THE ALGAE OF THE ST. MEINRAD AREA

A dissertation submitted to the Faculty
of the College Department of St. Meinrad
Seminary in partial fulfillment of the re-
quirements for a Bachelor of Science Degree.

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INTRODUCTION

The purpose of this study was to determine the algal species found in the immediate vicinity of St. Meinrad Archabbey. The collections, from which a list of algae was compiled, were made between September, 1958, and May, 1959. All the algae were collected within a radius of two miles of St. Meinrad Archabbey. As the collecting period did not include the summer months, the periodic algae which might be expected to flourish during these months are not found in this list. This unfortunately leaves a lacuna in our knowledge of the seasonal variation of the algal population of this area. However the geographical area covered by the study exhibits the major types of algal habitats found in the sandstone region of southern Indiana.

The writer wishes to extend special thanks to Fr. Fabian Frieders, O. S. B., under whose direction this work was made possible and accomplished, for his many helpful suggestions and for his interest in this project. The writer is also indebted to Dr. W. A. Daily of Eli Lilly & Co., for his suggestions, the use of unpublished keys on the Myxophytes, and his kindness in determining species.

All specimens collected for this study are deposited in the Henrietta Herbarium, St. Meinrad, Indiana.

PREVIOUS PUBLICATIONS IN STATE

Since 1876 there have been some seventy papers published treating the algae of Indiana under one or the other aspect. Many of these papers consider only one or two species, citing some interesting fact about the life cycle, nomenclature, or ecological relations of a particular species. Perhaps the first mention of the Indiana algae was in a paper by E. T. Cox in the 8th Annual Report of the Geological Survey of Indiana.[1] It listed some of the algae of Wayne County, including Oscillatoria, Pediastrum, Euastrum, and twelve genera of diatoms. The next study, published in 1882, was by the Rev. G. L. Curtiss, in which there is a list of 78 species of diatoms, chiefly from Marion County.[2] In 1891 L. N. Johnson, of Northwestern University, mentioned a number of algal species from Lake County in a publication of that University.[3] S. Burrage, in 1894, and P. M. Mottier, in 1895, reported on occurences of Pleodorina in the state.[4,5] Also in 1895, Eigermann, giving the first report of a biological station on Winona Lake, in Kosciusko County, mentions Ceratium, Palmella, and several diatoms found in that lake.[6] M. B. Thomas, in 1898, lists fifteen species of desmids found near Crawfordsville.[7]

The first more comprehensive list of algae for the state was compiled by F. M. Andrews of Indiana University, and was published in 1909.[8] This list includes 175 species, most of which were from Monroe County. In 1926 he added another

88 species to this list, and again in 1929, 52 more.[9] Everman and Clark, in their study of Lake Maxinkuckee, described 108 species of algae found in the lake. [10] In 1928, C. M. Palmer of Butler compiled a list of all the algae which had been reported for the state to date, consulting a total of 42 papers.[11] At that time 894 species had been collected and described, with twenty-two counties each represented by one or more species. In 1931 B. H. Smith reported on collections made over a paeriod of years throughout the state, which included 540 species and varieties, of which 272 species were new for the state.[12] Also in 1931, C. M. Palmer published a list of the algae of Marion County, describing 22 species, most of which had been collected on the Butler University campus in Indianapolis.[13] In another paper were listed the phytoplankton of White River, giving a total of 217 species.[14] In 1934 Dr. Palmer reported on algae collected in Steuben County, of which several species and genera were new for the state.[15]

Lawrence King, in 1942, described 61 species of Myxophytes from Wayne County, of which 30 species and three genera were new for Indiana.[16] In the same year W. A. Daily published a complete list of the Chroococcaceae of Indiana, Kentucky, and Ohio.[17] Since then he has written many papers on new species found in the state, most of which were published in the Butler University Botanical Bulletin. F. K. Daily has published several papers on the Charaphytes of the state,

including a key to all known species, which currently number nineteen.[18]

Although most of the counties of the state are represented by at least a few reported algal species, there has not been a great deal of work done in the southern section of the state. The chief contribution is that of Britton and Smith, whose collections were made from the lower Wabash Valley, in the southwest corner of the state.[19] It seems that only one species has been reported from Spencer County -- Chara sejuncta, collected by Charles Deam in 1916 from an artificial pond at Lincoln City.[20] There appear to be no reports on algae collected from Perry County.

algal floras. The other two lakes are only about five years old, and although they show occasional "blooms" of one or more species, they don't have the variety of species which the other lakes show.

GEOGRAPHICAL FEATURES

Since the physical nature of an area affects to a great extent the types of algae to be found in it, a short description of the area in which the collections were made is necessary. This area is shown on the accompanying map. The places in which algae were collected are indicated by a small "x."

St. Meinrad is in the Mansfield sandstone belt, and outcroppings of sandstone on the sides of hills and the banks of streams abound. When these are kept moist by water seepage from the hill or spray from small waterfalls they provide excellent habitats for semi-terrestrial and terrestrial algae; in dryer areas lichens are to be found on these outcroppings.

The elevation ranges from 440 to 620 feet, with the average elevation being about 500 feet. The Ohio River is about ten miles south of St. Meinrad, and one of its tributaries, the Anderson River, flows near St. Meinrad. The Anderson River itself is usually quite muddy, and has a very poor algal flora; but the smaller seasonal spring streams later have many small quiet ppols which have considerable quantities of algae growing in them. These pools, and roadside ditches similar to them, furnished a main source for the collections.

There are four artificial lakes in the immediate vicinity of St. Meinrad. The lake in the valley to the west of the abbey and the northern of the two lakes east of the Anderson River are both about twenty-five years old and have established

COLLECTION METHODS

The varied habitats of algae call for variations in collection methods. Though found chiefly in lakes, pools, and streams, the algae may also be encountered in lichens (in symbiosis with fungi), in soil, and on rocks and trees. They may be free-living, epiphitic, endophytic, or parasitic. The only conditions necessary for their growth, in general, are a sufficient supply of water and mineral nutrients, and either sunlight for photosynthesis or organic nutrients. The only groups of living things more ubiquitous are the bacteria and viruses -- and there are few places where these may be found where the algae cannot thrive.

For collecting the plankton algae of lakes and streams, a plankton net was used. A small glass vial was tied to the end of the conical silk net; this vial collects the plankton algae as the net is dragged though the water; algae clinging to the sides of the net are washed down into the bottle after the net is pulled from the water. The vial was then untied from the net and capped.

Large filamentous forms, such as Cladophora, were pulled by handfuls from the water in which they were growing and wrapped in damp, and then dry, newspapers. Wrapped in this way they stayed in perfect condition for three or four hours, until they could be examined in the laboratory. Smaller filamentous forms, such as Oscillatoria, were placed in wide-mouth bottles with enough water to fill the bottle about

three-fourths full. The algae cannot be crowded in the bottle as crowding, with consequent lack of oxygen, will kill them in a few hours.

A garden trowel and a knife were used to remove algae growing attached to rocks, soil, and trees. Species growing in an aerial habitat were wrapped in newspapers; those growing in aquatic habitats were placed in collection jars. In the case of algae growing on submerged stems of cattails and other aquatic plants, the section of the plant with the algae on it was cut away and placed in a collecting jar; the algae were separated from the plant stem later in the laboratory.

Soil algae were collected by digging down to the desired depth with a garden trowel and removing a small quantity of the soil at that level. About a gram of the soil was used to inoculate culture jars, as explained below in section on culture methods.

In order to identify the collections on return to the laboratory, 3 x 5 cards were cut almost through into strips and the strips were numbered. For each collection a numbered strip was torn off and placed in the bottle with the algae; a description of the collection site and other pertinent facts were written with the same number in a field notebook. This information was transferred to the herbarium specimens later.

CULTURE METHODS

Many algae grow in sufficient numbers in their natural habitat to be collected and identified without difficulty. However in the case of some algae -- for example the Myxophytes growing in garden soil -- it is very difficult to find enough specimens for identification just by examination of the material in which they are growing, since they are so few and scattered. Culture methods must then be used to obtain a sufficient number of the algae. The most used method was that of soil-culture, since this has been found to be an effective and relatively easy method. The other methods, mineral and peat solutions, have been used in some instances, especially for the cultivation of the Volvocales and Chlorococcales.

The cultures were grown under a fluorescent light. With constant illumination colonies appear in four to ten days after inoculation. Quart mason jars and pint milk bottles were used for liquid cultures and Petri dishes for agar plates. The cultures were inoculated with about one gram of soil, or one cc. of the stream or pond water whose algal population was to be determined.

In a culture solution some species which were rare in the inoculating material may become dominant, while the forms which were dominant may disappear. It is thus possible to exercise a selective action in the cultures by varying conditions to favor different algae. Until recent years no research had been done to determine the optimum conditions for culturing

various species, and to date most of the work has been done on a few genera, such as Chlorella. In general the Myxophytes seemed to fare best in a soil solution with little added nitrogen, while the Chlorophytes did well in mineral or soil solutions with a larger nitrogen content. In order to reach a definite conclusion along these lines, however, further studies would be needed.

Following are the methods of preparation of culture media used:

A. Soil solutions:

1. In the simplest soil culture method used, a half-inch of sifted soil was placed in the bottom of a quart mason jar. The jar was filled three-fourths full of tap water, one to ten cc. of a five percent solution of KNO_3 was added, the jar was stoppered with cotton, and autoclaved for thirty minutes at fifteen pounds pressure. When it had cooled, it was ready to be inoculated. This method presented difficulties, as colonies growing on the soil in the bottom were difficult to remove without stirring up the soil, and a great many soil particles remained attached to them, making microscopic examination of the specimen difficult.

2. To avoid the difficulties encountered in the above method a stock soil solution was made up by autoclaving 300 grams of soil in 600 cc. of tap water. After the soil had settled to the bottom of the jar, the water was decanted and filtered twice, the first time with coarse, the second time with fine

filter paper. This stock soil solution was then mixed with distilled water and five percent KNO_3 solution in various ratios, the most common one being:

Distilled water.....70 cc.

Stock soil solution.....25 cc.

KNO_3 solution..... 5 cc.

Pint or quart bottles were filled three-fourths full of this solution, stoppered with cottom, and autoclaved for 30 minutes at 15 pounds pressure. Upon cooling they were ready for inoculation.

B. Mineral solutions:

These are useful in the culture of some particular algae, such as Chlorella or Scenedesmus, and elaborate solutions have been compounded for several species. A solution containing the following was used with good results for the Volvocales and Chlorococcales:

KNO_3.....2.0 grams

KH_2PO_4.....1.0 gram

$MgSO_4$.....1.0 gram

Tap water.....1000.0 cc.

C. Peat solutions:

A stock solution of peat was made by autoclaving 100 gr. of peat moss in 500 cc. of tap water for 30 minutes at 15 pounds pressure, filtering the water off the peat, and diluting it 1/2 with distilled water. This solution is very prone to bacterial contamination, but when used in conjunction

with soil or mineral solutions, it seems to encourage the growth of the unicellular chlorophytes. It was used in the ratio of one part peat solution to three parts soil or mineral solution.

D. Agar Plates:

Any of the above solutions can be solidified by boiling them with two grams of agar per 100 cc. of solution, and pouring into Petri dishes. This method was particularly useful for the isolation of unicellular planktonic forms. The water with the algae in it was diluted 1:10 with distilled water, and this was either poured (in a very thin layer, which the agar absorbs) or streaked with a needle on the plate. The colonies appear in a week or two as small green dots scattered over the surface. One colony is then removed to another culture for further growth.

PRESERVATION OF SPECIMENS

Collections brought in from the field, if it was not desired to start cultures from them, were preserved in FAA solution (50% ethyl alcohol...90 cc.; acetic acid...5 cc.; formaldehyde...5 cc.). In the case of microscopic forms which could not easily be transferred to this solution enough formaldehyde was added to make a five percent solution.

Herbarium specimens were preserved by drying the algae on slides, in the case of small unicellular forms, or in newspapers, in the case of large filamentous species. The dried specimens were placed in packets made by folding an eight by nine inch paper over from the top and bottom, and tucking the ends under. Species identification, date and place of collection were written on the front of the top flap of the packet. In order to re-examine the dried specimens a few drops of a detergent solution were placed on the material, making the cells swell up to approximately their original size.

Microscopic slides were made of both stained and unstained material. Unstained material was mounted in glycerine. The specimens to be mounted were placed in a ten percent solution of glycerine in water, and set aside in a watch glass for several days, until most of the water had evaporated. An additional quantity of glycerine was then added and the material was mounted under cover slips ringed with balsam.

Some filamentous and unicellular forms were stained and mounted directly in balsam, according to ~~the~~ STANDARD methods. ~~of~~

~~Johansen.~~ [21] The filamentous green algae were killed and fixed in a weak chrome-acetic fluid, made up of:

10% chromic acid.....2.5 cc.

10% acetic acid.....5.0 cc.

Distilled water.....100.0 cc.

They were stained with Harris' hematoxylin[22] and fast green.[23] The material was dehydrated by successively stronger solutions of alcohol, and finally placed in 95% ethyl alcohol. Tertiary butyl was added to this in small quantities at intervals, and part of the mixture was poured off occasionally. When diffusion currents were no longer noticed at the addition of tertiary butyl alcohol the material was placed in pure tertiary butyl alcohol; from this it was transferred to a 10% solution of balsam in tertiary butyl alcohol. When the alchhol had evaporated after a day or two the material was mounted directly in the balsam on slides.

Unicellular forms were killed and fixed with Schaudin's fluid[24], and stained with eosin and Heidenheim's hematoxylin.[25] They were dehydrated and mounted in balsam just as the filamentous green algae.

LIST OF ALGAE COLLECTED

The nomenclature and classification used in this list is that of G. M. Smith, in Fresh-Water Algae of the United States, Second Edition.

I. Phylum Chlorophyta: grass-green algae.

A. Class Chlorophyceae: plants unicellular or forming colonies; colonies may be simple aggregates of cells, branched or unbranched filaments. Pigments are in definite chromatophores, which are generally bright green; several chlorophylls, carotenes, and xanthophylls are usually present, in approximately the same percentages as in vascular plants. Definite cell walls are usually present; these consist of an outer layer of pectose and an inner layer of cellulose. Motile cells generally have a red eyespot and a contractile vacuole at the base of the flagella.

1. Order Volvocales: vegetative cells motile, solitary or forming definite colonies; cell wall present on individual cells, colonial envelope gelatinous; single eyespot; one or more chloroplasts.

a. Family Chlamydomonadaceae: vegetative cells motile and solitary; sometimes forms amorphous nonmotile colonies.

1). Chlamydomonas globosa Snow. Slightly ellipsoidal motile cells; cell 7-9 x 8-10 microns; one contractile vacuole at base of flagella;

one cup-shaped chloroplast with a single pyrenoid. Lake Benet (northern of two lakes east of Anderson River).

b. Family Palmellaceae: vegetative cells form small colonies of definite or indefinite shape; cell sheaths distinct or confluent.

1). Palmella miniata Leiblein: Cells 10-14 microns in diameter, spherical to slightly ellipsoid, often occurring in pairs; gelatinous envelope on each cell, and thse form a large amorphous mass, which may be macroscopic; chloroplast parietal, covering 3/4 or more of cell, with a a single pyrenoid. Lake Placid.

2. Order Ulotrichales: cells form branched or unbranched filaments; cells uninucleate; one parietal chromatophore to a cell.

   a. Family Ulotrichaceae: unbranched filaments; cells uninucleate; parietal chromatophore of each cell usually covers 1/2 to 2/3 of cell.

      1). Ulothrix tenerrima Kuetzing. Unbranched filaments; chromatophore a parietal girdle, enclosing 2/3 of cell; cell 7-9 x 6-12 microns; single pyrenoid in chromatophore. Stream 1 mile west of St. Meinrad; on wet soil in greenhouse of Biology department.

      2). Ulothrix variabilis Kuetzing. Filaments 4-6 microns wide, cells 6-8 microns long; walls thin, parietal chromatophore occupying about 1/2 of cell; one pyrenoid. Lake Placid; Blackhawk Creek.

      3). Ulothrix zonata (Weber and Mohr) Kuetzing. Cell 11-45 x 10 -100 microns; parietal chromatophore enclosing 3/4 of cell; cell somewhat swollen at center. Lake Placid.

      4). Hormidium klebsii G. M. Smith. Unbranched filaments 5.5-7.0 microns wide; cells 8-15 microns long; single parietal chloroplast encircling about 1/2 of cell; one pyrenoid. Outlet of L. Benet; lake east of abbey.

b. Family Chaetophoraceae: branched filaments; cells with single parietal chromatophore; branches often terminated by long, tapering colorless cells (setae).

1). Chaetophora elegans (Roth) C. A. Agardh. Irregularly branched filaments radiating from common center; plant embedded in globose gelatinous matrix; setae at ends of some branches; cells of main filaments 8-11 x 25-60 microns. South east shore of Lake Benet.

2). Stigeoclonium stagnatile (Hazer) Collins. Branched filaments, with ends of branches tapered to a point; cells 7-11 x 8-32 microns; chloroplast a median girdles enclosing most of cell. Outlet of Cinder pit behind power house.

3). Stigeoclonium tenue (Agardh) Kuetzing. Cells 8-10 x 8-20 microns; branching predominantly opposite, with many branches terminating in setae. Lake Placid.

4). Draparnaldia plumoa (Vaucher) C. A. Agardh. Main axis sharply differentiated from branches; entire plant enclosed in gelatinous matrix; ends of branches with long setae; cells of main axis 50-70 x 150-200 microns; parietal chromatophore of cells of main axis occupying 1/3 to 1/2 length of cell. Small stream flowing

into north side of Lake Benet.

c. Family Protococcaceae: unicellular or cells united into small aggregates; thought to come from a filamentous ancestor.

1). Protococcus viridis C. A. Agardh. Cells solitary or in groups of 2-8 cells; cell wall thick; cells 4-10 x 4-12 microns. Tree on hillside east of abbey.

d. Family Coleochaetaceae: cells united into branched filaments, usually forming a radiating disk from a common center; some cells have setae, which are ensheathed in a gelatinous material at their base.

1). Coleochaete irregularis Pringsheim. Irregularly branched filaments; cells 18-25 x 18 - 30 microns; setae on some cells. Growing on footings of bridge over outlet of Lake Benet.

2). Coleochaete soluta (Brebisson) Pringsheim. Branched filaments radiately coming from a common center; cells 12-25 x 25-100 microns; filaments not joined laterally; single chromatophore to a cell. In stream 1/2 mile west of St. Meinrad.

3. Order Cladophorales: simple or branched filaments; cells multinucleate; numerous discoid chromatophores united by cytoplasmic strands into a net.

a. Family Cladophoraceae: characteristics of the Order.

1). Cladophora glomerata (Linnaeus) Kuetzing. Cells of main axis 50-150 x 300 -1000 microns; cells of branches 35-60 x 150-400 microns; cell walls of main axis heavier than walls of cells in branches; plant attains considerable length, about a foot in some specimens. Lake Placid.

2). Rhizoclonium fontanum Kuetzing. Branched filaments; branches two or three celled; cells 22-27 x 55-300 microns; multinucleate; chromatophores in parietal network. Fish tank in biology laboratory.

3). Rhizoclonium hieroglyphicum (Agardh) Kuetzing. Unbranched filaments; cells 30-35 x 75-110 microns. Lake east of abbey.

4). Pithophora oedogonia (Montagne) Wittrock. Branched filaments; cells much longer than broad, 40-120 x 200 -3000 microns; akinetes present. Tanks in biology laboratory.

4. Order Chlorococcales: cells solitary or in colonial aggregates; vegetative cells non-motile.

   a. Family Characiae: solitary cells growing on other algae, on stems of plants, or on other substrata; single parietal chromatophore with one or more pyrenoids.

      1). Chrarcium angustatum A. Braun. Fusiform, attached on lower end by a short stalk to substrate; cell 8-12 x 20-40 microns; single parietal chloroplast. Spillway of Lake Benet.

   b. Family Coelastraceae: cells united in hollow or solid colonies of from two to one-hundred twenty eight cells.

      1). Coelastrum microporum Naegeli. Colony spherical; cells 3-20 microns in diameter, joined to one another by short gelatinous processes; 8-64 cells in colony; colony 20-90 microns in diameter. Lake Benet; ditch near dairy.

   c. Family Oocystaceae: cells variable in shape, single or united in small colonies; single chromatophore with, in general, one pyrenoid; colonies formed by gelatinous adhesions between cells.

      1). Ankistrodesmus falcatus (Corda) Ralfs. Cells needle-like, 1.5-3 x 30-80 microns; slightly curved with pointed ends; solitary or in loose bundles of 2-8. Fish tanks in biology laboratory.

2). Chlorella vulgaris Beyerinck. Spherical cells 5-7 microns in diameter; single parietal chloroplast covering approximately 1/2 of cell; single pyrenoid. Fish tanks in biology laboratory; ditch by road, 1/2 mile south of St. Meinrad.

3). Nephrocytium agardianum Naegeli. Cells reniform, 8 or 16 enclosed in colonial envelope; cells 6-10 x 18-28 microns; single chromatophore. Lake east of abbey.

4). Oocystis borgei Snow. Cells solitary, or 2 to 4 cells in old mother cell wall; cells 9-13 x 9-17 microns, generally ellipsoid; without polar nodules; 1 to 4 chromatophores per cell. Ditch by road east of abbey.

5). Trochiscia reticularis (Reinsch) Hansgirg. Spherical cells, solitary; cell wall decorated with net design; cells 24-32 microns in diameter. In matrix of frog eggs from pool on hill northeast of St. Meinrad.

d. Family Hydrodictyoceae: cells united into plate-like colonies with a definite number of cells; chromatophores parietal.

1). Pediastrum simplex Meyer var. duodenarium (Bailey) Rabenhorst. Free-floating colonies; cells 10-24 x 20-45 microns, forming a flat

plate; 8-64 cells to colony; cell walls punctate. Fish pond behind abbey church.

e. Family Scenedesmaceae: two, four, eight or rarely more cells united in a definte colony; all cells in same plane and parallelled; cells spherical to fusiform.

1). Scenedesmus bijuga (Turpin) Lagerheim. Cells 6-7 x 10-15 microns, oblong with broad ends; no spines or teeth. Ditch by road east of abbey.

2). Scenedesmus dimorphus (Turpin) Kuetzing. Cells 3-5 x 18-20 microns, with sharply pointed apices; no spines; inner cells straight, outer cells sharply concave. Fish tank in biology laboratory.

3). Scenedesmus opoliensis P. Richter. Four cells to colony; cells 5-8 x 12-18 microns, ovoid, touching at centers; end cells with spines at each pole, inner cells without spines. Fish pond behind abbey church.

4). Scenedesmus quadricauda (Turpin) Brebisson. cells 4-6 x 12-15 microns, with broad ends; in straight series; end cells with spines at both poles. Ditch by road east of abbey.

5. Order Zygnematales: cells solitary or united into unbranched filaments; chromatophores flat plates,

spiralled or twisted, or stellate; formation of zygotes by union of two cells.

a. Family Zygnemataceae: unbranched filaments, cells not divided into halves.

1). Zygogonium ericetorum Kuetzing. Cells 12-30 x 10 -100 microns; two axillary chromatophores, disk-shaped with irregular edges; single pyrenoid in each chromatophore. Fish tanks in biology laboratory.

b. Family Desmidiaceae: cells divided into two halves by a median girdle; solitary or unbranched filaments.

1). Closterium didytomocum Ralfs. Cells 20-35 x 400-650 microns; almost straight, with broad ends; vacuole with large granules at each end of cell; many pyrenoids. Lake Placid.

2). Closterium turgidum Ehrenberg. Cells 60-80 x 600-700 microns; striations running lengthwise on wall of cell; cells slightly curved, ~~with~~ with a girdle around middle of cell; apices of cells are slightly recurved. Lake Placid.

3). Hyalotheca mucosa (J. E. Smith) Brebisson. Filaments; cells 16-22 x 14-26 microns; constricted at cross walls, slightly constricted at center of cell; enclosed in thin gelatinous sheath. Fish pond behind abbey church.

4). Desmidium swartzii C. A. Agardh. Twisted filaments; cells triangular in end view, divided into semi-cells by noticeable notch; cells 38-45 x 16-19 microns; isthmus of cells 26-30 microns; cells in contact over entire end surfaces; one chromatophore in each semicell, with lobes extending to angles of triangle. Small lake east of Lake Benet.

II. Phylum Chrysophyta: golden brown algae.

Pigments localized in chromatophores which appear yellowish green to golden brown because of the predominance of carotenes and xanthophylls over chlorophylls. The cell wall is composed of two overlapping halves, and frequently is impregnated with silica.

A. Class Bacillariophyceae: diatoms. Cells solitary or in colonies, without flagella; have silicified cell wall consisting of two valves, one of which overlaps the other. The valves are decorated with various striations which may be radiately, transversely, or longitudinally arranged. Some species are motile, their movements consisting of short jerks; this is caused, according to most authorities[26] by the streaming of cytoplasm over the outside of the cell wall.

1. Order Pennales: cells solitary or united into colonies either filamentous or non-filamentous; valves elongate bilaterally symmetric.

a. Family Tabellariaceae: cells solitary or united into chains; valves elongate, symmetric on transverse and longitudinal axes.

1). Tabellaria fenestrata (Lyngbye) Kuetzing. Cells forming zigzag chains; inflated at center and at ends; 4 longitudinal septa, two on each side of median girdle; cell 9-11 x 120-170microns. Lake Benet.

b. Family Fragilariaceae: cells forming stellate or zigzag colonies, or solitary; free-floating or sessile, often stalked; valves symmetric in both axes; chromatophores small, discoid, numerous.

1). Fragilaria capunica Desmaziers. Cells 2-3 X 30-60 microns; united into filaments; striations very fine; valves linear, rectangular on sides of cells touching in fialments. Lake east of abbey.

2). Synedra capitata Ehrenberg. Colony formation absent; very long and narrow cells, with capitate ends; transverse striations evident, with no central nodule; cells 7-10 x 200-400 microns. Lake Benet.

3). Synedra ulna (Nitzsch) Ehrenberg. Cells 9-12 x 160-200 microns; solitary, free-floating; transverse striations run full length of cell. Lake Placid.

c. Family Naviculaceae: cells solitary, free-floating; valves elliptic to rectangular, symmetric in both axes; central and polar nodules present.

1). Navicula seminiculum Grunow. Cells 4-5 x 11-16 microns; valves elongate, with slight median expansion and rounded poles; transverse striations radial. Fish tank, biology laboratory.

2). Stauroneis anceps Ehrenberg. Cells 6-8 x 25-100

microns; solitary; valves elliptic; with captiate ends; raphe straight; transverse striations radial. Ditch flowing into Anderson near dairy.

III. Phylum Euglenophyta

Cells solitary, motile (rarely forming immobile dendrite colonies); protoplast naked, or enclosed in cell wall; protoplast frequently ridged or striated; color dark green; anterior end has reservoir with one or more contractile vacuoles emptying into it.

A. Class Euglenophyceae: with characteristics of the Phylum.

1. Order Euglenales: cells always solitary and motile. Other characteristis as in the Phylum.

a. Family Euglenaceae: characteristics of the Order.

1). Euglena elongata Schewiakoff. Cell very elongated, 5-7 x 60-70 microns; anterior end broad, posterior end pointed; periplast smooth. Small stream one mile south of St. Meinrad.

IV. Phylum Myxophyta: blue-green algae.

A. Class Myxophyceae: unicellular or in colonies of regular or irregular form, filamentous or otherwise; cell wall has two layers, the of cellulose, the outer of expanded gelatinous materials; this outer layer may be almost invisible (as in Oscillatoria) or very thick and conspcuous (as in Anabaena). There is no nucleus, though a central body is smmetimes considered to be nuclear in nature; chromatophores are never found, the pigments being scattered throughout the cell; besides chlorophylls, xanthophylls and carotenes, there are found c-phycocyanin (blue) and c-phycoerythrin (red).

1. Order Chroococcales: plants unicellular or colonial; not filamentous.

a. Family Chroococcaceae: same characteristics as in the Order.

1). Anacystis incerta (Lemmermann) Drouet and Daily. Small spherical to ovoid cells, 0.5 to 2.0 microns in diameter; similar to coccoid bacteria. Ditch east of dairy.

2. Order Oscillatoriales: cells forming filaments, either branched or unbranched; with or without visible sheath; formation of heterocysts and akintes in some species.

a. Suborder Oscillatorineae: filaments unbranched; of same diameter throughout; no formation of

heterocysts or akinetes.

1). Family Oscillatoriaceae: same characteristics as in the Suborder.

a). Lyngba aestuarii (Mertens) Liebmann. Filaments 8-12 microns wide, cells 3-5 microns long; filaments enclosed in individual sheaths; tips of filaments taper slightly, the end cell being rounded at the tip; young filaments are light blue-green, older filaments are yellow or olive; plant mass grows attached to substrate. Ditch beside road 1/2 mile north of St. Meinrad.

b). Lyngba putealis Montagne. Unbranched filaments, with firm sheath, extending beyond end cell on some fialments; cells 8-11 x 3-8 microns; filaments constricted at cross walls; end cell rounded, not capitate. Ditch east of dairy.

c). Oscillatoria agardhii Gomont. Unbranched filaments without sheaths; cells 4-5 x 3-4 microns; very granulate, with many vacuoles; not constricted at cross walls, slightly tapered at tip of filament; end cell acutely rounded. Lake Placid.

d). Oscillatoria curviceps C. A. Agardh. Filaments 8-10 microns wide, cells 2-3

microns long; not constricted at cross walls nor narrowed at tips of filaments; end cell rounded, not capitate; tips of filaments are slightly curved. Lake Placid.

e). Oscillatoria formosa Bory. Cells 4-5 x 3-5 microns; slightly constricted at cross walls; end cell rounded; ends of filaments slightly bent. Ditch near road 1 mile north of St. Meinrad.

f). Oscillatoria geminata Meneghini. Unbranched filaments; cells 2.5-4 x 2.5-8 microns; end cell rounded, not capitate; constricted at cross walls. Blackhawk Creek.

g). Oscillatoria grunowiana Gomont var. articulata (Gardner) Drouet. Cells 3.0-3.3 x 1.0 -1.5 microns; end cell rounded; slightly constricted at cross walls. Earth in greenhouse, biology department.

h). Oscillatoria sancta (Kuetzing) Gomont. Unbranched filaments; cells 10-12 x 3-5 microns; slightly constricted at cross walls; granulate at cross walls; end cell rounded. Fish tank in biology laboratory.

i). Oscillatoria tenuis C. A. Agardh. Cells 6-8 x 3-5 microns; granulate and slightly constricted at cross walls; end cell rounded. Earth in greenhouse.

j). Oscillatoria tenuis C. A. Agardh var. natans Gomont. Unbranched filaments; cells 8-10 x 3-5 microns; cross walls thick; slightly constricted at cross walls. Ditch east of dairy.

k). Phormidium ambiguum Gomont. Unbranched filaments, thin gelatinous sheath; cells 4-6 x 1.5-3 microns; protoplasm granulate; slightly constricted at cell walls. Earth in greenhouse, biology department.

l). Phormidium favosum (Bory) Gomont. Cells 5-7 x 3-6 microns, granulate at cross walls; end cell capitate; thin sheath on filament. Earth in greenhouse, biology department.

b. Suborder Nostochineae: filaments branched or unbranched; of same diameter throughout or attenuated at apex; heterocysts and akinetes present.

1). Family Nostocaceae: trichomes unbranched; of same diameter throughout; akinetes and heterocysts present.

a). Anabaena variabilis Kuetzing. Unbranched filaments; cells barrel shaped; 4-5 x 3-6 microns; heterocysts round, 6-7 microns in diameter; akinetes elongate, 7-8 x 8-12 microns; heterocysts separated from akinetes by several vegetative cells; sheath thin.

Jar of water sitting in greenhouse, biolgy department.

2). Family Rivulariaceae: trichomes attenuated at at apex; heterocysts generally basal; akinetes present or not.

a). Amphithrix janthina (Montagne) Bornet and Flahault. Colony made up of dense lower portion of closely compressed cells and upper portion of filaments; cells 1-2 x 1-2 microns; sheaths thin; end of filaments tapered. Fish pond behind abbey church.

FOOTNOTES

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[4] S. Burrage, "A New Station for Pleodorina californica Snow," Proceedings of the Indiana Academy of Science, 1895, p. 99

[5] P. M. Mottier, "Pleodorina in Indiana," Botanical Gazette, vol. 19 (1894), p. 383.

[6] Eigenmann, "First Report of the Biological Station," Proceedings of the Indiana Academy of Science, vol. 5 (1895) p. 204.

[7] M. B. Thomas, "Some Desmids of Crawfordsville," Proceedings of the Indiana Academy of Science, vol. 8 (1898), p. 163.

[8] F. M. Andrews, "A List of Algae -- Chiefly from Monroe Co," Proceedings of the Indiana Academy of Science, vol. 19, p. 375.

[9] F. M. Andrews, "Additions to Monroe Co. Algae," Proceedings of Indiana Academy of Science, vol. 36, p. 223.

[10] Everman and Clark, Lake Maxinkuckee -- A Physical and Biological Survey, Department of Conservation, State of Indiana, p.

[11] C. Mervin Palmer, "Algae of Indiana -- Classified Check List of Those Published Between 1875 and 1928," Proceedings of the Indiana Academy of Science, vol. 38 (1928), p. 109

[12] B. H. Smith, "The Algae of Indiana," Proceedings of the Indiana Academy of Science, vol. 41 (1931) p. 177

[13] C. Mervin Palmer, "Algae of Marion Co,, Indiana," Butler University Botanical Studies, vol. 2 (1931-32) p. 1.

[14] C. Mervin Palmer, "Phytoplankton of White River," Butler University Botanical Studies, vol. 2 (1931-32), p. 125

[15] C. Mervin Palmer, "Algae of Steuben Co., Indiana," Butler University Botanical Studies, vol. 3 (1934) p. 102

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[17] William A. Daily, "The Chroococcaceae of Ohio, Kentucky, and Indiana," American Midland Naturalist, vol. 27 (1942) p. 636.

[18] F. K. Daily, "The Characeae of Indiana," Butler University Botanical Studies, vol. 11 (1953-54) p. 5

[19] M. E. Britton and B. H. Smith, "Some Algae of the Lower Wabash Valley," Proceedings of the Indiana Academy of Science, vol. 42 (1932) p. 45.

[20] F. K. Daily, "The Algae of Indiana -- A Preliminary Report," Butler University Botanical Studies, vol. 7, (1945) p. 124

[21] D. A. Johansen, Plant Microtechnique (New York, 1940), p. 110

[22] Ibid., p. 76.

[23] Ibid., p. 118.

[24] Ibid., p. 47.

[25] Ibid., p. 72.

[26] G. M. Smith, Fresh-Water Algae of the United States, (New York, 1950) p. 449.

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