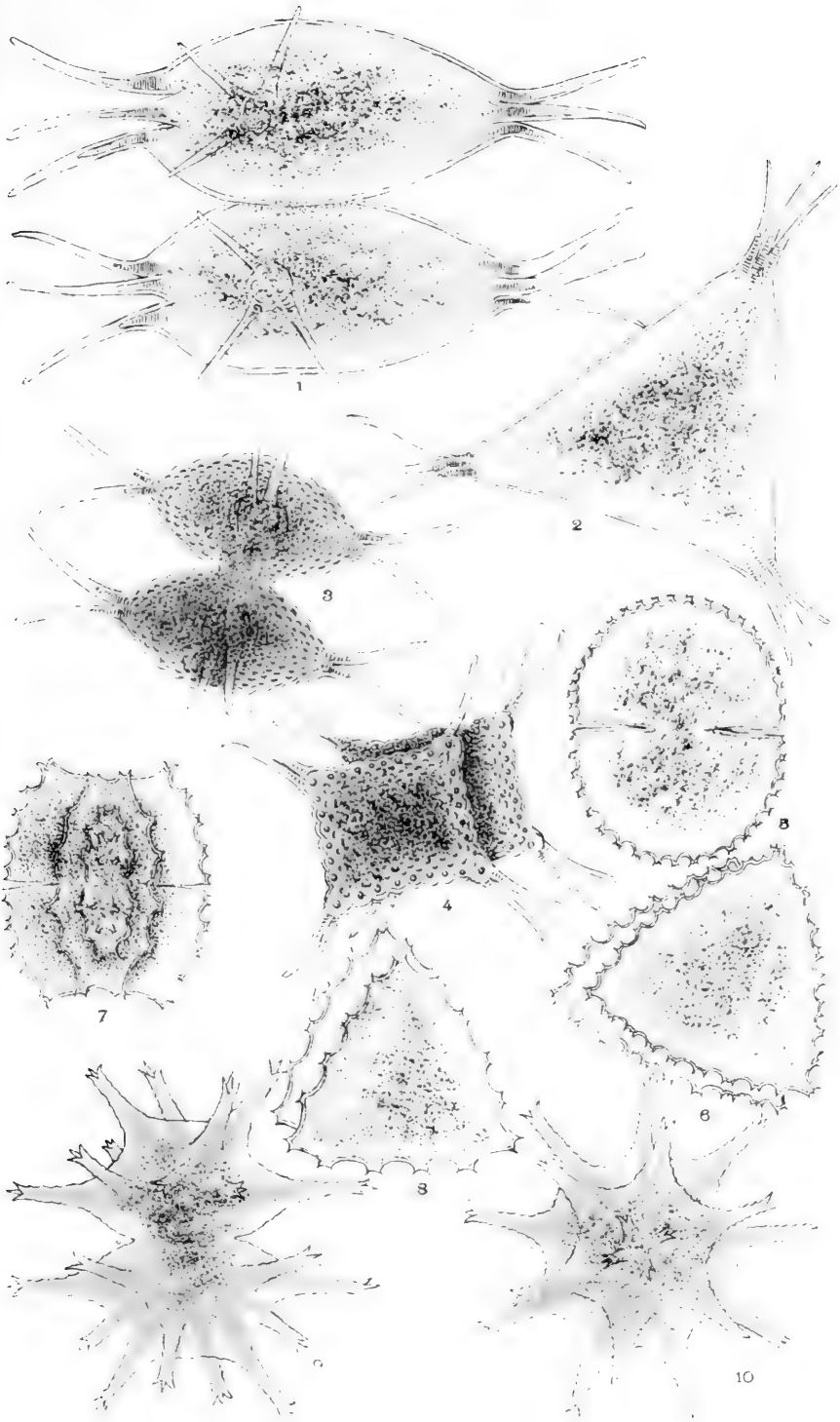
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PLATE XLVIII.

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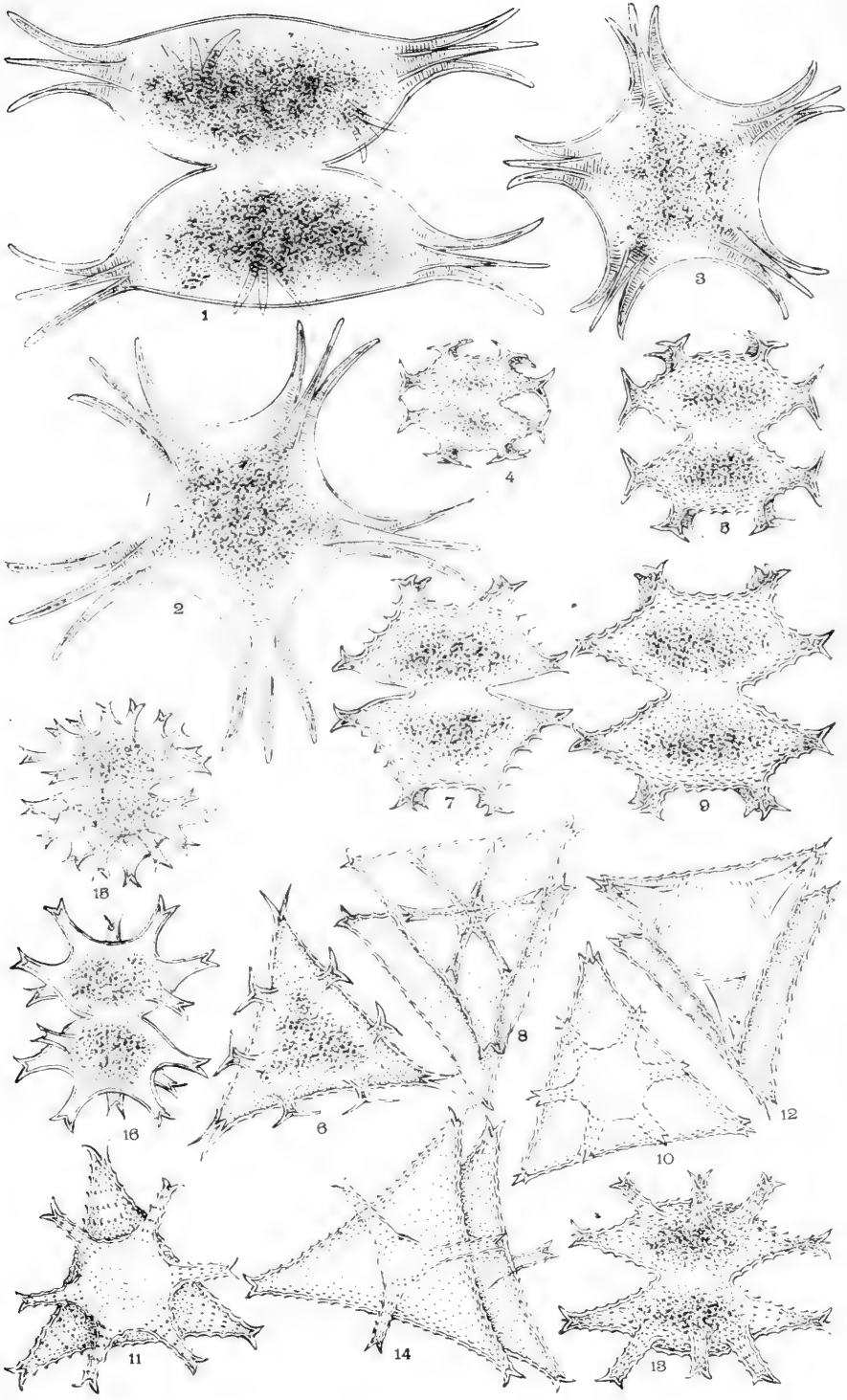
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PLATE XLXIX.

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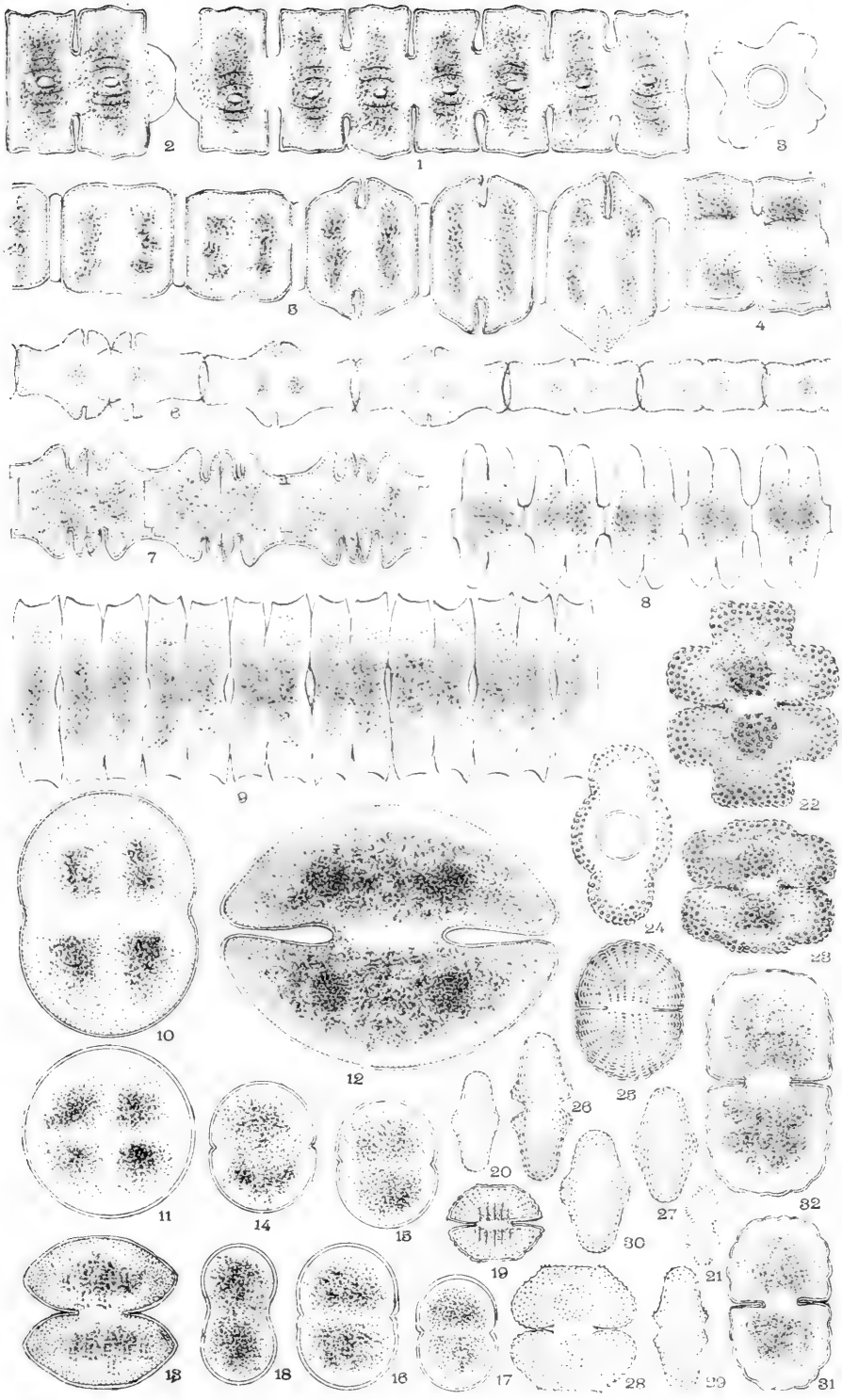
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Figures magnified 500 diameters.

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* C. Beckei. Wille. (Omitted in proper place). Cells slightly longer than broad; semi-cells nearly semicircular, apices truncate five crenate: sides incised crenate; two series of granules of about 15 and 9 near the margins: centre inflated and sparsely granular: variable in size; larger form about 28 Mic. M. long; 25 Mic. M. wide.

Not quite, but nearly in accord with Wille's diagnosis.

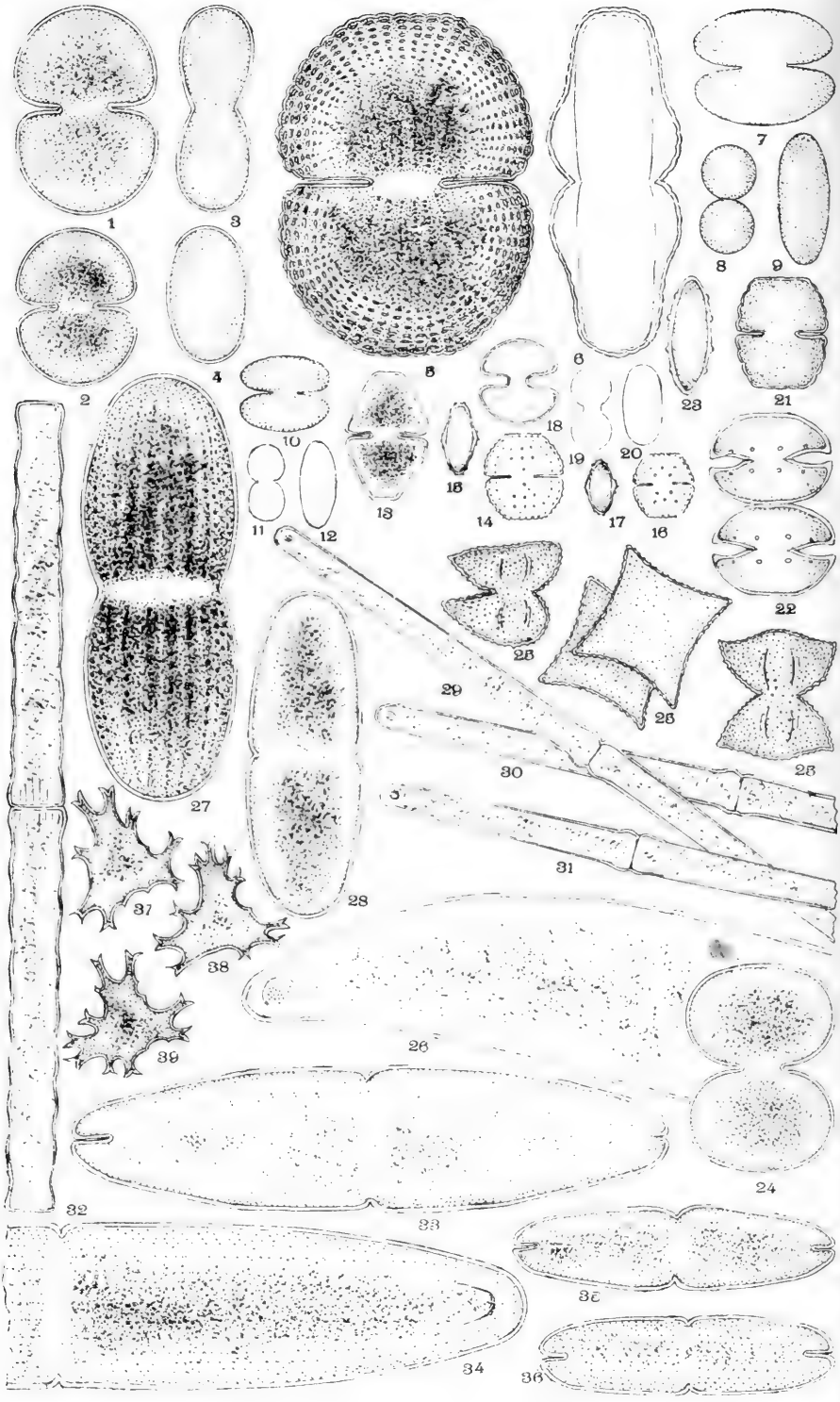
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PLATE LI.

Figures magnified 500 diameters.

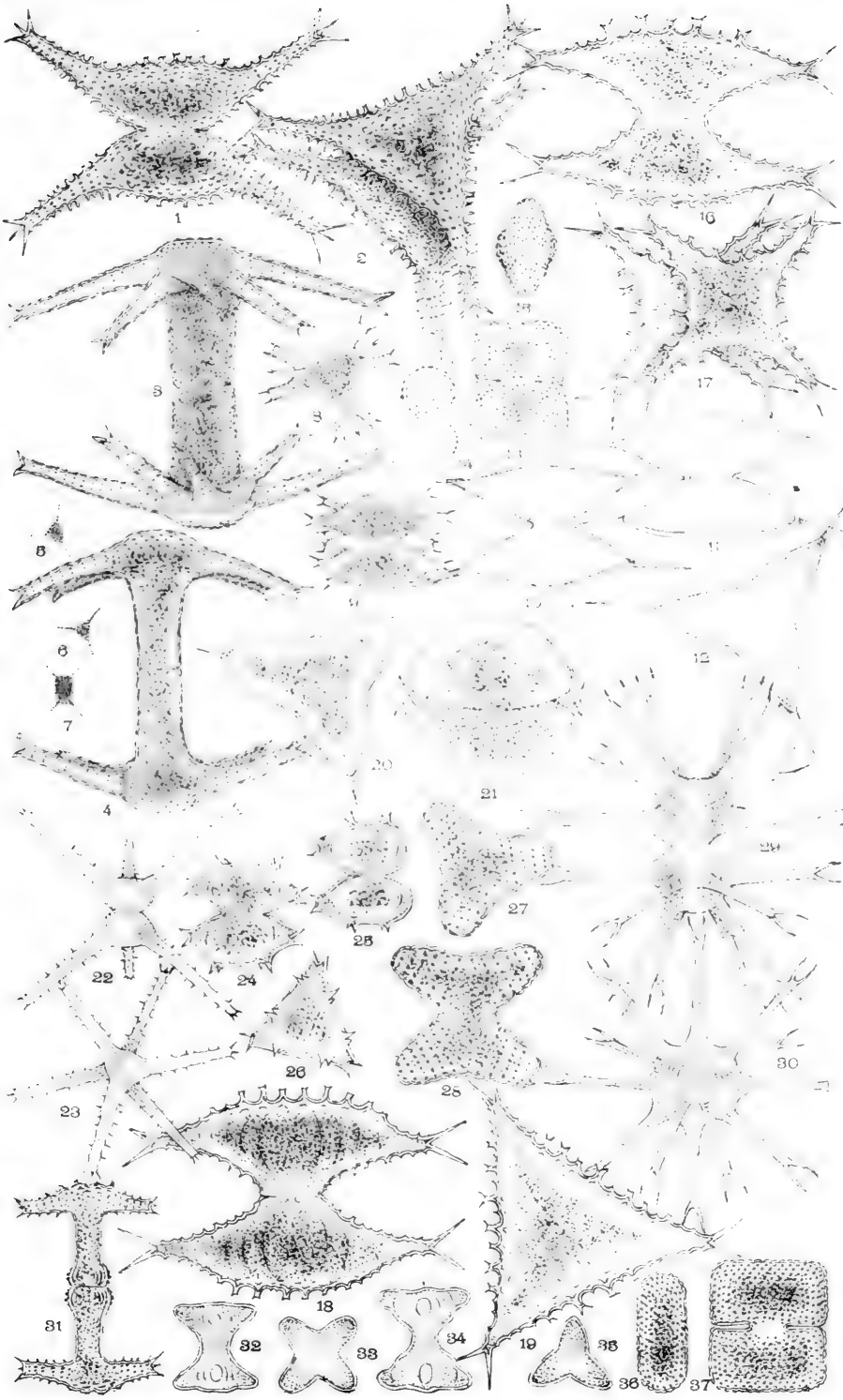
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PLATE LII.

Figures magnified 500 diameters, except the Micrasterias 375.

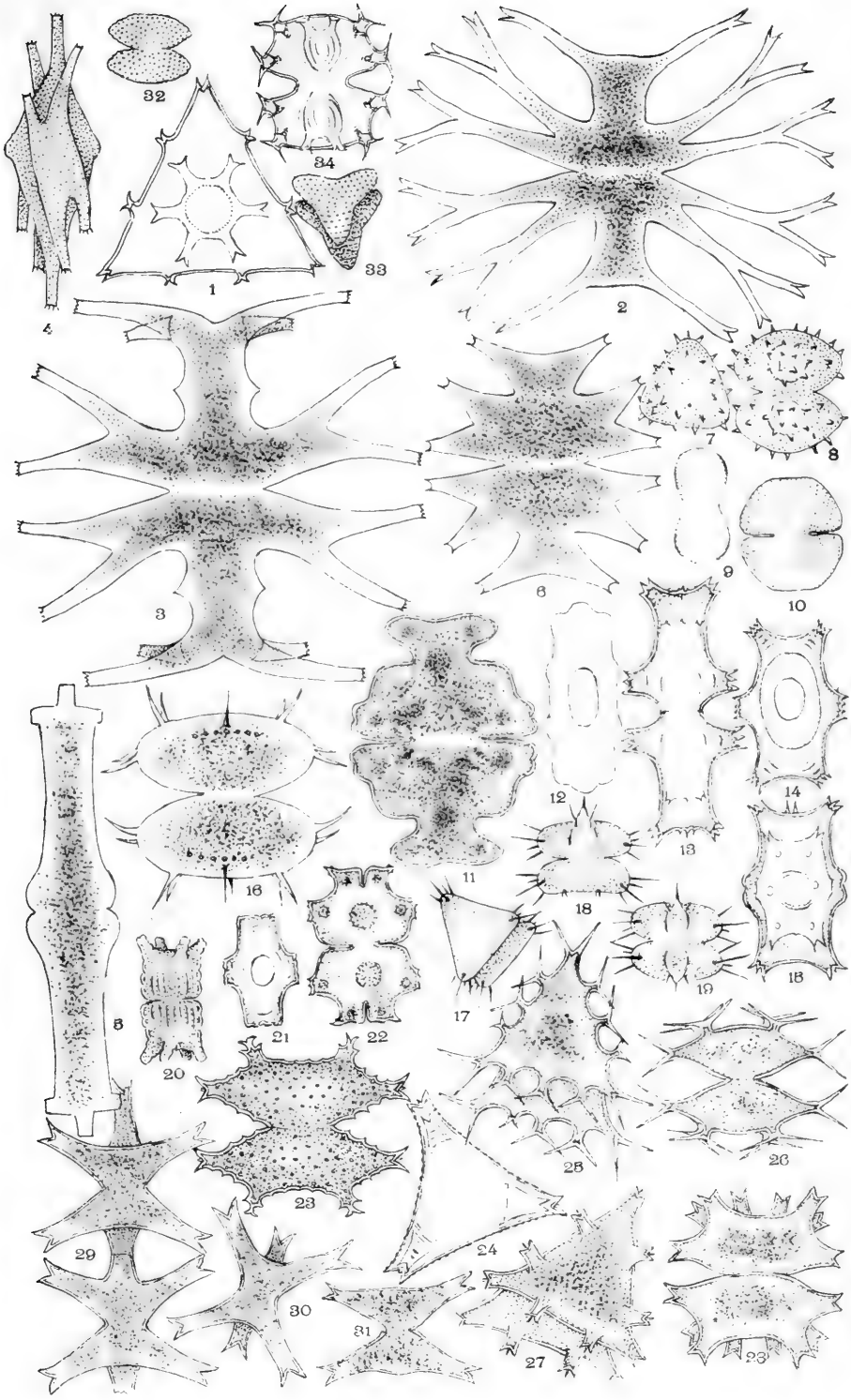
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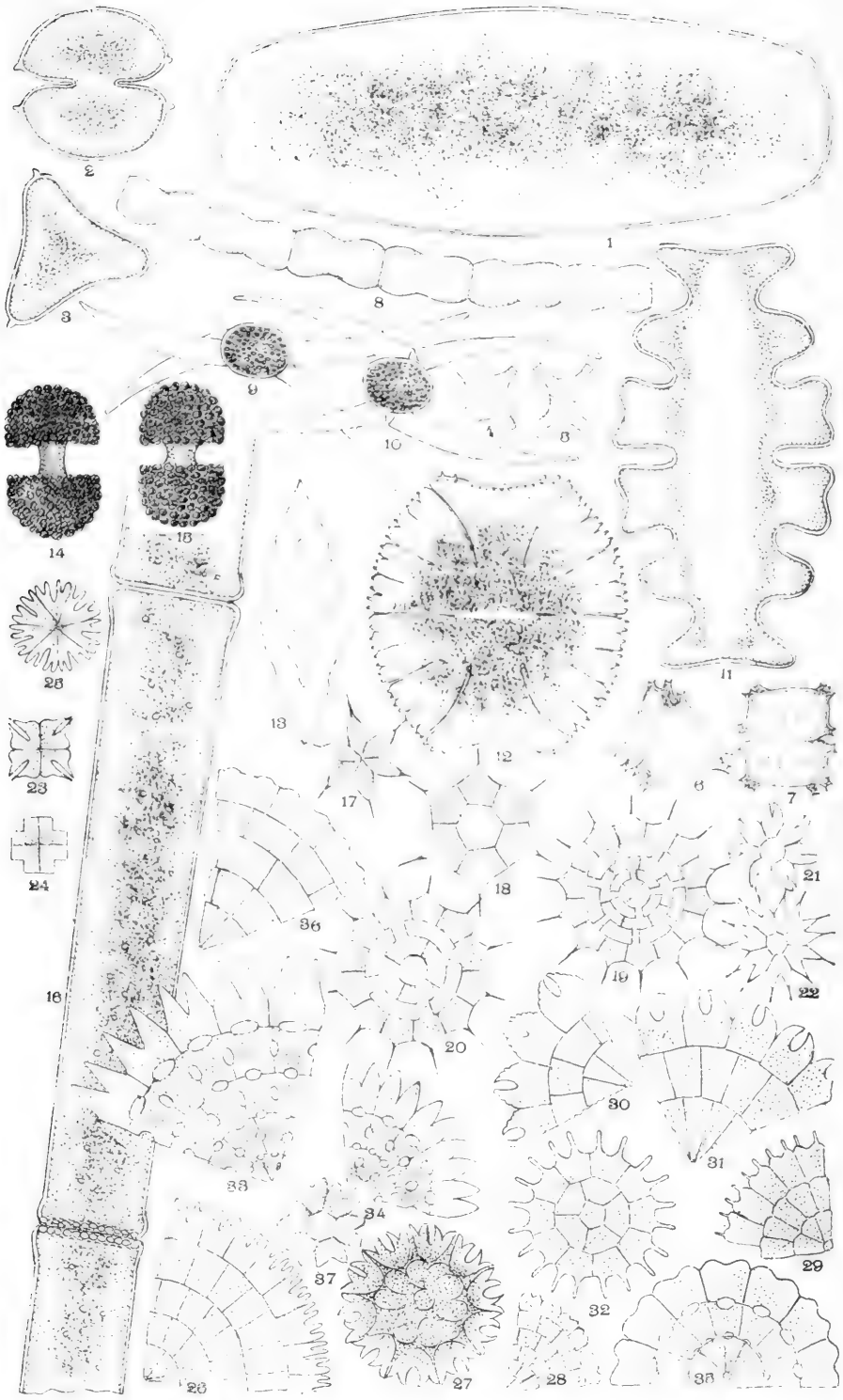
PLATE LIII.

Figures magnified 500 diameters.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