Butler University Botanical Studies

Volume 14 Article 6

Glacial and Post-Glacial Charophytes from New York and Indiana

Fay Kenoyer Daily

Butler University Botanical Studies

(1929-1964)

Edited by

J. E. Potzger

The *Butler University Botanical Studies* journal was published by the Botany Department of Butler University, Indianapolis, Indiana, from 1929 to 1964. The scientific journal featured original papers primarily on plant ecology, taxonomy, and microbiology. The papers contain valuable historical studies, especially floristic surveys that document Indiana's vegetation in past decades. Authors were Butler faculty, current and former master's degree students and undergraduates, and other Indiana botanists. The journal was started by Stanley Cain, noted conservation biologist, and edited through most of its years of production by Ray C. Friesner, Butler's first botanist and founder of the department in 1919. The journal was distributed to learned societies and libraries through exchange.

During the years of the journal's publication, the Butler University Botany Department had an active program of research and student training. 201 bachelor's degrees and 75 master's degrees in Botany were conferred during this period. Thirty-five of these graduates went on to earn doctorates at other institutions.

The Botany Department attracted many notable faculty members and students. Distinguished faculty, in addition to Cain and Friesner , included John E. Potzger, a forest ecologist and palynologist, Willard Nelson Clute, co-founder of the American Fern Society, Marion T. Hall, former director of the Morton Arboretum, C. Mervin Palmer, Rex Webster, and John Pelton. Some of the former undergraduate and master's students who made active contributions to the fields of botany and ecology include Dwight. W. Billings, Fay Kenoyer Daily, William A. Daily, Rexford Daudenmire, Francis Hueber, Frank McCormick, Scott McCoy, Robert Petty, Potzger, Helene Starcs, and Theodore Sperry. Cain, Daubenmire, Potzger, and Billings served as Presidents of the Ecological Society of America.

Requests for use of materials, especially figures and tables for use in ecology text books, from the *Butler University Botanical Studies* continue to be granted. For more information, visit www.butler.edu/herbarium.

GLACIAL AND POST-GLACIAL CHAROPHYTES FROM NEW YORK AND INDIANA

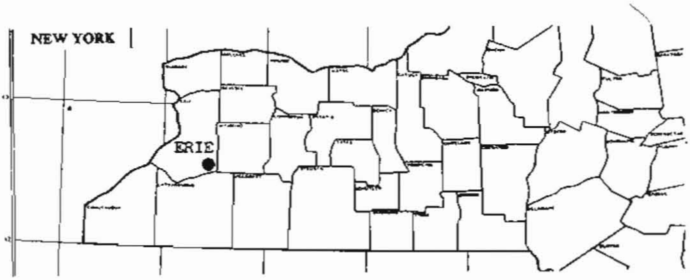
FAY KENOYER DAILY
Butler University
Indianapolis, Indiana

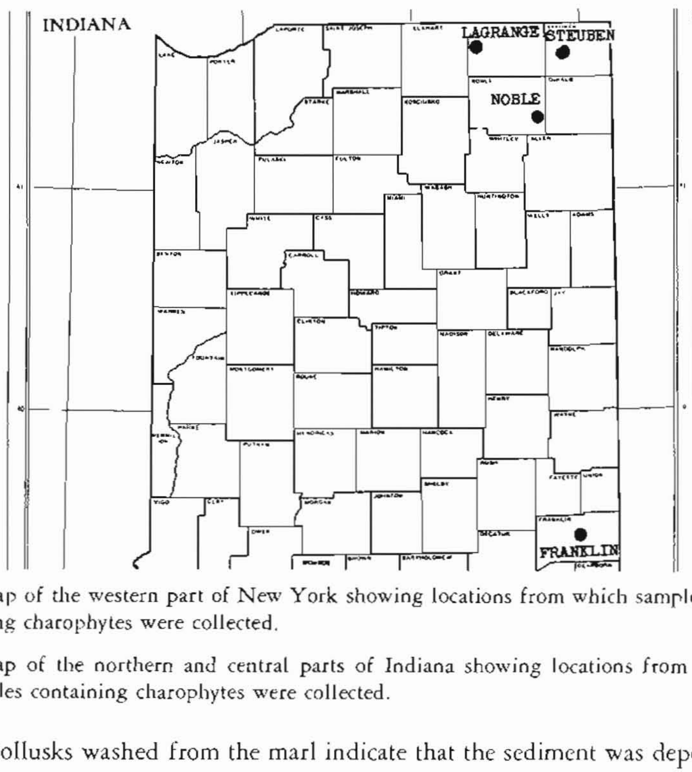
INTRODUCTION

Fossil charophytes from glacial and post-glacial deposits of North America have been studied very little, probably because they were expected to be similar to extant species for the most part and of little interest. The present study, however, disclosed charophytic remains of considerable variety, and extends chronologically the occurrence of several genera usually associated with older deposits.

COLLECTION DATA—GEOLOGY OF COLLECTION SITES

The specimens collected by W. J. Wayne came from several locations. The New York material is from a marl exposure along Nichols Creek, two miles south of Chaffee, Erie County (Arcade Quandrangle) (text-figure 1). Marl accumulated in a shallow depression in a pitted outwash plain that was deposited south of the Valley Heads Moraine when glacial meltwater escaped through Cattaraugus Creek. Nichols Creek now flows through the filled depression and has exposed the upper part of the marl. The lower part was sampled by coring until gravel was reached. The 0 to 1.1 foot level of the core sample is light yellowish gray marl containing wood fragments and mollusk shells. The charophytes isolated from it are *Charaxis, Charites strobilocarpa, Charites bitruncata, Latochara Waynei, Chara evoluta, Chara sejuncta, Chara contraria* and *Charites strobilocarpa* var. *ellipsoidea.* The 1.1 to 2.1 foot level is a medium to dark gray marl, lighter toward the base containing wood and shells. Fossil charophytes isolated from it are *Charaxis* , *Latochara Waynei, Charites strobilocarpa* var. *ellipsoidea, Grambastichara cylindrica, Obtusochara cylindrica, Charites bitruncata, Chara sejuncta* and *Chara evoluta.* The 2.1 to 2.9 foot level is white, sparsely fossiliferous marl containing *Charaxis, Charites .trobilocarpa, Tolypella* sp., *Chara contraria, Chara evoluta, Charites strobilocarpa* var. *ellipsoidea, Charites bitruncata* and *Grambastichara cylindrica.*





Map of the western part of New York showing locations from which samples containing charophytes were collected.

Map of the northern and central parts of Indiana showing locations from which samples containing charophytes were collected.

Mollusks washed from the marl indicate that the sediment was deposited near the margin of a pond where it was heavily vegetated. Both pollen and snails suggest a climate that was somewhat cooler than the present. The site is also one from which part of the remains of a mastodon, now in the Buffalo Museum of Natural Sciences, was recovered. Wood from the base of the exposed marl at this locality has been dated by radiocarbon technique as 12,000 years old (Rubin and Alexander, 1960, p. 134, W-507).

It is interesting that a large number of *Chara contraria* oogonia and oospores were found in the early stage of this pond, as this species is an early inhabitant of gravel-bottomed ponds and lakes in present days. When the pond had matured, the most abundant species were *Charites strobilo-*

carpa var. *ellipsoidea, Chara sejuncta, Latochara Waynei* and *Charites bitruncata. Chara sejuncta* is typically from an aquatic habitat with mud or ooze bottom.

Specimens collected in Indiana came from several sites (text-figure 2). In Steuben County on the north side of Silver Lake, a marl digging exposed part of a former lake bed occupied by Silver Lake. This is located in the center NE¼ sec. 30, T. 37N., R. 13E. From the top down the deposit consisted of marl, interlayered with beds of peaty or mucky marl, 1.6 m. thick; marl, yellowish-white, granular, 0.9 m. exposed above water level. No sampling could be done below the water level even with a tube core sampler because the granular nature of the material and the high water content caused it to flow out of the tube. This particular sample (Field No. WJW-53-59B) is the lowermost of the two marl units exposed. It contained *Chara evoluta, Maedlerisphaeria ulmensis* and also 14 species of mollusks of which two, *Lymnaea parva* and *Gyraulus parvus* made up 83 per-cent of the sample. A small number of valves of *Pisidium* sp. were present; the remainder of the sample consisted of land pulmonates that inhabit vegetation around springs and marshy places. Both normal and zebrine forms of *Lymnea parva* and *Gyraulus parvus* were in the sample. The marl is post-Wisconsin in age.

In Lagrange County, Indiana, a core was taken along the southeast edge of Cass Lake, about 3 miles east of Middlebury, in the W½NW¼ sec. 5, T. 37N., R. 8E. (Field sample nos. WJW 53-64A and B). Cass Lake is in one of many depressions that formed in northern Indiana after the last glacier disappeared and probably came into existence when a buried ice block melted. Surrounding sediments are largely sand and gravel. Land drainage programs of the past few decades have lowered the water level in the lake and exposed some of the marl banks that were still accumulating at that time. The samples from which charophytes were collected came from the lower part of the following core: the 0 to 7.5 foot level consisted of light gray marl in which fossils were rare. The 7.5 to 10.5 foot level was of gray marl having very few fossils. In the 10.5 to 15 foot level was found gray, marly gyttja (Field sample no. WJW 53-64A) from which *Chara sejuncta* oospores were isolated. The 15.0 to 15.5 foot level was gray to black marly gyttja (Field sample no. WJW 53-64B) and contained *Charites bitruncata.*

Sediments in the lower part of this core were less calcareous than those in the upper part and contained a larger proportion of fine-grained organic debris. Mollusks were scarce throughout all of three cores taken from the south end of Cass Lake, thus ecologic interpretations based on mollusks species cannot be made. Presumably, however, the peaty marl and gyttja in the lower part of this core were deposited within the first few thousand years following deglaciation, while the dominant forest vegetation was coniferous trees and a somewhat cooler climate than the present prevailed.

In Noble County, Indiana, a peat bed was studied, located in a gravel pit in NW¼NE¼ sec. 13, T. 33N., R. 11E., along Little Cedar Creek (Garrett Quadrangle) (Field sample no. WJW 55-7). Since 1955, when the materials in this pit were studied, the gravel operation has destroyed most of the exposure. The section exposed in 1955 reported by Wayne and Thornbury (1955, p. 10) consisted of 6 feet of gravelly sand over 2 feet of highly fossiliferous marly muck that in turn overlay gravel. Till underlay the gravel at a depth of about 12 feet below the water in the pit. The dark gray marly muck sandwiched between two beds of sand and gravel contained abundant wood fragments, spruce cones, and mollusk shells. Wood from this bed has been dated as 12,300 years old (Suess, 1954, p. 470, W-58), thus the sediment represents early postglacial material in Indiana. Undoubtedly it represents the sediments deposited in a shallow basin or slough that existed in the valley train outwash along Little Cedar Creek, and the gravel and sand above the fossiliferous bed were laid down subsequently as channel or floodplain sediments. This sediment contained *Charites strobilocarpa* var. *ellipsoidea, Clavatorites noblensis, Charites bitruncata, Charites strobilocarpa* and *Chara evoluta.*

In Franklin County, Indiana, exposures along the bed and banks of Yellow Bank Creek reported by Wayne and Thornbury (1955, p. 27) were studied. The location is SW¼SW¼ sec. 34, T. 12N., R. 13E., 3 miles northwest of Brookville (Field sample no. WJW 58-16A). Tributaries of major glacial sluiceways such as the Whitewater Valley were ponded during each of the glaciations of the Pleistocene Epoch as a result of a gravel dam that accumulated at their mouths. Sediments exposed in Yellow Bank Creek record the events that affected the valley during the Wisconsin glaciation while ice approached the area. A massive, yellowish-gray, fossiliferous silt, the lowermost unit exposed, is overlain by non-fossiliferous, laminated, silty clay. Sand and till overlie the laminated sediments a short distance upstream and represent the sediments laid down as ice entered the valley from the north. The lake sediments increase in coarseness toward the mouth of the valley.

The massive, fossil-rich bed at the base of the exposed section contains wood, mosses, and mollusks. The upper 10- 20 cm. of the bed is contorted locally and contains a mollusk fauna dominated by small, cool water species, including *Gyraulus altissimus, Lymnaea parva,* and *Pisidium* sp. Charophytes found there are *Charaxis, Chara sejuncta, Latochara spherica* and *Latochara latitruncata.* The lower part of the same bed contains a similar fauna but includes the large *Lymnaea palustris* and *Oxyloma retusa* along with the smaller forms. All of these faunal species live in the moderate to heavy vegetation in shallow water and above the water on plants.

The entire unit probahly was deposited in relatively shallow water that flooded the valley when glacial outwash gravels began to accumulate in the Whitewater Valley. Thus glacial ice probably was no farther than 50 or 60 miles to the north. Deposition of the overlying barren, laminated, silty clay took place when the dam of outwash gravel thickened with the approaching ice sheet and thus deepened the water in the lake.

METHODS

Collections were soaked in water containing a detergent until the particles separated. Some charophyte oospores floated and were removed from the top of the liquid. Then the sample was screened to separate remains of different sizes and allowed to dry. Charophyte oogonia, oospores and vegetative fragments were sorted from the screened sample by means of a damp camel hair brush while viewing under the microscope.

Fossils were not sectioned, but the preservation of the oospores inside the lime-shell facilitated determination of the thickness of the spirals (spiral cells). When wet, thin areas of the lime-shell appeared darker than thicker areas due to the dark oospore showing through. These observations could be verified when lime-shells were partially broken.

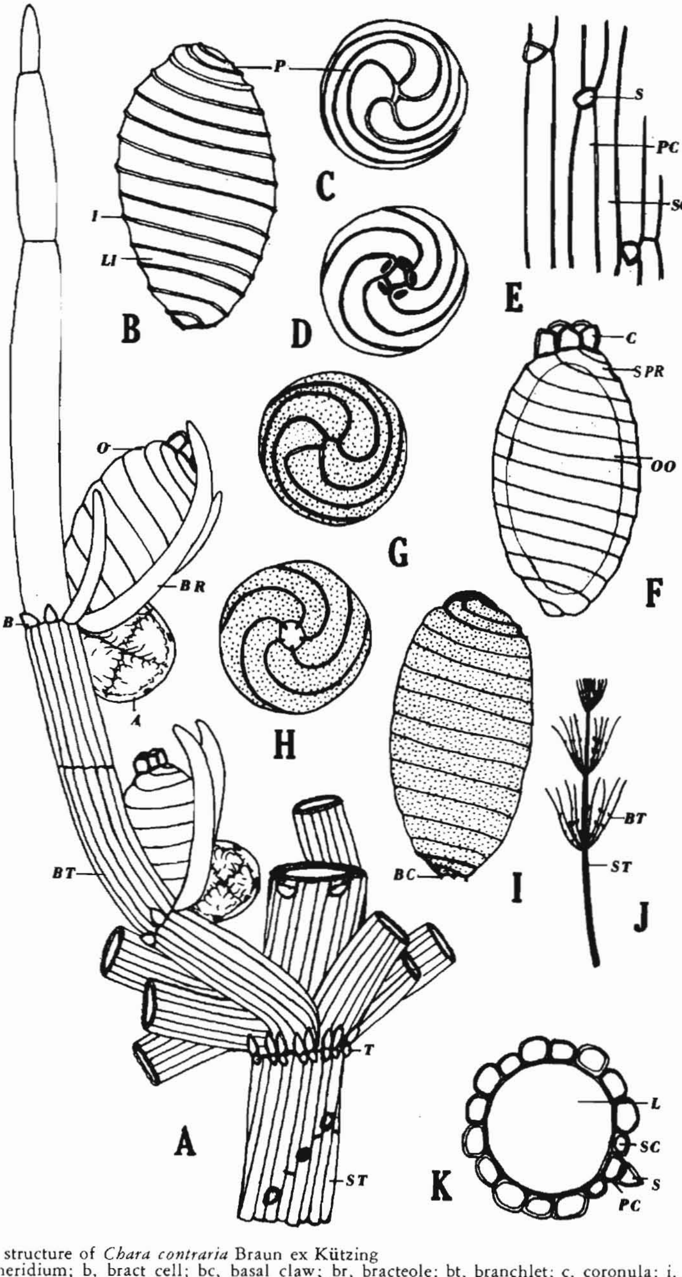
Photographs of the charophytes were taken by the author employing a Bausch and Lomb stereoscopic microscope with 15X ocular and 5.9X objective for most of the illustrations. A Model 800 Polaroid Land Camera was rested lens to miscroscope ocular with a distance of 3½ feet and 17 shutter control. Type 47, speed 3000 film was used. Glossy lime-shells were dulled by treating with dilute Shaeffer's writing fluid (blue black) number 22. Methylene blue can also be used. For reflected light, a 100 W. Bausch and Lomb Microscope Lamp was employed with diaphram nearly closed to provide about a ¾ inch opening affording a reduced light beam. Diaphram to specimen was about 8 inches. To backlight the specimens, a small glass reflector ⅛ by 1/16 inch with beveled edges on the reflecting face was used. The coated back was composed of two planes at a 45° angle to the two long edges of the reflector face meeting at a line at the center back, and two triangular planes at the same angle to the face on each side. The reflector, tipped slightly forward, was cemented to a cover glass and could be placed close to the back of the specimen facing the light. Before photographing, specimens were placed in a minute drop of water with a damp camel hair brush on a glass slide and manipulated into proper position on the glass stage using a black metal background. A few pictures were taken using a white background. Immediately upon drying, the picture was taken using a 5 second exposure.

Some pictures of the oospore membrane were taken with another microscope at a higher magnification, and a few illustrations of vegetative material and fruiting bodies were taken at a low magnification. Lateral views of lime-shells and oospores are arranged in the plates with the bases down and apices up or nearly so.

Charophytes are stored with the author's herbarium in small plastic boxes or Falcon plastic serological plates containing 10 wells each, sealed with glass cover slips. One cardboard slide with well completes the storage.

STRUCTURE OF A COMMON CHAROPHYTE

The plant form of modern charophytes is diverse, but fundamentally consists of a *stem* branched or unbranched with nodes and internodes. At the nodes are whorls of *branchlets* greatly differing in organization in different genera of the Characeae. Text-figure 3 shows *Chara contraria* A. Br. ex Kütz. This species grows as a condensed form in shallow water or may be several feet long in deep water. In J, the tip of the plant is seen to be composed of a stem bearing four whorls of branchlets, each whorl having about eight branchlets. A illustrates an enlarged view of a stem node with one branchlet shown in detail. The short section of stem shown above and below the node appears striated. The internodal portion of the stem consists of a very large central cell extending from node to node along the stem axis covered externally by a layer of cells, one cell thick, called the *cortex* which produces the striated appearance of the stem. One of the chief distinguishing characteristics used in the Characeae is the presence or absence of cortex and its nature if present. In the stem of *Chara contraria* there are prominent *primary cortex* cells distinguished by having nodes and internodes with one-celled *spines* produced at the nodes. *Secondary cortex* cells do not have the nodal-internodal alternation and produce no spines. They are less prominent than the primary cells in *Chara contraria.* (The longitudinal strip of cortex in E and the stem cross section in K show the details of structure in a more enlarged view.) At the bases of the branchlets in A, it is seen that there are two circles, one above the other around the stem, of one-celled processes termed *stipulodes.* The branchlet illustrated in detail is unbranched, possessing two corticated internodes at the base and a 3-celled undifferentiated ecorticate tip. At the two nodes are whorls of 1-celled processes. The long ones associated with the gametangia are termed *bracteoles,* the posterior short ones are *bracts.* An *oogonium* and an *antheridium* below it are produced at the nodes of the branchlets in this monoecious species. The term *oogonium* is used here as it is commonly employed in reference to the Characeae to indicate the many-celled reproductive organ including besides other sterile cells and the egg cell, the *spirals* or spiral cells topped by the



The structure of *Chara contraria* Braun ex Kützing
a, antheridium; b, bract cell; bc, basal claw; br, bracteole; bt, branchlet; c, coronula; i, intercellular ridge; l, central cell lumen; li, lime-shell; o, oogonium; oo, oospore; p, peripheral groove; pc, primary cortex cell; s, spine cell; sc, secondary cortex cell; spr, spiral cell; st, stem; t, stipulode. A, Stem node with one branchlet shown in detail. B-D. Lime-shell of a mature oogonium shown in lateral, apical and basal views respectively. E. Portion of stem cortex in external surface view. F. Oogonium after fertilization previous to heavy deposition of lime. G-I. Oospore divested of outer spiral covering (lime-shell) in apical, basal and lateral views, respectively. J, Apical portion of plant, natural size. K. Cross section of stem.

coronula. The coronula may be 5-celled as in *Chara contraria* or another tier of five cells may be produced to form a 10-celled coronula in other genera. The term *oogonium* is commonly applied to the complex female reproductive structure after fertilization of the egg, also, because the exact time of fertilization cannot be determined satisfactorily by casual observation. Several changes take place upon maturation of the fertilized egg to form the *oospore.* It becomes covered with an outer and inner *colored membrane* (the sporostine and ectosporine respectively of Horn af Rantzein, 1959b, p. 197) and an outer and inner colorless membrane (the *endosporine* of Horn af Rantzien, 1959b, p. 197). Starch grains and oil droplets are stored inside the oospore.

The term *antheridium* is also used here as it is commonly applied in the Characeae to designate the globular body consisting of the covering of *shield cells,* enclosed sterile cells, and the *antheridial filaments* made up of the cells giving rise directly to the male gametes.

The terms *antheridium* and *oogonium* are considered inappropriately used in this way by some authors who restrict the use of the terms to the enclosed single cells which directly produce gametes. Unfortunately, the terms proposed to replace them usually have been applied in another connotation in the algae or higher plants or have become associated as synonymous with the terms which they are to replace and so are subject to the same inappropriateness and confusion.

Some authors also think that *oospore* should be confined to indicate the structure enclosed by membrances directly derived from the fertilized egg rather than include the complete membranous covering of the fruiting body including the outer colored membrane which may be derived from the spiral cells. *Oospore* is used in this paper to indicate the fruiting body enclosed by the outer colored membrane.

If considerable resistance is present toward the terms *oogonium* and *oospore,* as used commonly in the charophytes, perhaps they could be replaced by the following: *gyrogonium*- many-celled female reproductive organ in the charophytes (unfertilized or oospore producing, covered externally by the outer spiral cell walls; or if a lime-shell is produced and the outer integument disappears, the outer covering would be the lime-shell; or, in some instances, a utricle might be produced to partially or totally cover the exterior of the organ); *gyrospore*- a structure produced after fertilization of the egg, covered externally by the outer colored membrane. A term for this latter structure seems desirable since it is a natural unit, easily isolated in extant and some fossil charophytes. A valuable taxonomic tool is provided by its characteristics, some of which could be ascertained in sectioned fossil material and compared with isolates. If these terms were adopted, it is hoped that they be only defined in glossaries and not cited .n synonomy with other terms subject to confusion.

The derivation of the proposed terms is from Greek. *Gyrogonium* is from the combining forms *gyro,* spiral, referring to the covering of spiral cells or derivatives, and *gonium,* reproducing cell. *Gyrospore* comes from the combining forms *gyro* and *spora,* seed. These appellations are seen to have parts in common with the familiar, *gyrogonite,* used to designate fossil charophytic fructifications. It seems that *gyrogonium* and *gyrospore* might be suitable to indicate both extant and fossil structures; but if not, *gyrogonite* could be used to indicate a fossil *gyrogonium* and *gyrosporite* for a fossil *gyrospore.*

Text-figure 3F shows an oogonium of *Chara contraria.* It is covered by five *spiral cells* which spiral to the left around the organ producing the striae at their lateral walls and are topped by a crown of five cells called the *coronula.* The distal end of the oogonium and oospore is called the *apical pole* and the proximal is the *basal pole.* Measurements are taken of the widest part across fructifications and from the apex to the base along the longitudinal axis. The ends of the spiral cells as they approach the apex may be modified in various ways to produce useful systematic characteristics, and the width of the spirals at the basal pole is compared with the width at the equator. The typical configuration of the spiral cell ends at the apex of the oogonium of *Chara contraria* is seen in C and at the base in D, and the apex and base of the oospore are in G and H. In H, it can be seen that the *basal claws* are clasping the white calcified *basal plug* which is pentagonal in basal view. It is filling the depression outlined by the pentagonal base of the oospore. During maturation of the oospore in *Chara contraria,* lime is deposited within the spiral cells of the oogonium, so that a *lime-shell* (B) is formed covering the oospore. Some species do not produce a lime-shell. At the lateral junction of the spiral cell walls of the lime-shell in B, the low *intercellular ridges* are formed. At the periphery of the apical pole (B and C) of the lime-shell, a groove is formed by the decrease in width and thickness and increase in concavity of the spiral cells. They then expand to meet along an irregular line at the apex. At the basal pole of the lime-shell (D), the spirals meet at the pentagonal base. In *Chara contraria,* a pore is found at the center of the basal pole partly filled by the thin basal plug. Perforations in the spirals around the basal opening are also found in this species.

For structure, development and a glossary of terms for the charophytes, the work of Groves and Bullock-Webster (1920, p. 16-76) is recommended. Terms used here have been selected chiefly from that publication and Horn af Rantzien (1956, p. 212-259).

NATURE OF FOSSIL CHAROPHYTE REMAINS

Lime-shells (mature and immature), oospores and calcareous stem and branchlet fragments were preserved. In some genera of fossil charophytes, a covering is developed over the lime-shell, called the *utricle,* but none were found in the specimens reported here. Coronulas were not preserved and so not found in any of these specimens, either. Lime-shells were, for the most part, easily cleaned of debris with needles and brush, but a few were split and delicate requiring a minimum of handling. Bits of outer spiral cell wall or *integument* were occasionally found adhering. In one instance, (*Obtusochara cylindrica*) an immature lime-shell was particulate in nature and organic remains of the spiral cells were still pliable and could be unwound to produce the five spiral units.

Many oospores were found, some divested of lime-shells or partly so, and some were isolated from the lime-shells when ample material was available. The oospores appeared to have only the outer and inner colored membranes preserved, but although the contents had disappeared, they retained their original shape with only small areas collapsed for the most part. Slight mineral deposits were found in some.

The vegetative material was fragmentary and difficult to examine because of mineral deposits on the exterior of the stems, particularly.

ACKNOWLEDGEMENTS

The author is grateful for: the encouragement given by W. A. Daily; the samples, geological interpretations and ecological data based on mollusks provided by W. J. Wayne; the grant to help finance the photography given by the A.A.A.S. through the Indiana Academy of Science Research Foundation Committee; slides for the paper presented at a meeting of the American Institute for Biological Sciences provided by Eli Lilly and Company; copies of the photographs providing negatives by Eli Lilly and Company; photocopies of several articles supplied by Eli Lilly and Company and Indiana University; and the aid in making inter-library loans by the Butler University Library.

SYSTEMATIC SECTION

Considerable difference of opinion has been expressed about classification of isolated fossil organs assigned to the charophytes. Proponents of strict adherence to referring all isolated fossil fruiting bodies to artificial taxa within this division, readily refer these structures, however, to the charophytes, even though major divisions in the algae are differentiated, primarily, on the basis of pigments. The above classification is obviously based on morphology of a plant part. It seems logical, then, to extend this policy to lower taxa, too. Therefore, the unattached fossil charophyte organs reported here are referred to taxa for extant charophytes when the morphological characteristics preserved are similar, and to organ species and genera when similar unattached organs are known only from the fossil record.

KEY

The following key to the genera of charophytes is based on characteristics of the lime-shell; all lack a utricle and have 5 (4-6) spiral cells:

Apical pole bearing a cylindrical projection (neck) formed by upturned ends of spiral cells surrounding a small opening at apex.
  Groove absent at apical periphery .... 1. *Clavatorites*
Apical pole ± conical, subtruncate or rounded to protruding Groove at the periphery of the apical pole
  Spirals wider at base than at equator .... 2. *Charites*
  Spirals more or less the same width at base as at equator .... 3. *Chara*
Apical pole broadly truncate
  Groove at periphery of apical pole, conical projection at apical center......................... 4. *Latochara*
    Groove absent at periphery of apical pole. Prominence or depression absent at apical center .... 5. *Obtusochara*
Apical pole bearing a rosette or apical cap formed by the marked expansion of spiral cell ends. Groove at apical periphery
    Spirals form indistinct depressions in apical periphery .... 6. *Maedlerisphaera*
    Spirals lack depressions in apical periphery... 7. *Grambastichara*

In addition to those charophytes keyed, one oospore is referred to the genus *Tolypella* and all vegetative remains are classified as *Charaxis*.

DESCRIPTIONS

Division CHLOROPHYTA
Class CHAROPHYCEAE
Order CHARALES
Family CLAVATORACEAE

1. Organ-genus CLAVATORITES Horn af Rantzien, 1954

Clavatorires noblensis Daily, new species

Lime-shell without utricle and developed by 5 spiral cells, 827 μ long (neck included which is 175 μ long) 470 μ broad, ellipsoid-elongate, tapering at the summit to form a neck, narrowly truncate at the base, 13 inconspicuous ridges in lateral view. Lime-spirals 5, thin, nearly flat except at base and apex where they are somewhat concave, not forming a groove at the apical periphery, turning upward at the summit to form a cylindrical projection (neck) with little change in diameter, meeting at the apical center around a narrow opening, turning out to form a small, 5-lobed lip, widening at the base to meet at a large pentagonal depression which is outlined by black organic remains presumably extending from the base of the oospore through the lime-shell. Surface of the lime-shell yellowish-white, smooth, glossy and punctate in reflected light.

Oospore dark brown, dull, ellipsoid-elongate, 745 μ long, 450 μ wide, tapering to base and apex, apex conical and protruding, base narrowly truncate, 11 prominent ridges in lateral view. Spirals approach base and apex with little change in diameter, turn upward at apical center to meet around a small opening. This description is based upon some unique oospores broken from their lime-shells, which because of their shape, size, strong ridges, apical opening and association in the same collection as well as the unique apical structure are tenatively assigned to this species until more oogonia of *Clavatorites noblensis* can be found in order to isolate oospores substantiating or refuting this assumption.

This species differs from *Clavatorites höllvicensis* Horn af Rantzien (1954, p. 48), to which it seems most closely related, chiefly in having a long neck at the apical center and its larger size. The neck and spiral endings at the summit are similar to *Clavator harrisi* Peck (1941, p. 292), but it differs from that species in several respects, particularly, in lacking a utricle. In lateral view, it is somewhat similar to some species assigned to *Stellatochara* by Horn af Rantzien (1954, p. 26), but does not have a stellate apical opening, is more elongate, and has a longer, narrower neck.

Specimens Seen: *Illustrated* oospore (Plate 5, fig. 12, right), Slide 4-4, oospore (Plate 5, fig 14), Slide 4-4, Noble Co., Ind.; oogonium (HOLOTYPE), (Plate 5, figs. 15-17), Slide 4-1, Noble Co., Ind. *Not Illustrated:* 5 oospores, Slide 4-4, Noble Co., Ind. (Slide 1-1, etc. = serological plate 1, well 1, etc.)

Family CHARACEAE

2. Organ-genus CHARITES Horn af Rantzien, 1959 a

Charires bitruncata (Reid and Groves) Horn af Rantzien

Chara strobilocarpa var. *bitruncata* REID and GROVES, 1921, Quart. Jour. Geol. Soc. of London, pt. 3, no. 307, p. 188, pl. V, fig. 13.

Charites bitruncata (Reid and Groves) HORN AF RANTZIEN, 1959 a, Acta Univ. Stockholm., Stockholm Contrib. in Geol., vol. 4, no. 2, p. 67, pl. III, figs. 1-4.

Lime-shell without utricle and developed by 5 spiral cells, ellipsoidal, apical pole rounded to subtruncate, base rounded to slightly protruding, showing 11-12 prominent intercellular ridges in lateral view, 720-750 μ long, 500-535 μ wide. Spirals concave, narrowed at the apical periphery, then widened again before meeting in a zigzag line at the apex. Spirals widening at the basal pole before they meet at the pentagonal base which is 88 μ broad.

Oospore ellipsoid-elongate, tapered to base and summit, 635-685 μ long, (including the peak which is 30 μ long and the basal claws which are 50 μ long), 350-385 μ wide, brown (probably immature) to shiny black, showing 11 striae in lateral view. Spirals slightly concave, narrow in apical periphery then widen on the apical pole to meet at the apical center in a peak, widen somewhat approaching base. Surface punctate in reflected light. Basal plug pentagonal in basal view (Plate V, fig. 7) 105 μ across the base, 125 μ across the top, and 50 μ thick (Plate 4, fig. 5), apparently convex and thinner at center based on study with transmitted light.

This oospore differs from that of *Chara globularis* Thuill. which it superficially resembles, in its strong peak at the summit, larger angle of the spirals at the equator, strongly tapering summit and base, widening of spirals as they approach the base, and the size.

Previous Occurrence. Lower Headon Beds, Hordle (Hordwell) Cliffs (South Hampshire), England. Upper Bartonian, Eocene.

Specimens Seen: *Illustrated:* Oospore (Plate 2, fig. 9), Slide 1-6, 1.1-2.1 ft. level of core, Erie Co., N. Y., oogonium and oospore isolated from it. (Plate 4, figs. 4-7), Slide 2-2, oogonium, (Plate 4, figs. 14-16), Slide 2-10, 0-1.1 ft level of core, Erie Co., N. Y., oospore (Plate 5, figs. 7-9). Slide 5-2, LaGrange Co., Ind. *Not Illustrated* 10 oospores, Slide 5-7, 12 oospores, Slide 5-8, 0-1.1 ft. level of core, Erie Co., N. Y., oospore, Slide 3A-1, 2 oospores, Slide 3A-2, 5 oospores, Slide 3A-4, 2.1-2.9 ft. level of core, Erie Co., N. Y.; ca. 30 oospores, Slide 4-2, ca. 30 oospores, Slide 4-3 & 4, Noble Co., Ind.

Charites strobilocarpa (Reid and Groves) Horn af Rantzien

Chara strobilocarpa REID and GROVES, 1921, Quart. Jour. Geol. Soc. of London, vol. 77, pt. 3, no. 307, p. 187, pl. V, figs. 7-8.

Charites strobilocarpa (Reid and Groves) HORN AF RANTZIEN 1959 a, Acta Univ. Stockholm., Stockholm Contrib. in Geol., vol. 4, no. 2, p. 61, pl. II, figs. 4-8.

Lime-shell without utricle and developed by 5 spiral cells, elongate-ellipsoidal, 870 μ long, 500 μ wide, apical pole and base protruding and subtruncate. Lime spirals very concave, showing 11 prominent intercellular ridges in lateral view, 75 μ in diameter at the equator of the oogonium, becoming 145 μ wide near the apical center and base, narrowing at the apical periphery before widening and turning onto the apical pole, meeting at the apical center along a short line, producing very prominent intercellular ridges at the base where they meet at the pentagonal depression which is 75 μ in diameter. Lime-shell 55 μ thick at equator, creamy white, surface glossy and punctate in reflected light.

Oospore black, glossy, 750-800 μ long, 370-420 μ wide (including peak and cage), elongate-ellipsoid, tapering somewhat to base and apex. Apex narrowly truncate with spirals upturned. Base producing a cage, 135 μ long, containing a calcareous plug, 135 μ across the top and 110 μ across the bottom and 70 μ thick. Spirals forming a peak 105 μ long at the apex, narrowing at the periphery of the apical pole, widening as they turn upward to meet at a point on the summit. Surface of oospore punctate in reflected light.

Previous Occurrence. "Limestone band", Lower Headon Beds, Hordle (Hordwell) Cliffs (South Hampshire), England, Upper Bartonian, Eocene.

Specimens Seen: *Illustrated* oogonium, (Plate 1, figs. 7-9), and oospore isolated from it (Plate 1, figs. 4-6), Slide 3-2, 2.1-2.9 ft. level of core, Erie Co., N. Y., oospore, (Plate 5, fig. 13), Slide 4-4, Noble Co., Ind. *Not Illustrated:* 3 oogonia and 2 oospores, Slide 5-7, oogonium, Slide 2A-3, 0-1.1 ft. level of core, Erie Co., N. Y., oospore in each of Slide 3-8, Slide 3A-1, Slide 3A-2 and Slide 3A-4, 1 oogonium, Slide 3A-3, 2.1-2.9 ft. level of core, Erie Co., N. Y.; 15 oospores, Slide 4-2 to 4, Noble Co., Ind

Charites strobilocarpa var. **ellipsoidea** (Reid and Groves) Daily, new combination

Chara strobilocarpa var. *ellipsoidea* REID and GROVES, 1921, Quart. Jour. Geol. Soc. of London, vol. 77, pt. 3, no. 307, p. 188, pl. V, fig. 10.

Dr. Horn af Rantzien examined specimens of *Chara strobilocarpa* and *Chara strobilocarpa* var. *bitruncata* when these were transferred to the Genus *Charites*. However, he (1959 a, p. 63) states, "No specimens have been examined and neither from the description nor from the illustration (Reid and Groves, op. cit., pl. V, fig. 10) can it be decided whether the var. *ellipsoidea* is conspecific with *C. strobilocarpa* or not."

Since the specimens reported here seem to fit the illustration and description of *Chara strobilocarpa* var. *ellipsoidea* very well, were found associated with *(Chara) Charites strobilocarpa* and appear to be conspecific with it, it seems desirable to retain this variety. Since *Chara strobilocarpa* has been transferred to *Charites,* it is necessary to make a new combination for the var. *ellipsoidea.* In the absence of typification, Plate V, fig. 10, (Reid and Groves, op. cit.), is designated as the lectotype.

Their description is interpreted to establish the variety as differing from the type chiefly by the oogonium being somewhat tapered at both ends, slightly more below than above or ellipsoid as the name and illustration indicate, rather than protruding at the base and summit as is typical.

Lime-shell without utricle, developed by 5 (4-6) spiral cells, elongate-ellipsoid, slightly pointed at base and apex or base slightly truncate, 620-785 μ in length (including slight peak) 450-500 μ in width, 11-12 ridges in lateral view (variant, 4-spiralled oogonium 620 μ long, 450 μ wide having 9 ridges in lateral view). Spirals not quite as strongly concave as in type (only slightly concave in 4-spiralled oogonium), narrowing slightly at summit periphery and then widening considerably before meeting on the apical pole along a short line, widening also at the basal pole before meeting at the pentagonal (4-6-sided) base which is 120 μ wide (70 μ in 4-spiralled oogonium). Ridges prominent at base and summit. Lime-shell thin, smooth, off-white, glossy, surface punctate in reflected light.

Oospore dark brown (almost black), elongate-ellipsoid, tapering slightly at apex to a short peak similar to, but shorter than the type, base narrowly truncate with prominent ridges extending to form short claws, less than 620-735 μ long (including peak), 350-370 μ wide, 12 striae in lateral view. Spirals narrow at the apical periphery, widen before turning upward to form peak, widen somewhat before meeting at pentagonal (4-6-sided) base. Membrane punctate in reflected light.

Previous Occurrence. "Limestone band." Lower Headon Beds, Hordle (Hordwell) Cliffs (South Hampshire), England, Upper Bartonian, Eocene.

Specimens Seen. *Illustrated* Variant, 4-spiralled oospore, (Plate 1, figs. 15-17), Slide 3-9, 2.1-2.9 ft. level of core, Erie Co., N. Y.; variant, 4-spiralled oogonium, (Plate 3, figs. 1-3), lost, 5-spiralled oogonium (Plate 3, figs. 10-12), Slide 1-4, a variant 6-spiralled oogonium, (Plate 3, figs. 16-18, Slide 1-1, 1.1-2.1 ft. level of core, Erie Co., N. Y., 5-spiralled oogonium, (Plate 4, figs. 17-19), Slide 2A-1, 0-1.1 ft. level of core, Erie Co., N. Y.; oospore (Plate 5, fig. 12 on left, Slide 4-4, Noble Co., Ind. *Not Illustrated*: 15 oospores, Slide 1A-1, and oospore isolated from an oogonium, Slide 1A-6, 10 oogonia, Slide 1-7, 1.1-2.1 ft level of core, Erie Co., N. Y.; 6 oospores, Slide 3A-4, 5 oospores, Slide 3A-5, 2.1-2.9 ft. level of core, Erie Co., N. Y.; 30 oospores and an oogonium, Slide 4-3 & 4, Noble Co., Ind.

3. Genus CHARA Linnaeus, 1753

Chara evoluta T. F. Allen

Chara evoluta T. F. ALLEN, 1882, Torrey Bot. Club, Bull., vol. 9, no. 4, p. 41, pl. 19.

Lime-shells absent.

Oospore ellipsoid-oblate, apex and base broadly rounded or only slightly tapering, 10 inconspicuous striae in lateral view, 460-650 μ long, 300-405 μ wide, dark brown, dull, surface punctate in reflected light. Spirals narrow slightly in apical periphery, then widen to meet along a short line at apical center, little change in width at basal pole where they meet at a pentagonal depression 88 μ in diameter. Outer colored membrane brown, granulate in transmitted light.

Previous Occurrence. Although a somewhat similar brackish water species, *Chara canescens*, has been found in the fossil state, the brackish and fresh-water *Chara evoluta* apparently has been known only from recent collections, exclusively, and is found in widely scattered areas in North America. The type locality is Saskatchewan, Alberta, Canada, in lakes and ponds. It has also been reported from ponds and lakes in Nebraska (Daily, 1944, p. 158), from Little Compton, Rhode Island by Wood (1949, p. 197), and from lakes and ponds in British Columbia (Allen, 1951, p. 151). It has also been found in mineral springs at 7000 ft. elevation in Colorado (collector unknown).

Specimens Seen: *Illustrated* Oospore (Plate 1, figs. 22-24), Slide 3-4, oospore (Plate 1, figs. 28-30), Slide 3-1, 2.1-2.9 ft level of core, Erie Co., N. Y.; oospore (Plate 2, figs. 26-28), Slide 1A-4, 1.1-2.1 ft. level of core, Erie Co., N. Y., oospore, (Plate 5, figs. 4-6 and outer colored membrane, Plate 5, fig. 10), Steuben Co., Ind. *Not Illustrated*: Oospore, Slide 2-8, 0-1.1 ft. level of core, Erie Co., N. Y.; 25 oospores, Slide 6-2, Steuben Co. Ind., 12 oospores, Slide 4-4, Noble Co., Ind.

Chara contraria Braun ex Kützing

Chara contraria BRAUN ex KÜTZING, 1845, Phyc. Germ., p. 258.

Lime-shell without utricle, developed by 5 spiral cells, ellipsoid-prolate, top broken so complete fossil unknown, base narrowly truncate and protruding. Spirals slightly concave, almost flat, ridges moderately prominent, strongly developed at the pentagonal base which is 85 μ in diameter. Lime-shell grayish-white, surface punctate in reflected light.

Oospore sooty brown, surface punctate in reflected light, ellipsoid-prolate, 12-14 prominent striae in lateral view, base narrowly truncate and protruding, summit protruding, ca. 650 μ long, 320 μ wide. Spirals narrow at the periphery of the summit then expand to meet at the apex in a short irregular line, turn onto the basal region without much change in width and meet at a small pentagonal depression. The basal plug is retained in the basal depression in the view shown in Plate 1, fig. 20, but is removed in Plate 1, fig. 21.

Previous Occurrence. This species has been reported from the Quaternary of Europe several times, but this is the first fossil record for North America as far as is known. A recent species, it grows in a rather wide range of habitats, but is conspicuous as the early inhabitant of gravel pit ponds in Indiana, and elsewhere. It has been reported several times for New York (Wood & Muenscher, 1956, p. 36) and Indiana (Daily, 1953, p. 43).

Specimens Seen: *Illustrated:* broken oogonium showing top of oospore, (Plate 1, figs. 11-13), and oospore isolated from it, (Plate 1, figs. 19-21), Slide 3-3, oospore, (Plate 2, figs. 6-8), Slide 3-7, 2.1-2.9 ft. level of core, Erie Co., N. Y. *Not Illustrated:* 3 oospores, Slide 5-6, 0-1.1 ft. level of core, Erie Co., N. Y.; 16 oospores, Slide 3A-1, 11 oospores, Slide 3A-2, 20 oospores, Slide 3A-4, 45 oospores, Slide 3A-5, 2.1-2.9 ft. level, Erie Co., N. Y.

Chara sejuncta Braun

Chara sejuncta BRAUN, 1845, Boston Jour. Nat. Hist., vol. 5, p. 264.

Lime-shell without utricle and developed by 5 spirals, prolate-ellipsoid, or subovoidal, 750-785 μ long, 450-500 μ wide, 12 or 13 inconspicuous striae in lateral view, summit slightly protruding and broadly rounded, base protruding and truncate. Lime spirals thin, slightly concave, narrow in apical periphery, then expand to meet along a short line at the apex, approach the base without much change in diameter until the ends, which narrow and project slightly around the pentagonal depression at the base. Base 75 μ in diameter. Immature lime-shell thin, rough, dull (Plate 5, figs. 18-20). Mature lime-shell smooth, glossy, off-white, punctate in reflected light (Plate 3, figs. 19-21).

Oospore dull, dark brown, ellipsoid-elongate, apical pole and base protruding and narrowly truncate, 685 μ long, 350 μ wide, 12 striae in lateral view which are inconspicuous except at summit where they form a crest and at the base where they form claws. Spirals narrow in apical periphery where a groove is formed, expand to meet along a short line at apex, not much wider at the pentagonal depression at the base which is 90 μ in diameter. Basal plug thin (Plate 4, fig. 3). Surface of oospore punctate in reflected light.

Previous Occurrence. Apparently the only fossil record of this species is by Horn af Rantzien (1951, p. 666) as follows: "Pleistocene, at the eastern end of Lake Tacarigua (= L. Maracay), northern Venezuela. – –" The type locality of this recent species is in lakes in the lowlands of the Mississippi, Illinois, opposite St. Louis, Missouri. Robinson (1906, p. 297) gives the distribution as, "Massachusetts and Alabama to Minnesota and Mexico; also reported from South America." Horn af Rantzien (1950, p. 398) gives the distribution for Latin America as: Mexico, West Indies, and in South America–Brazil, Colombia, and Bolivia. It has been reported by Prescott (1951, p. 340) for Wisconsin and by Wood and Muenscher (1956, p. 36) for New York. In Daily (1953, p. 43-44), it can be seen that this species has been collected in many types of habitats in Indiana including ponds (artificial, sink-hole, seepage, stream fed), rivers, lakes of glacial origin with collected mud or muck on the bottom (stream fed), and strip mine ponds. The chief factors in common, though, seemed to be the mud, muck or ooze bottom of the body of water, and that the species is more abundant in southern localities, although it is occasionally found in the northern part of the state.

Specimens Seen: *Illustrated:* Oogonium (Plate 3, figs. 19-21) and the oospore isolated from it (Plate 4, figs. 1-3), Slide 1-10, 1.1-2.1 ft. level of core, Erie Co., N. Y.; immature oogonium, (Plate 5, figs. 18-20), Slide 6-1, Franklin Co., Ind. *Not Illustrated:* 5 oospores, Slide 1A-2, 1.1-2.1 ft. level of core, Erie Co., N. Y.; 11 oospores, Slide 5-1, LaGrange Co., Ind.; crushed oospores and broken oogonia, Slide 6-1 and Slide 7, Franklin Co., Ind.; 5 oospores, Slide 5-8, 0-1.1 ft. level of core, Erie Co., N. Y.

4. Organ-genus LATOCHARA Mädler, 1955

Latochara Waynei Daily, new species

Lime-shell without utricle and developed by 5 spirals, 785-820 μ long (including peak), 500-550 μ wide, with 10-11 ridges in lateral view which are prominent and decorated with small projections, spheroidal or ovoid, basal pole rounded or somewhat tapering to the narrowly truncate base, summit broadly truncate with a conical projection or peak. Spirals usually decorated with small to large, rounded, low projections. Spirals slightly to moderately concave, narrow and more concave at the periphery of the summit, somewhat wider as they turn upward to form the conical projection at the apical center, narrowing gradually to a point at the apex where they surround a small opening. Some apical spiral ends are distorted to form a scroll (Plate 2, fig. 11) or are separated to form points. Spirals approach the base with little change in width where they meet at a pentagonal depression about 80 μ wide. Lime-shell surface moderately glossy, off-white.

Oospore 585-750 μ long, 370-420 μ wide, with 11 prominent ridges in lateral view, black, glossy, ovoid, rounded at base, truncate at summit which has a prominent peak (peak included in measurement of length). Spirals separated by very prominent ridges at summit, slightly concave, more concave in apical periphery where they narrow then widen to turn upward tapering to a point at the apex forming the peak, approach the pentagonal base (110 μ wide) with little change in width, outer colored membrane punctate in transmitted light (Plate 2, fig. 23 inset).

This species probably resembles *Latochara latitruncata* in shape more than any other species of the genus, but is larger and has decorated spirals of the lime-shell and the intercellular ridges are decorated. It is similar to *Latochara collina* in having decorated ridges, but differs in size, number of ridges and particularly in having the spirals also decorated, although decoration in *Latochara Waynei* is sometimes slight and variable in different parts of the same specimen.

Specimens Seen: *Illustrated:* oogonium, (Plate 2, figs. 11-13), (HOLOTYPE), Slide 1-5, oogonium, (Plate 2, figs. 20-22), oospore isolated from oogonium just cited (Plate 2, figs. 23-25) sacrificed for membrane illustrated (Plate 2, fig. 23 inset), Slide 7M, 1.1-2.1 ft. level of core, Erie Co., N. Y.; oogonium, (Plate 4, figs. 8-10), sacrificed for the oospore (not shown) Slide 2-3, 0-1.1 ft. level of core, Erie Co., N. Y. *Not Illustrated:* 3 oogonia, Slide 1-7, 3 oogonia, Slide 1-8, 1.1-2.1 ft. level of core, Erie Co., N. Y.; oogonium, Slide 2-7, broken oogonium, Slide 2A-4, 2 oogonia, Slide 5-7, 2 oogonia, Slide 5-8, 0-1.1 ft. level of core, Erie Co., N. Y.

Latochara latitruncata (Peck) Mädler

Aclistochara latitruncata PECK, 1937, Jour. Pal., vol. 11, p. 89, pl. 14, figs. 1-4.

Latochara latitruncata (Peck) MÄDLER, 1955, Geol. Jahrb., vol. 70, p. 271.

Lime-shell without utricle and developed by 5 spirals, slightly prolate spheroidal to top-shaped with broadly truncate apical pole which forms a low conical peak at the center, rounded to narrowly truncate at the base, 420-585 μ long (including peak, 335-420 μ wide, 9-11 striae—inconspicuous to prominent in lateral view. Spirals slightly convex or concave, concave in apical periphery where they are easily broken; turning upward on the summit to form a low, conical peak; widen as they turn upward, then narrow to a point at a small apical opening; meeting at the irregularly pentagonal base which is 80 μ in diameter without flanges or raised border. Lime-shell glossy, yellowish-gray, surface punctate in reflected light.

Oospore black, glossy, ovoidal, with a peak at the summit and truncate at the base, 370 μ long, 285 μ wide, with 9 low, intercellular ridges. Spirals narrow at apical periphery, then widen and turn upward narrowing again to a point forming a short peak, meet with little change in width at the basal depression.

Previous Occurrence. (From Peck, 1957, p. 33) "Brushy Basin shale member of the Morrison in east-central Utah (USGS paleobotanical locality D290) and in the undivided Morrison of central and eastern Wyoming and central Montana." Ross (1960, p. 720) reports this species from the Morrison of Colorado. All of these occurrences are Upper Jurassic, Mesozoic.

Specimens Seen: *Illustrated:* oogonium, (Plate 5, figs. 24-26), Slide 6-1, Franklin Co., Ind. *Not Illustrated:* 2 oogonia, (broken but identifiable), 2 oospores, Slide 6-1, Franklin Co., Ind.

Latochara spherica Peck

Latochara spherica PECK, 1957, U. S. Geol. Survey Prof. paper 294-A, p. 33, pl. 5, figs. 34-36.

Lime-shell without utricle and developed by 5 spirals, spheroidal, narrowly truncate summit area bearing a low conical peak, basal pole rounded but having a slightly truncate protrusion at the pentagonal base, 585-665 μ long (peak included, 501-535 μ wide, 10 or 11 prominent ridges (inclusion of short ridges at base and apex results in a larger number than is sometimes stated by other authors). Spirals concave, slightly more concave in apical periphery, then widen slightly as they turn upward to meet around an opening at the apex, widen somewhat in the basal region as they meet around the pentagonal base 70 μ in diameter having a raised border. Lime-shell glossy (illustrated specimen with debris adhering), gray or yellowish-gray.

Oospore black, glossy, ovoidal, with a peak at the apex, rounded at base, 500 μ long, 365 μ wide, 10 ridges in lateral view. Spirals narrow at the apical periphery widen and turn upward narrowing again to form a short peak at the apical center, meet with little change in width at basal pentagonal depression.

Previous Occurrence. (From Peck, 1957, p. 33) "Salt Wash member of the Morrison formation at Church Rock locality (USGS paleobotanical locality D289), San Juan County, Utah. Poorly preserved specimens that probably belong to this species were collected from the Morrison on the southern flank of the Maverick Springs anticline, Fremont County, Wyo."
Specimens Seen: *Illustrated* oogonium (Plate 5, figs. 21-23), Slide 6-1, Franklin Co., Ind. *Not Illustrated:* oogonium and 2 oospores, Slide 6-1, Franklin Co., Ind.

5. Organ-genus OBTUSOCHARA Mädler, 1952

Obtusochara cylindrica Peck

Aclistochara cylindrica PECK, 1941, Jour. Pal., vol. 15, p. 291, pl. 42, figs. 38, 39, 41-44.

Obtusochara cylindrica PECK, 1957, U. S. Geol. Survey Prof. paper 294-A, p. 38, pl. 6, figs. 1-4.

Lime-shell without utricle and developed by 5 (4) spirals, obovoidal with flattened summit and protruding base, 8 intercellular ridges in lateral view, 700 μ long, 450-500 μ wide. Spirals narrow very little without a groove in the apical periphery, widen slightly as they turn onto the apical pole, meet at the apical center along a short line, approach the base with little change in width, slightly convex to slightly concave in the equatorial region, but more concave with intercellular ridges protruding at the basal depression which is 70 μ wide. Lime-shell well developed, glossy, off-white, surface punctate in one specimen (Plate 3, fig. 13). Another specimen (Plate 2, fig. 14) possessed an immature lime-shell, particulate in nature, which disintegrated when wet, allowing the organic remains of the 5 spiral cells to unwind as they were still pliable. The oospore described below was thus isolated.

Oospore dark brown, slightly obovoid, showing 8 ridges in lateral view, 570 μ long, 365 μ wide. Spirals decrease in width and are slightly concave forming a groove in the apical periphery, widen slightly as they approach the summit where they meet at a short line at the apical center, decrease slightly in width approaching the pentagonal base which is 70 μ in diameter. Surface glossy and punctate in reflected light.

In the legend for the original illustration of this species by Peck (op. cit.) as *Aclistochara cylindrica,* it is mentioned that the specimen, demonstrating seven intercellular ridges in lateral view, has only 4 spirals which is the same number demonstrated by one specimen in this report.

Previous Occurrence. (From Peck, 1957, p. 38) "Draney limestone and lower Bear River (Aptian) localities." The Bear River formation is in Wyoming, North America and the Draney limestone is in Idaho, North America, both from the Lower Cretaceous.
Specimens Seen: *Illustrated:* 5-spiralled oogonium (Plate 2, figs. 14-16) from which the oospore (Plate 2, figs. 17-19) was isolated, Slide 1-2, 4-spiralled oogonium (Plate 3, figs. 13-15), Slide 1-9, 1.1-2.1 ft. level of core, Erie Co., N. Y.

6. Organ-genus MAEDLERISPHAERA Horn af Rantzien, 1959 a

Maedlerisphaera ulmensis (Straub) Horn af Rantzien

Chara ulmensis STRAUB, 1952, Geol. Jahrb., vol. 66, p. 470, Taf. A, fig. 19.

Maedlerisphaera ulmensis (Straub) HORN AF RANTZIEN, 1959 a, Acta Univ. Stockholm., Stockholm Contrib. in Geol., vol. 4, no. 2, p. 100, pl. X, figs. 1-12.

Lime-shell without utricle and developed by 5 spirals, broadly ellipsoid (immature), with base and apex protruding, 560 μ long, 350 μ wide, 11 broad ridges in lateral view. Spirals slightly concave, narrowing slightly with some more concave and others less (forming depressions) at the apical periphery, widening to form a rosette with the spiral tips distinct, approaching the pentagonal base with little change in width, pentagonal base 50 μ wide. Lime-shell dull and particulate in nature.

This seems to fit the description of immature *Maedlerisphaera ulmensis,* except it is narrower which could indicate greater immaturity.

Previous Occurrence. (From Horn af Rantzien, 1959 a, p. 100) "Type locality. ——— Between Ehingen and Ulm a. d. Donau, Wüttemberg-Hohenzollern, Germany. Type Stratum. ——— Opfinger Schichten, Lower Freshwater Molasse, Oligocene. Stratigraphic Distribution. ——— Oligocene (Middle Stampian upwards) sparsely up into the Miocene (Tortonian) (Mädler, 1955 b). Horizontal Distribution. ——— Southern Germany, Switzerland."

Specimens Seen: *Illustrated:* oogonium (Plate 5, figs. 1-3) Slide 6-2, Steuben Co., Ind. *Not Illustrated:* 3 oogonia (top broken), Slide 6-2, Steuben Co., Ind.

7. Organ-genus GRAMBASTICHARA Horn af Rantzien, 1959 a

Grambastichara cylindrica (Mädler) Horn af Rantzien

Tectochara cylindrica MÄDLER, 1955, Geol. Jahrb., vol. 70, p. 295, Taf. 26, figs. 13-18.

Grambastichara cylindrica (Mädler) HORN AF RANTZIEN, 1959 a, Acta Univ. Stockholm., Stockholm Contrib. in Geol., vol. 4, no. 2, p. 74, pl. IV, figs. 7-11, pl. V, figs. 1-3.

Lime-shell without utricle and developed by 5 spirals, ellipsoid-elongate, with 12 distinct ridges in lateral view, summit rounded to truncate and protruding, basal pole protruding and truncate, 685-750 μ long, 400 μ wide. Spirals thick, slightly convex to slightly concave, very narrow and thin in the apical periphery where they are easily broken, without depressions in the apical periphery, widen considerably on the summit and thicken at the tips to form a rosette, meet at a very short line at the apex, widen considerably approaching the pentagonal base which is 50 μ in diameter. Lime-shell dull, punctate in reflected light, off-white or light brown.

Oospore black, dull, 500-585 μ long, 285-335 μ wide, 12 distinct ridges in lateral view, base narrowly truncate, summit broadly rounded to truncate. Spirals narrow and concave in the apical periphery, widen considerably on summit, meet at apex along a short line, widen considerably as they approach the small pentagonal base which is 50 μ wide. Surface punctate in reflected light.

Previous Occurrence. The material reported here seems to resemble an immature specimen with fluted protruding apical pole and a more mature specimen with rounded apical pole reported by Mädler (op. cit., Plate 26, fig. 17 and fig. 13 respectively—the immature specimen is slightly more developed than in fig. 17, but not quite as mature as in fig. 16) as *Tectochara cylindrica* from the Oligocene. In Southern Germany, this species was found in the Aquatanian, while in Switzerland, it came from the middle Stampian, Mädler mentions the similarity to this species of *Chara subcylindrica* from the upper Eocene, Lower Headon Beds, England. Horn af Rantzien (op. cit.) transferred *Chara subcylindrica* to *Granbastichara subcylindrica* as a new combination, but was uncertain that this species should be separate from *G. cylindrica*.

Specimens Seen: *Illustrated* oospore (Plate 1, figs. 1-3), Slide 3-6, 2.1-2.9 ft. level of core, Erie Co. N. Y., oogonium (Plate 3, figs. 4-6) sacrificed, oogonium (Plate 3, figs. 7-9) Slide 1A-5, 1.1-2.1 ft. level of core, Erie Co , N. Y. *Not Illustrated:* oogonium, Slide 1-3, 3 oogonia and an oospore (isolate), Slide 1-7, 1.1-2.1 ft. level of core, Erie Co. N. Y.

Genus TOLYPELLA von Leonhardi, 1863

Tolypella sp.

Oospore terete (with one side damaged), spheroidal with broadly rounded poles, 385 μ long, 365 μ wide (because of damage, this is slightly greater than actual size), 10 prominent ridges. Spirals narrow, narrowing only slightly at apical periphery, widening slightly before narrowing to meet at a point at the apical center, width varies little along the whole length of the spirals except where they taper at the apical ends, appear grooved at the apex because the prominent ridges cast shadows, meet at the pentagonal base 80 μ in diameter. The outer colored membrane dark brown, opaque and minutely punctate in reflected light. The nature of the outer colored membrane in transmitted light, outer spiral elements (with or without calcification), coronula, and exact size and shape (damaged) are unknown. Therefore, it seems desirable to refer this specimen without species designation to the genus *Tolypella,* although it is probably *Tolypella prolifera.*

Previous Occurrence. (From Horn af Rautzien. 1959 b, p. 213) "The first gyrogonites referred to *Tolypella* were from the Lower Headon Beds of England (Reid and Groves, 1921). These beds are referred to the Upper Bartonian (uppermost Eocene). Groves (1926, p. 173) referred a species from the Lattorfian (Oligocene) Bembridge Beds of England (see Gignoux, op. cit.) to this genus. Mädler (1952, pp. 30-36) referred four Kimmeridgian (Upper Jurassic) gyrogonite species from Germany to *Tolypella;* he also noticed that certain gyrogonites described from the Bartonian (Eocene) of the Paris Basin and from the Morrison Formation (Upper Jurassic) of the Rocky Mountains should preferably be included. The same author (1955, pp. 307-308) described and discussed two gyrogonite species of *Tolypella,* from the Chattian (Oligocene) and Tortonian (Miocene) of southern Germany and Switzerland."

This is a recent genus and the species *Tolypella prolifera,* to which it seems the oospore reported here is most closely allied, has been reported for Canada and New York among many records. It comes from Lake Huron and Lake Ontario as well as other lakes and ponds primarily, as well as from a river pond and roadside ditch.

Specimen Seen: *Illustrated:* oospore (Plate 1, figs. 25-27), Slide 3-5, 2.1-2.9 ft. level of core, Erie Co., N. Y.

VEGETATIVE REMAINS

Organ-genus CHARAXIS Harris, 1939

Charaxis sp.

All vegetative material found was so fragmentary that reconstruction of the plant would be very difficult. There were broken nodal and internodal sections of stems and branchlets with the critical characteristics discernible similar to modern charophytes. All such material is referred to *Charaxis* sp. Harris (1939, p. 67).

Plate 1, fig. 10, see following paragraph.

Plate 1, fig. 14, shows a surface view of a stem internode with the bases of broken spine cells in a cluster appearing as dots in the lower left part of the figure particularly and scattered elsewhere. A cross sectional view of the same stem shown in Plate 1, fig. 10 is 535 μ in diameter. The lumen of the larger cortex cells is 65 μ in diameter, of smaller cells 50 μ. A cross section across the bases of three spine cells in a cluster is seen at the upper edge of the stem section. There are 11 cortical cells surrounding the central cylinder. *Illustrated Specimen:* stem fragment, Box 1, 2.1-2.9 ft. level of Core 3, Erie Co., N. Y.

Plate 1, fig. 18, shows a broken corticated branchlet internode 250 μ in diameter. The internodal meeting of the cortex cells is seen near the mid-point of the internode. From the number of cells contained in the section, it would appear that this is a diplostichously corticated branchlet fragment. *Illustrated Specimen:* branchlet internodal fragment, Box 1, 1.1-2.1 ft. level of Core 3, Erie Co., N. Y.

Plate 2, fig. 1, illustrates a stem fragment with a broken nodal portion at mid-section, but little can be told about the node since the exterior is so heavily encrusted. The stem is 420 μ in diameter with erratically occurring frequent openings in the cortex. The openings are variable in diameter and are probably not all former spine cell locations, but some of them are probably the result of damage by natural causes. *Illustrated Specimen:* stem fragment, Box 1, 1.1-2.1 ft. level of Core 3, Erie Co., N. Y.

Plate 2, fig. 2, is of a stem cross section 335 μ in diameter, 200 μ across the central cell lumen and about 17 μ across the lumen of the smaller cortex cells. Altogether there are 16 cortex cells. Spine cell pattern is not discernible. *Illustrated Specimen:* stem fragment, Box 1, 1.1-2.1 ft. level of Core 3, Erie Co., N. Y.

Plate 2, fig. 3, is an interior view of a fragment of branchlet cortex from an internodal area showing the meeting of the cortical cells in a similar way to modern charophytes. Plate 2, fig. 5, is a less enlarged view of the exterior surface of the same branchlet fragment showing diplostichous cortication common among modern charophytes. *Illustrated Specimen:* Branchlet fragment, Box 1, 1.1-2.1 ft. level of Core 3, Erie Co., N. Y.

Plate 2, fig. 4, is another stem cross section similar to that shown in Plate 1, fig. 10, but less enlarged. *Illustrated Specimen:* stem section, Box 1, 1.1-2.1 ft. level of core 3, Erie Co., N. Y.

Plate 2, fig. 5, please see Plate 2, fig. 3 above.

Plate 2, fig. 10, illustrates the cross section of a stem bearing single, long spine cells. The base of one can be seen well at the lower side of the specimen. Eighteen cortical cells differing slightly in size surround the central cylinder, the lumen of which is 285 μ in diameter. This probably is similar to some long-spined forms of *Chara contraria* which is diplostichously corticated with the primary cells prominent, but not much larger than the secondary cells. Cells of the secondary series sometimes slip past one another adding a cell or two to the normal number of 16 cortical cells altogether surrounding the central cylinder. The fossil stem is about 500 μ in diameter which compares favorably with *Chara contraria,* too. *Illustrated Specimen:* stem fragment, Box 1, 1.1-2.1 ft. level of core 3, Erie Co., N. Y.

Plate 4, figs. 12 and 13, illustrate material very similar to the stem fragment illustrated in Plate 1, fig. 14 and Plate 1, fig. 10. This cross section shows 12 cortex cells, however, and the section is 500 μ in diameter. *Illustrated Specimen:* stem fragment, Slide 2-1, 0-1.1 ft. level of core 3, Erie Co., N. Y.

Plate 4, fig. 11, is a cross sectional view of a stem fragment. It is 435 μ across section, 250 μ across the lumen of the central cell and 65 μ across the largest cortical cells, 50 μ across the smallest cortical cells. There are 16 cortical cells around the central cell with the primary prominent and bearing long spine cells. This is similar to a long-spined *Chara contraria. Illustrated Specimen:* stem fragment, Slide 2-6, 0-1.1 ft. level of core 3, Erie Co., N. Y.

Plate 4, fig. 20 and Plate 5, fig. 11, are a surface and cross sectional view, respectively, of a stem fragment similar to that shown in Plate 2, fig. 10, having 18 cortical cells and long single spine cells. This stem is 420 μ in diameter with the cortex cells varying from the median of 50 μ for the size of the lumina. *Illustrated Specimen:* stem fragment, Slide 2-1, 0-1.1 ft. level of core 3, Erie Co., N. Y.

Previous Occurrence. This artificial genus was established for fossil vegetative materials agreeing in so far as known with the living Genus *Chara*. Due to the fragmentary nature of the material, it would be hazardous to refer any of it to a species of *Chara*. However, there appear to be stems with diplostichous, irregularly haplostichous, and possibly irregularly triplostichous arrangements of the cortex, and some diplostichous branchlets. Spines range from single to fascicles of several, and apparently long to short. The first material assigned to this genus was from the British Purbeck, upper Jurassic.

SUMMARY AND CONCLUSIONS

Glacial and post-glacial deposits in New York and Indiana are described and charophytes as well as some associated fossils which were isolated from samplings are listed. Fossil charophytes were represented by lime-shells, oospores and fragmentary vegetative material. Methods of isolating and photographing them are given. The structure of an extant species of charophyte, *Chara contraria,* is given with a discussion of terminology. A key to the lime-shell characteristics representing seven genera, twelve species and one variety of fossil charophytes found is included with descriptions and illustrations of the species and variety. An oospore lacking a lime-shell and some vegetative remains represent two more genera described and illustrated. A new species of *Clavatorites* and *Latochara* are included and a new combination is formed.

The variety of charophytes reported here should stimulate interest in a neglected field. Chronologically, several genera are extended into glacial and post-glacial time which were known only from older deposits.

Since oospores were preserved in these collections, their study adds to the knowledge of some of the species described from older deposits in which oosporal remains were missing, fragmentary or were known only from sectional study of oogonia and membrane fragments. Further study of glacial and post-glacial deposits in which oospores may be preserved offers possibilities to enlarge the knowledge of older genera.

Fossil representatives of extant species associated with strictly fossil species of charophytes as reported here gives an interesting ecological tool to apply to the latter.

Variation in the occurrence of decoration from individual to individual and in different areas of the same oogonium emphasizes the limitation in the use of this characteristic in systematics.

Variation in the number of spiral cells in lime-shells of a species emphasizes the limitation of use of this characteristic in systematics, also. Four and six-spiralled lime-shells were found in species normally having five spiral cells.

BIBLIOGRAPHY

Allen, G. O. 1951. Notes on charophytes from British Columbia. Proc. Linnean Soc. London, session 162, pt. 2, 1949-50, pp. 148-152.

Allen, T. F. 1882. Development of the cortex in Chara. Torrey Bot. Club. Bull., vol. 9, no. 4, pp. 37-47, pls. 15-22.

Braun, A. 1845. In Engelmann and Gray—Plantae Lindheimerianae. Boston Jour. Nat. Hist., vol. 5, p. 264.

Daily, F. K. 1944. The Characeae of Nebraska. Butler Univ. Bot. Stud., vol. 6, pp. 149-171.

———. 1953. The Characeae of Indiana. Ibid., vol. 11, pp. 5-47.

Gignoux, M. 1950. Geologie Stratigraphique. Paris: ed. 4, pp. 1-735, 155 figs.

Groves, J. and Bullock-Webster, G. R. 1920. The British Charophyta. London: Ray Soc., vol. 1, pp. vii-141, 25 figs., 20 pls.

Groves, J. 1926. In E. M. Reid and M. E. J. Chandler—Charophyta. Cat. of Cainozoic Plants in British Mus. of Nat. Hist., vol. 1, pp. 165-197, 5 figs., 1 pl.

Harris, T. M. 1939. British Purbeck Charophyta. London: British Mus. of Nat. Hist. pp. v-83, figs. 1-16, pls. 1-17.

Horn af Rantzien, H. 1950. Charophyta reported from Latin America. Kungl. Svenska Vet. Ak., Arkiv f. Bot. ser. 2, bd. 1, no. 8, pp. 355-411.

———. 1951. On the fossil Charophyta of Latin America. Svensk Bot. Tidskr., vol. 43, no. 4, pp. 658-677, Uppsala.

———. 1954. Middle Triassic Charophyta of South Sweden. Opera Bot. (suppl. ser. of Bot. Notiser), vol. 1, no. 2, pp. 1-83, 7 pls.

———. 1956. Morphological terminology relating to female gametangia and fructifications. Bot. Notiser, vol. 109, no. 2, pp. 212-259.

———. 1959a. Morphological types and organ-genera of Tertiary charophyte fructifications. Acta Univ. Stockholm., Stockholm Contrib. in Geol., vol. 4, no. 2, pp. 45-197, 21 pls.

———. 1959b. Recent charophyte fructifications and their relations to fossil charophyte gyrogonites. Kungl. Svenska Vet. Ak., Arkiv f. Bot., ser. 2, bd. 4, no. 7, pp. 165-332, 19 pls.

Kützing, F. T. 1845. Phycologia Germanica. Nordhausen: pp. 255-260.

Leonhardi, H. von. 1863. Die Böhmischen Characeen. Lotos, vol. 13, pp. 55-80, 110-111.

Linnaeus, C. 1753. Species Plantarum. Stockholm: vol. 2, pp. 1156-7.

Mädler, K. 1952. Charophyten aus dem nordwestdeutschen Kimmeridge. Geol. Jahrb., bd. 67, pp. 1-46, 2 figs., 8 pls.

———. 1955. Zur Taxionomie der Tertiären Charophyten. Geol. Jahrb., vol. 70, pp. 265-328, pls. 23-26.

Peck, R. E. 1937. Morrison Charophyta from Wyoming. Jour. Pal., vol. 11, pp. 83-90, pl. 14.

———. 1941. Lower Cretaceous Rocky Mountain non-marine microfossils. Jour. Pal., vol. 15, pp. 285-304. 3 pls.

———. 1957. North American Mesozoic Charophyta. Geol. Survey Prof. Paper 294-A, U. S. Printing Office, Washington, D. C., pp. 1-44, 8 pls., 7 text-figures.

Prescott, G. W. 1951. Algae of the Western Great Lakes area. Cranbrook Inst. of Sci. Bull., vol. 30, pp. 1-946.

Reid, C. and Groves, J. 1921. The Charophyta of the Lower Headon Beds of Hordle (Hordwell) Cliffs (South Hampshire). Quart. Jour. Geol. Soc. London, vol. 77, pt. 3, no. 307, pp. 175-192, 3 pls.

Robinson, C. B. 1906. The Chareae of North America. Bull. New York Bot. Gard., vol. 4, no. 13, pp. 244-308.

Ross, C. A. 1960. Population study of charophyte species, Morrison formation, Colorado. Jour. Pal., vol. 34, no. 4, pp. 717-726.

Rubin, M. and Alexander, C. 1960. U. S. Geological Survey radiocarbon dates V. Amer. Jour. Sci., Radiocarbon Suppl., vol. 2, pp. 129-185.

Straub, E. W. 1952. Mikropalaöntologische Untersuchungen im Tertiär zwischen Ehingen und Ulm a. d. Donau. Geol. Jahrb., vol. 66, pp. 433-523, Taf. 4, Texttaf. A-C, Abb. 1-24, Hannover.

Suess, H. E. 1954. U. S. Geological Survey radiocarbon dates I. Science, vol. 120, pp. 467-473.

Wayne, W. J. and Thornbury, W. D. 1955. Wisconsin stratigraphy of northern and eastern Indiana. Guidebook, 5th Bienn. Pleistocene Field Conf., State Geol. Survey of Indiana and Ohio, pp. 1-34.

Wood, R. D. 1949. The Characeae of Woods Hole region, Massachusetts. Biol. Bull., vol. 96, no. 2, pp. 179-203.

Wood, R. D. and Muenscher, W. C. 1956. The Characeae of the State of New York. Agr. Exp. Sta. of the New York Col. of Agr., Cornell Univ., Mem., no. 338, pp. 1-77, 18 pls.

EXPLANATION OF PLATES

PLATE 1

Fossil charophytes from the 2.1-2.9 ft. level of core 3, Erie Co., N. Y., except Fig. 18 which is from the 1.1-2.1 ft. level of core.

FIGURES 1-3. *Grambastichara cylindrica* (Mädler) Horn af Rantzien
Oospore: 1, lateral view; 2, basal view; 3, apical view. 40X.

FIGURES 4-6. *Charites strobilocarpa* (Reid and Groves) Horn af Rantzien
Oospore isolated from oogonium in figs. 7-9: 4, lateral view; 5, apical view; 6, basal view. 43 X.

FIGURES 7-9. *Charites strobilocarpa* (Reid and Groves) Horn af Rantzien
Oogonium: 7, lateral view; 8, apical view; 9, basal view; 7 inset, another view of basal plug of oospore seen in fig. 4. 43 X.

FIGURE 10. *Charaxis* Harris
Cross section of stem fragment seen also in Plate 1, fig. 14. 43 X.

FIGURES 11-13. *Chara contraria* A. Braun ex Kützing
Broken oogonium: 11, lateral view; 12, apical view; 13, basal view. 43 X.

FIGURE 14. *Charaxis* Harris
Surface view of a stem fragment. 26X.

FIGURES 15-17. *Charites strobilocarpa* var. *ellipsoidea* (Reid and Groves) Daily, nov. comb.
Four-spiralled oospore: 15, lateral view; 16, apical view; 17, basal view. 43X.

FIGURE 18. *Charaxis* Harris
Branchlet internodal fragment. 71X.

FIGURES 19-21. *Chara contraria* Braun ex Kützing
Oospore isolated from oogonium shown in Plate 1, figs. 11-13: 19, lateral view; 20, basal view with plug; 21, basal view without plug. 43X.

FIGURES 22-24. *Chara evoluta* T. F. Allen
Oospore: 22, lateral view; 23, apical view; 24, basal view. 43X.

FIGURES 25-27. *Tolypella* sp.
Oospore: 25, lateral view; 26, apical view; 27, basal view. 43X.

FIGURES 28-30. *Chara evoluta* T. F. Allen
Oospore: 28, lateral view; 29, basal view; 30, apical view. 43X.

PLATE 2

Figs. 6-8. Fossil charophytes from the 2.1-2.9 ft. level of core 3, Erie Co., N. Y.
Figs. 1-5 and 9-28. Fossil charophytes from the 1.1-2.1 ft. level of core 3, Erie Co., N.Y.

FIGURE 1. *Charaxis* Harris
Stem fragment. 26X.

FIGURE 2. *Charaxis* Harris
Stem cross section. 43X.

FIGURE 3. *Charaxis* Harris
Fragment of cortex from a branchlet internode. 32X.

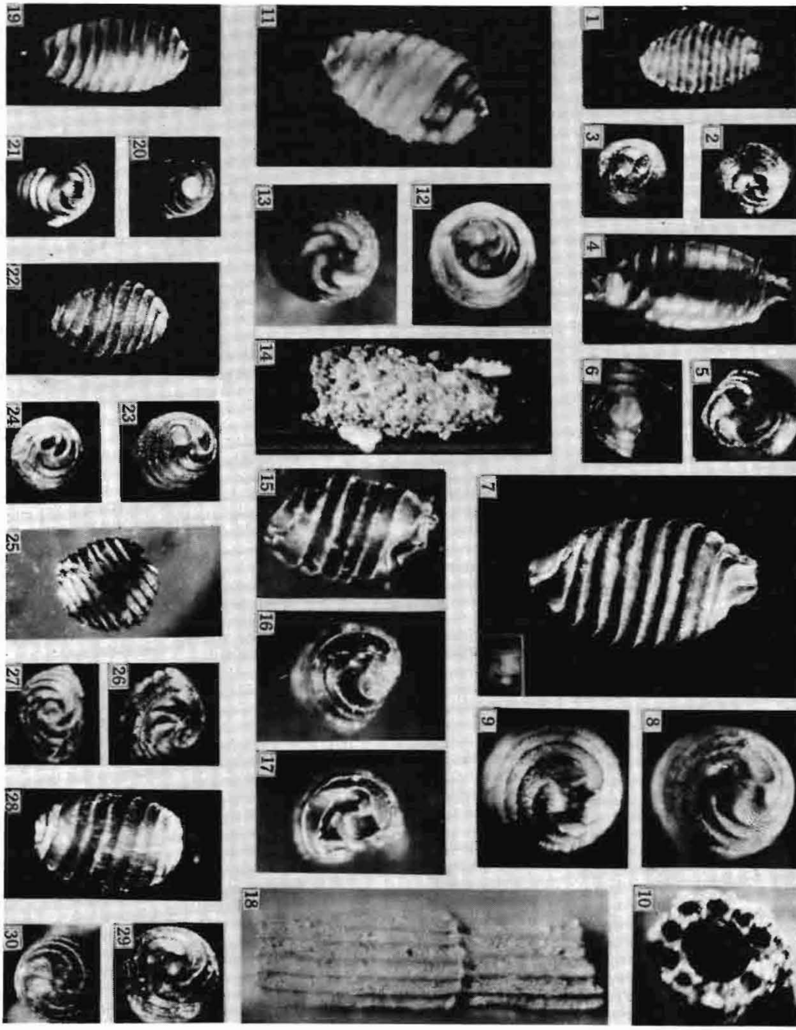


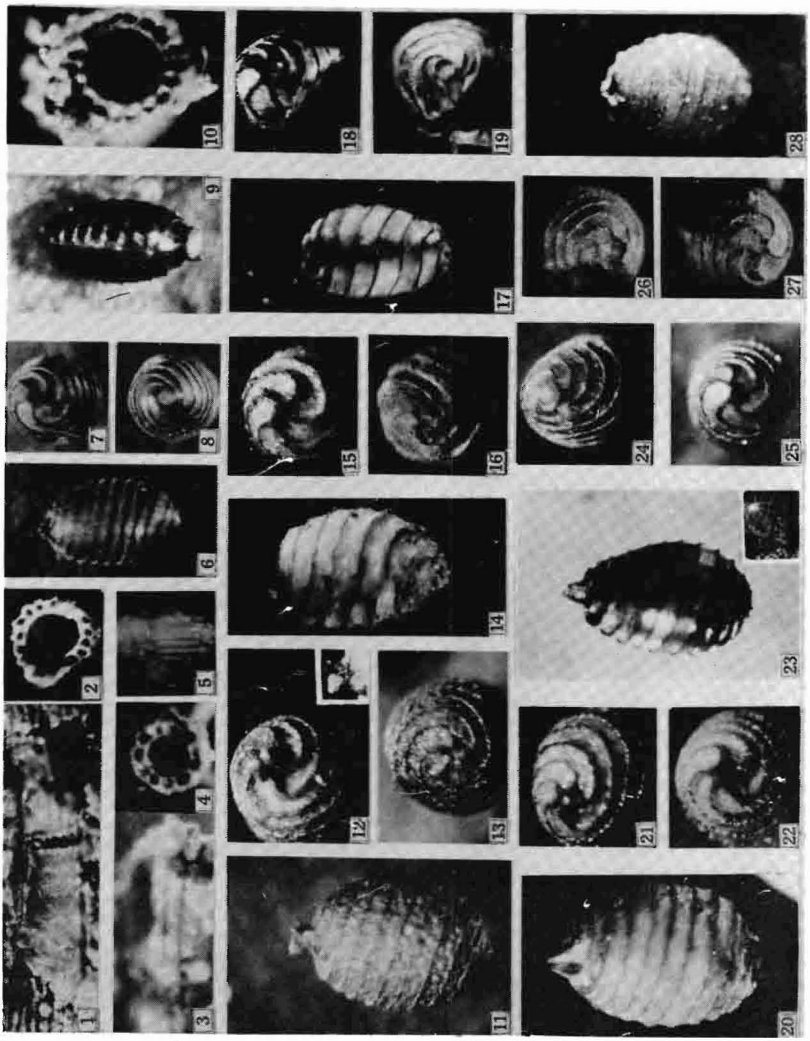
FIGURE 4. *Charaxis* Harris
Stem cross section. 26X.
FIGURE 5. *Charaxis* Harris
Branchlet cortex fragment showing a nodal area. 15X.
FIGURES 6-8. *Chara contraria* Braun ex Kützing
Oospore: 6, lateral view; 7, apical view; 8, basal view. 43X.
FIGURE 9. *Charites bitruncata* (Reid and Groves) Horn af Rantzien
Oospore in lateral view. 43X.
FIGURE 10. *Charaxis* Harris
Stem cross section. 43X.
FIGURES 11-13. *Latochara Waynei* Daily, new species
Oogonium, holotype: 11, lateral view; 12, apical view; 13, basal view. 43X.
FIGURES 14-16. *Obtusochara cylindrica* (Peck) Peck
Oogonium: 14, lateral view; 15, apical view; 16, basal view. 43X.
FIGURES 17-19. *Obtusochara cylindrica* (Peck) Peck
Oospore isolated from the oogonium shown plate 2, figs. 14-16; 17, lateral view; 18, apical view; 19, basal view. 43X.
FIGURES 20-22. *Latochara Waynei* Daily, new species
Oogonium, co-type: 20, lateral view; 21, basal view; 22, apical view. 43X.
FIGURES 23-25. *Latochara Waynei* Daily, new species
Oospore isolated from the oogonium shown in plate 2, figs. 20-22: 23, lateral view; 24, basal view; 25, apical view. 43X. 23, inset, is a piece of the outer colored membrane of the oospore. 307X.
FIGURES 26-28. *Chara evoluta* T. F. Allen
Oospore: 26, basal view; 27, apical view; 28, lateral view. 43X.

PLATE 3

Fossil charophytes from the 1.1-2.1 ft. level of core 3, Erie Co., N. Y.
FIGURES 1-3. *Charites strobilocarpa* var. *ellipsoidea* (Reid and Groves) Daily, new combination
Four-spiralled oogonium: 1, lateral view; 2, basal view; 3, apical view. 43X.
FIGURES 4-6. *Grambastichara cylindrica* (Mädler) Horn af Rantzien
Oogonium: 4, lateral view; 5, apical view; 6, basal view. 43X.
FIGURES 7-9. *Grambastichara cylindrica* (Mädler) Horn af Rantzien
Oogonium: 7, lateral view; 8, apical view; 9, basal view. 43X.
FIGURES 10-12. *Charites strobilocarpa* var. *ellipsoidea* (Reid and Groves) Daily, new combination
Five-spiralled oogonium: 10, lateral view; 11, apical view; 12, basal view. 43X.
FIGURES 13-15. *Obtusochara cylindrica* (Peck) Peck
Broken oogonium: 13, lateral view; 14, apical view; 15, basal view. 43X.
FIGURES 16-18. *Charites strobilocarpa* var. *ellipsoidea* (Reid and Groves) Daily, new combination
Six-spiralled oogonium: 16, lateral view; 17, basal view; 18, apical view. 43X.
FIGURES 19-21. *Chara sejuncta* Braun
Oogonium: 19, lateral view; 20, apical view; 21, basal view. 43X.

PLATE 4

Figs. 1-3. Fossil charophytes from the 1.1-2.1 ft. level of core 3, Erie Co., N. Y.
Figs. 4-20. Fossil charophytes from the 0-1.1 ft. level of core 3, Erie Co., N. Y.



FIGURES 1-3. *Chara sejuncta* Braun

Oospore isolated from oogonium shown in plate 3, figs. 19-21: 1, lateral view; 2, apical view; 3, basal view. 43X.

FIGURE 4. *Charites bitruncata* (Reid and Groves) Horn af Rantzien

Oogonium in lateral view. 43X.

FIGURES 5-7. *Charites bitruncata* (Reid and Groves) Horn af Rantzien

Oospore isolated from oogonium in plate 4, fig. 4: 5, lateral view; 6, apical view; 7, basal view. 43X.

FIGURES 8-10. *Latochara Waynei* Daily, new species

Oogonium, co-type: 8, lateral view (32X); 9, basal view (15X); 10, apical view (15X).

FIGURE 11. *Charaxis* Harris

Stem cross section. 26X.

FIGURES 12 and 13. *Charaxis* Harris

Stem fragment: 12, cross section (43X); 13, surface view (32X).

FIGURES 14-16. *Charites bitruncata* (Reid and Groves) Horn af Rantzien

Oogonium: 14, lateral view; 15, apical view; 16, basal view. 43X.

FIGURES 17-19. *Charites strobilocarpa* var. *ellipsoidea* (Reid and Groves) Daily, new combination

Oogonium: 17, lateral view; 18, apical view; 19, basal view. 43X.

FIGURE 20. *Charaxis* Harris

Stem fragment, surface view. 43X. (Cross section of the same fragment of stem shown plate 5, fig. 11.)

PLATE 5

Fossil charophytes: Figs. 1-6 and 10 from Steuben Co., Ind.: Figs. 7-9, from the 15-15½ ft. level of core, edge of Cass Lake, LaGrange Co., Ind.; Fig. 11, 0-1.1 ft. level of core 3, Erie Co., N. Y.; Figs. 12-17, from Noble Co., Ind.; Figs. 18-26, from Franklin Co., Ind.

FIGURES 1-3. *Maedlerisphaera ulmensis* (Straub) Horn af Rantzien

Oogonium: 1, lateral view; 2, apical view; 3, basal view. 43X.

FIGURES 4-6 and 10. *Chara evoluta* T. F. Allen

Oospore: 4, lateral view; 5, apical view; 6, basal view. 43X. 10, Outer colored membrane. 307X.

FIGURES 7-9. *Charites bitruncata* (Reid and Groves) Horn af Rantzien

Oospore: 7, basal view; 8, lateral view; 9, apical view. 43X.

FIGURE 11. *Charaxis* Harris

Stem fragment, cross section. 43X. (Same fragment of stem as shown in surface view plate 4, fig. 20.

FIGURE 12, left. *Charites strobilocarpa* var. *ellipsoidea* (Reid and Groves) Daily, new combination

Oospore in lateral view. 43X.

FIGURE 12, right. *Clavatorites noblensis* Daily, new species

Oospore in lateral view. 43X.

FIGURE 13. *Charites strobilocarpa* (Reid and Groves) Horn af Rantzien

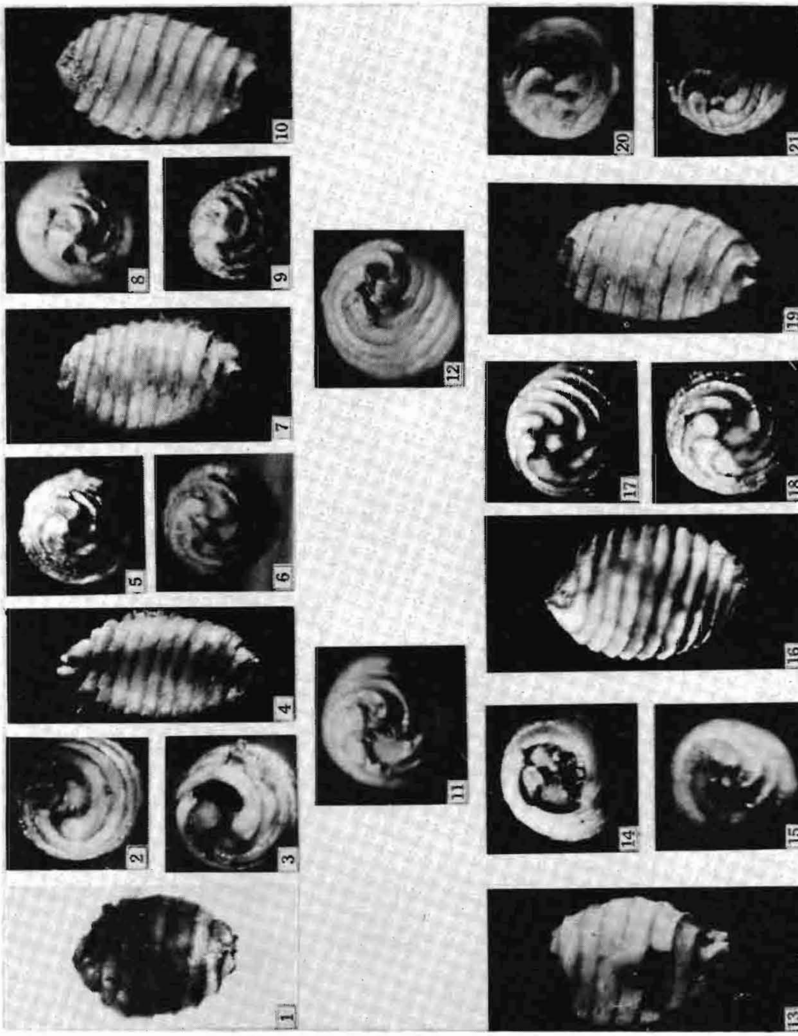
Oospore, lateral view. 43X.

FIGURE 14. *Clavatorites noblensis* Daily, new species

Oospore, lateral view. 43X.

FIGURES 15-17. *Clavatorites noblensis* Daily, new species

Oogonium, holotype: 15, lateral view; 16, apical view; 17, basal view. 43X.



FIGURES 18-20. *Chara sejuncta* Braun

Oogonium: 18, lateral view; 19, apical view; 20, basal view. 43X.

FIGURES 21-23. *Latochara spherica* Peck

Oogonium: 21, lateral view; 22, apical view; 23, basal view. 43X.

FIGURES 24-26. *Latochara latitruncata* (Peck) Mädler

Oogonium: 24, lateral view; 25, apical view; 26, basal view. 43X.