Fossil diatoms from Lakeville Bog, Indiana

Jack R. Weaver

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Edited by

Ray C. Friesner
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.
FOSSIL DIATOMS FROM LAKEVILLE BOG, INDIANA

By Jack R. Weaver

In the study of diatoms, bogs furnish an excellent record of diatom flora during the post glacial period. As a result of the Late Wisconsin glacial activity Northern Indiana was dotted with numerous lakes, many of which are of the kettle-hole type and have become extinct due to deposition of marl and peat. In many bodies of water where diatoms are present, a portion of this sedimentation is composed of the silicified walls of the diatom cells which remain unaltered after the death of the organism. Thus diatoms become deposited and preserved in stratigraphic order.

Diatoms although a somewhat isolated group in the organic world, appear to be more sensitive indicators of ecological conditions than the higher plants. Diatom growth is controlled by such factors as temperature, light intensity, amount of dissolved gases, minerals and nutrients as well as the chemical composition of the water. Most of these can become limiting factors thus influencing the flora present or preventing their growth entirely.

In bogs the water as a rule is high in humic acid and low in dissolved nutrients and oxygen. As a result, an acid condition develops which means that only a specialized flora can exist. The different species which are commonly found in peat, have been referred to by Hanna (4) as the “peat bog flora.” Some of the common diatom genera composing this flora are Eunotia, Pinnularia, Fragilaria, Naviculalia, Melosira, Cyclotella, Nitzschia and Frustulia.

The study of Lakeville bog had two objectives first, to identify the species found at the various levels; and second, to use degree of abundance of certain genera and species as indicators of changing ecological conditions as the bog developed from an open lake to maturity.

...A portion of a thesis submitted in partial fulfillment of the requirements for the Master of Science degree in the Division of Graduate Instruction. 126
HISTORY

Interest in peat bog profile studies first developed in Europe where their relation to ecological succession of plant associations was seen. The study of diatoms of bogs has been of a rather limited nature in this country. Hanna (4) reports that the flora which typically inhabits bogs was first made known in America by F. W. Lewis in 1864 and was determined by a study of peat material in the White Mountains of New England. Since that time there have been several workers who have made significant and important studies of the diatom floras in peat deposits. Among these as reported by Patrick (10) are Cunningham's study of a swamp deposit at Montgomery, Alabama, and Mann's study of diatom deposits found in an excavation at Washington, D. C. Also of importance are Hanna's (4) study of Florida peat deposits, Cocke, Lewis and Patrick's (3) study of Dismal Swamp peat and Patrick's (10) study of diatoms from Patschke bog, Texas.

Most of the studies by Americans except those of Dr. Patrick have been solely of a taxonomic nature. Dr. Patrick has shown that diatoms are sensitive indicators of their ecological habitats. By knowing these ecological relations, she has been able to determine the past climatic and water conditions associated with a bog from its origin until the completion of its deposition.

DESCRIPTION OF BOG

Lakeville bog is located in the north half of section 3 (35 north, 2 east), Union Township, St. Joseph County, Indiana. The bog had a total depth of 30 feet with water pockets at the 21- and 22-foot levels. The sediments are largely organic in nature except at the 29- and 30-foot levels which are composed of marl. The peat is dark brown in color, light in weight and obviously composed to a large extent of decayed vegetable debris.

Since glaciation was responsible for the formation of the bogs of Northern Indiana, it can be assumed that the history of Lakeville Bog begins early in post glacial times. It is obvious that in the formation of peat deposits the element of time enters in as an essential factor. Hanna (4) reports Soper and Osborn as computing the average rate of accumulation of peat for the Great Lakes region at the rate of .72-2.16 inches per century. By using these two rates of deposition it is seen that the time required for the filling of Lake-
ville Bog could vary from 16,000 to 50,000 years assuming that the rate of deposition had been constant. At best, these figures are only estimates and cannot be made with any claim of accuracy.

METHODS

The peat samples were obtained from Lakeville Bog by the use of the Hiller type borer. They were taken from each foot level from the surface to the bottom of the bog. This material was placed into bottles, corked and then sealed with paraffin pending its preparation for microscopic study.

The process of cleaning diatoms involves the separation of the small silicious frustules from the peat and other material composing the bog deposit. The cleaning method used in the present study was a rather simple procedure but produced excellent results. A small amount of peat material (2-3 cc.) was placed into a test tube with approximately 10 cc. of distilled water. The peat and water were then heated and violently shaken until all the peat material was thoroughly washed. The water and peat material were then placed into a small crucible and by the use of a pipette the water which contained the diatoms was removed, leaving most of the peat material in the crucible. This process permits the separation of a large portion of the diatoms present in the original sample.

A drop of water containing the diatoms was placed on a cover glass, distributed evenly over the surface and then dried. The prepared cover glasses were mounted on glass slides by the use of hyrax, a special mounting medium with a high refractive index.

Four slides with two cover glasses each were prepared for each foot level, thus assuring that most of the species present would be represented. Extreme care was taken to eliminate contamination of the material while in preparation, thus preventing introduction of errors in the record of distribution.

An attempt has been made to identify every species present in each foot level. In the 12- and 13-foot levels, where the flora is well developed, five hundred individual diatoms were identified and the percentage of each species observed was computed. The results of this computation are represented in table 1.

Reference to name authority, distribution and habitat characteristics (wherever possible) will be made in the systematic section of this paper.
The distribution of diatoms in Lakeville Bog is rather unusual in that a well-developed diatom flora is expressed only in the 12- and 13-foot levels. Several of the remaining levels contain diatoms or numerous fragments, but these are not of sufficient abundance to be considered indicative of the conditions which were present at the time of deposition. Twenty species representing 11 genera of diatoms were observed to be present in the bog.

From the 30- to the 23-foot level there were 110 diatom frustules or fragments but numerous sponge spicules were observed. Sediments at the 22- and 21-foot levels were of an unconsolidated nature so that no sample could be taken. The 19- to the 16-foot levels contained a few scattered fragments of frustules which appeared to consist mainly of the genera Eunotia and Pinnularia. The 15-foot level had numerous species present but their frequency was very small. Very little material was available for observation in the 14-foot level, but a few frustules of *Gomphonema sarcophagus* and *Melosira italica* were observed.

In the 12- and 13-foot levels where the diatom flora is well developed the percentage of each species observed is represented in table 1. The 13-foot level had an abundant flora with *Melosira italica* composing 94 per cent, *Cyclotella meneghiniana*, 3.4 per cent, and *Gomphonema sarcophagus*, 1.4 per cent. *Melosira italica* had the highest frequency and abundance of any species in the bog. In the 12-foot level *Melosira italica* composed 55.4 per cent, *Cyclotella meneghiniana*, 11.2 per cent, and *Fragilaria construens* 9 per cent of the forms present. The larger species such as *Cymbella aspera*, *Cymbella cuspidata*, *Navicula americana*, *Navicula seman*, *Pinnularia major* and *Pinnularia streptoraphe* had their greatest abundance in the 12-foot level but in comparison with the smaller forms they do not appear very numerous. Most of the larger forms are present in the 13- and 15-foot levels but their abundance is very low.

All of the species present in the bog were found represented in the 12-foot level except *Amphora ovalis*, which was present only in the 13-foot level. All of the species tabulated had a greater abundance in the 12-foot level than in the 13-foot level with the exception of *Melosira italica*. From table 1 it is seen that the most abundant species appearing in the bog are *Melosira italica*, *Cyclotella meneghiniana*,...
ana, *Gomphonema sarcophagus* and *Fragilaria construens*.

From the 11- to the 1-foot level there are only a few scattered fragments of diatom frustules with an occasional isolated form. *Cyclotella meneghiniana* appeared in the 7-, 6- and 5-foot levels with a very few frustules in each. The fragments present seemed to be mainly of the genera *Eunotia* and *Finnularia*.

**SYSTEMATIC SECTION**

*Amphora ovalis* Kützing 1844

Occurrence: only in the 13-foot level and represented by only three frustules. It is possible that they were carried into the bog by some external force. A fresh water species common in ponds.

Illustrations seen: Boyer (1) pl. 15, f. 7; Pasher (8) p. 142, f. 311; Van Heurck (7) pl. 1, f. 1-7.

*Cyclotella meneghiniana* Kützing 1844

Occurrence: best represented in the 12- and 13-foot levels, although it appeared in the 6-, 7-, 14- and 15-foot levels. A common fresh water species.

Illustrations seen: Boyer (1) pl. 2, f. 6; Justedt (6) p. 100, f. 67c; Van Heurck (17) pl. 94, f. 11.

*Cymbella aspera* (Ehr.) Cleve 1894

Occurrence: in the 12-, 13- and 15-foot levels, being most abundant in the 12-foot level. Patrick (9) reports this species as being frequent in a lake with a pH of 7.3. A common fresh water species.

Illustrations seen: Boyer (1) pl. 18, f. 1; Hustedt (6) p. 365, f. 680; A. Schmidt (15) pl. 9, f. 2; Van Heurck (17) pl. 2, f. 8.

*Cymbella cuspidata* Kützing 1844

Occurrence: in the 12-, 13- and 15-foot levels, being best developed in the 12-foot level. Frustules badly eroded or broken. A fresh water species generally distributed northward.

Illustrations seen: Boyer (1) pl. 18, f. 17; Van Heurck (17) pl. 2, f. 3; A. Schmidt (15) pl. 9, f. 50-53.

*Eunotia formica* Ehrenberg 1843

Occurrence: in only the 12- and 13-foot levels with only a few specimens represented. The length of the frustules seemed to vary somewhat. A fresh water species found in ponds of New England.
Fragilaria construens.  If there are only a few scattered through occasional isolated forms. The 7-, 6- and 5-foot levels with fragments present seemed to be

SECTION

A common fresh water species present and in ponds of New England. Illustrated by: A. Schmidt (15) pl. 27, f. 305; Van Heurck (17) pl. 134, f. 1.

Eunotia monodon v. major (W. Smith) Hustedt apud Pasher 1930

Occurrence: most abundant in the 12- and 13-foot levels but also represented in the 5- and 15-foot levels. Frustules quite variable in size and striation. Patrick (9) reports this species as being in association with surface littoral vegetation. A fresh water species quite common in New England lakes.

Illustrations seen: A. Schmidt (15) pl. 287, f. 103; pl. 271, f. 13, 14.

Eunotia pectinata v. minor (Kutz.) Rabenhorst 1864

Occurrence: most abundant in the 12- and 13-foot levels but also represented by one frustule in the 1-foot level. A fresh water species frequently found in swamps and bogs.

Illustrations seen: Hustedt (6) p. 80, f. 239; Van Heurck (17) pl. 33, F. 20-21.

Eunotia praecox v. bidentis (Ehr.) Grunow 1880

Occurrence: in only the 12- and 13-foot levels. Patrick reports it as being associated with Fontinalis and Sphagnum. A fresh water species common in peat deposits.

Illustrations seen: Boyer (10) pl. 13, f. 19; Hustedt (6) pl. 173, f. 213; A. Schmidt (15) pl. 273, f. 26-28; W. Smith (16) pl. 33, f. 284; Van Heurck (17) pl. 34, f. 20.

Fragilaria brevistriata Grunow apud Van Heurck 1881

Occurrence: in only the 12- and 13-foot levels with only a very few specimens present. A fresh water species common in lakes.


Fragilaria construens (Ehr.) Grunow 1862

Occurrence: only the 12 and 13-foot levels. The frustules present were extremely variable in outline. A common fresh water species.

Illustrations seen: Boyer (1) pl. 10, f. 30; Hustedt (6) p. 145, f. 131; W. Smith (16) 2: pl. 34, f. 291.

Gomphonema sarcohagus Gregory 1856

Occurrence: rather well developed in the 12- and 13-foot levels. A very few frustules were also present in the 14-, 15-, 17- and 18-foot levels. A fresh water species appearing as a fossil in Canada.
Illustrations seen: Boyer (1) pl. 19, f. 16; A. Schmidt (15) pl. 234, f. 36-37; Van Heurck (17) pl. 25, f. 2.

Melosira italica (Ehr.) Kützing 1844

Occurrence: best expressed in the 12- and 13-foot levels although a few isolated frustules appeared in the 14-, 15-, 17- and 18-foot levels. As reported by W. Smith (16) there has been much confusion in the synonymy of Melosira italica, Melosira oricholea and Melosira italica v. crenulata. W. Smith places all the above forms together because of the much diversity in the length and breadth as well as a greater or less distinctness of denticulations. Many spores of this species were present in the 12-foot level. A common fresh water species.

Illustrations seen: Van Heurck (17) pl. 88, f. 7.

Navicula americana Ehrenberg 1843

Occurrence: in the 12-, 13- and 15-foot levels. It apparently reached its best development in the 12-foot level where it was most common. A fresh water species and found occasionally in ponds.

Illustrations seen: Boyer (1) pl. 26, f. 8; Hustedt (6) p. 280, f. 464; Van Heurck (17) pl. 12, f. 37.

Navicula semen Ehrenberg 1843

Occurrence: in the 12-, 13- and 15-foot levels but reached its best development in the 12-foot level. Patrick (9) reports finding this species in a bog. A fresh water species found frequently as a fossil in the eastern states. It may occur in ponds of New England.

Illustrations seen: Boyer (1) pl. 26, f. 11; A. Schmidt (15) pl. 72, f. 1.

Nitzschia spectabilis v. americana Grunow, Cleve and Grunow 1880

Occurrence: apparently present in many levels of the bog; but because the frustules were always broken, it was difficult to make a determination accurately. It was apparently well developed in the 12- and 13-foot levels and was present in the 14- and 15-foot levels. This form seems to be a fossil in post glacial deposits as reported by Boyer (1). A fresh water species present in New England ponds.

Illustrations: Boyer (1) pl. 33, f. 3; pl. 39, f. 1.

Pinnularia lata (Breh.) W. Smith 1853

Occurrence: in the 12- and 15-foot levels but had very few frustules present in New England.

Illustration pl. 45, f. 5-8;

Pinnularia mar

Occurrence: it appeared to be a fossil in the New England.

Illustration pl. 42, f. 8; W. Smith 1853

Pinnularia stp

Occurrence: present in the 12- and 13-foot levels.

Illustration pl. 42, f. 11-12.

Tabellaria fen

Occurrence: fragments of it became common.

Illustration Hustedt (6) 1843

The distribution in that a well developed the characteristic of post glacial successional changes will be discussed. The level was com
The distribution of diatoms in the Lakeville bog is rather unusual in that a well-developed flora is present in only the 12- and 13-foot levels. The assemblage which is present, however, is very characteristic of peat bog floras. In order to give a detailed account of the successional change of the diatom flora in the bog, each foot level will be discussed as to the character of the sediments. The 30-foot level was composed of marl and contained little or no plant remains.

**Pinnularia streptoraphe** Cleve 1891
- Occurrence: rather well developed in the 12-foot level but also present in the 2-, 13- and 15-foot levels. A fresh water species present in New England ponds.
- Illustrations seen: Boyer (1) pl. 30, f. 23; A. Schmidt (15) pl. 45, f. 5-8; W. Smith (16) pl. 18, f. 167.

**Pinnularia viridis** Ehrenberg 1843
- Occurrence: best represented in the 12-foot level but present, with only one frustule observed, in the 2- and 17-foot levels. A common fresh water species.
- Illustrations seen: Boyer (1) pl. 28, f. 4; A. Schmidt (15) pl. 42, f. 8; W. Smith (16) pl. 18, f. 162; Van Heurck (17) pl. 5, f. 3-4.

**Tabellaria fenestrata** (Lyng.) Kützing 1844
- Occurrence: most abundant in the 12- and 13-foot levels. Some frustules present in either one. A fresh water species present in New England.
- Illustrations seen: Boyer (1) pl. 30, f. 23; A. Schmidt (15) pl. 45, f. 5-8; W. Smith (16) pl. 18, f. 167.

**Pinnularia major** (Kutz.) W. Smith 1853
- Occurrence: rather well developed in the 12- and 13-foot levels; it appeared to be the most abundant species of Pinnularia present. A fresh water species common eastward.
- Illustrations seen: Boyer (1) pl. 28, f. 4; A. Schmidt (15) pl. 42, f. 8; W. Smith (16) pl. 18, f. 162; Van Heurck (17) pl. 5, f. 3-4.

DISCUSSION
The distribution of diatoms in the Lakeville bog is rather unusual in that a well-developed flora is present in only the 12- and 13-foot levels. The assemblage which is present, however, is very characteristic of peat bog floras. In order to give a detailed account of the successional change of the diatom flora in the bog, each foot level will be discussed as to the character of the sediments. The 30-foot level was composed of marl and contained little or no plant remains.
There were also no diatom frustules or fragments present in this level. At the 29-foot level sponge spicules were observed and these became increasingly more abundant to the 23-foot level where sponges apparently reached their maximum development in the bog. No diatom frustules or fragments were observed in any of these levels.

By comparing the ecological requirements of fresh water sponges as reported by Jewell (7) and those of diatoms, it is seen that they require many of the same conditions for existence. Especially important is the amount of dissolved salts and nutrients in the water. The fresh water sponges seem to have a wider range of tolerance to most ecological conditions such as nutrients, minerals, pH, and light than diatoms and therefore are able to exist where diatoms are not. In the levels where diatoms are present the number of sponge spicules seems to be less.

From the 20- to the 16-foot level conditions apparently were not favorable for the growth of either diatoms or sponges. Scattered fragments of diatom frustules were observed which were too small for positive identification, but appeared to consist mainly of the genera Eunotia and Pinnularia. These two genera are characteristic of strongly dystrophic water conditions.

Beginning with the 15-foot level conditions more conducive to the growth of diatoms must have been present. The flora of this level is rather well represented by numerous forms but all are very low in abundance. The available material from the 14-foot level was such a small quantity that the writer feels a true representation of this level was not obtained since very few frustules were observed of species which were rather abundant in the 15- and 13-foot levels.

The species present in the 15-foot level became most abundant in the 13- and 12-foot levels. In only these two levels is a diatom flora sufficiently abundant to indicate favorable environmental conditions. We must thus assume that the bog during the greater part of its history was not a favorable habitat for diatoms. The abundant planktonic forms in the 12- and 13-foot levels such as Melosira and Cyclotella seem to be closely correlated with the temperature of the water as well as with dissolved nutrients and gasses. Temperature can be one of the most important factors influencing diatom growth as it affects the solubility of salts present in the water.

The fossil pollen study of Lakeville Bog by Hamp (5) would indicate that warmer, drier climate was making an appearance about

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1. This
2. Twen
SUMMARY AND CONCLUSIONS

The time the 15-foot level was deposited and continued during the remaining time of deposition of bog material. These conclusions are based on the assumption that an increase of Quercus indicates a warmer climate and a decrease of Acer indicates a drier climate. These conditions are noticeably apparent beginning at the 15-foot level, as indicated by the pollen frequency of these two species.

The diatom flora in the 11-foot level ends abruptly and does not appear again in any of the succeeding levels. The 11- to 1-foot levels have a few isolated forms which were present in the 12- and 13-foot levels but never reach a frequency of importance. The scattered fragments of diatom frustules in these levels would indicate that perhaps Pinnularia and Eunotia were the dominant species.

In summarizing the ecological factors which are indicated by the distribution of diatoms and the species present, it is evident that many changes took place during the filling in of the bog. The water conditions to the 23-foot level were perhaps of an oligotrophic nature, being low in dissolved nutrients, thus the absence of diatoms. From the 20- to the 16-foot level the water apparently became of a dystrophic character. At the 15-foot level the water became warmer and began to approach eutrophic conditions as evidenced by the large number of genera present. Apparently eutrophic conditions were reached in the 12- and 13-foot levels where the greatest distribution and frequency were reached. The abundance of such genera as Melosira, Cyclotella, Cymbella and Gomphonema are strongly indicative of eutrophic conditions. This condition was apparently short-lived as indicated by the sudden disappearance of the diatom flora from the 11- to the 1-foot level. The increase of such genera as Pinnularia, Eunotia and Gomphonema in the 12-foot level indicated perhaps a shallowing of the water which could bring about dystrophic conditions. This would account for the few scattered fragments of frustules of Eunotia and Pinnularia in the 11- to 1-foot levels which indicate dystrophic conditions.

SUMMARY AND CONCLUSIONS

1. This paper presents a study of fossil diatoms present in Lakeville Bog, Indiana.
2. Twenty species of diatoms representing eleven genera were found.
3. A well developed flora was expressed only at the 12- and 13-foot levels.

4. *Melosira italica* showed greatest abundance totaling 94.2 per cent of the organisms of the 13-foot level and 55.4 per cent in the 12-foot level.

5. The dominant species from the standpoint of abundance are *Melosira italica*, *Cyclotella meneghiniana*, *Gomphonema sarcophagus* and *Fragilaria construens*.

6. All species tabulated had a greater abundance in the 12-foot level than in the 13-foot level except *Melosira italica*.

7. Lack of diatom frustules or fragments in the 30- to the 23-foot level indicated that oligotrophic water conditions had existed in the bog when sediments of these levels were being deposited.

8. Warmer climate introducing eutrophic water conditions is perhaps responsible for the well developed flora in the 12- and 13-foot levels.

9. The scattered fragments of the genera *Eunotia* and *Pinnularia* in the 11- to the 1-foot levels suggest that dystrophic water conditions existed while sediments accumulated at these levels.

ACKNOWLEDGMENT

The writer expresses his sincere thanks to Dr. C. M. Palmer for supervision of the research and critical reading of the manuscript, to Dr. J. E. Potzger for helpful suggestions, to Dr. Ruth Patrick, Associate Curator of Microscopy at the Academy of Natural Sciences of Philadelphia, for her encouragement and verification of several species of diatoms found in the Lakeville Bog.

LITERATURE CITED

expressed only at the 12- and 13-foot levels were being deposited. The eutrophic water conditions is eloquent in the 12- and 13-foot levels, with the genera Eunotia and Pinnularia that dystrophic water conditions at these levels.

Acknowledgements
Thanks to Dr. C. M. Palmer for critical reading of the manuscript, questions, to Dr. Ruth Patrick, the Academy of Natural Sciences for permission to use the specimen data, and verification of several diatoms. To Prof. A. H. Wood, for critical reading of the manuscript, and to Dr. Ruth Patrick, for the loan of the diatoms.

CITED
3. Florida State, 1933.
5. Study of two northern Indiana bogs. Acad. of Sci., 1940.

TABLE 1

<table>
<thead>
<tr>
<th>Species</th>
<th>12-foot</th>
<th>13-foot</th>
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<tbody>
<tr>
<td>1. Melosira italica</td>
<td>55.4 per cent</td>
<td>94.2 per cent</td>
</tr>
<tr>
<td>2. Cyclotella meneghiniana</td>
<td>11.2</td>
<td>3.4</td>
</tr>
<tr>
<td>3. Gomphonema sarcophagus</td>
<td>12.0</td>
<td>1.4</td>
</tr>
<tr>
<td>4. Fragilaria construens</td>
<td>9.0</td>
<td>.4</td>
</tr>
<tr>
<td>5. Cymbella aspera</td>
<td>3.2</td>
<td>.6</td>
</tr>
<tr>
<td>6. Eunotia monocline v. major</td>
<td>2.6</td>
<td>.5</td>
</tr>
<tr>
<td>7. Tabellaria fenestrata</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>8. Navicula seman</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>9. Eunotia formica</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>10. Eunotia praeirta v. bidens</td>
<td>.8</td>
<td></td>
</tr>
<tr>
<td>11. Navicula americana</td>
<td>.6</td>
<td></td>
</tr>
<tr>
<td>12. Pinnularia streptoraphic</td>
<td>.4</td>
<td></td>
</tr>
<tr>
<td>13. Pinnularia lata</td>
<td>.2</td>
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<td>14. Pinnularia major</td>
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<tr>
<td>15. Pinnularia viridis</td>
<td>.2</td>
<td></td>
</tr>
</tbody>
</table>

17. VAN HEURCK, HENRY. Synopsis des Diatomees de Belgique. 1883.
| Species | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19-20 |
|---------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|      |
| 1. Amphora ovalis |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | x    |
| 2. Cyclotella meneghiniana |   |   |   |   | x |   | x | x | x |   |   | x |   |   |   |   |   |   |      |
| 3. Cymbella aspera |   | x | x | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 4. Cymbella cuspidata |   |   | x | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 5. Eunotia formica |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 6. Eunotia monodon v. major | x |   |   |   | x |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 7. Eunotia pectinalis v. minor |   | x |   |   | x | x |   | x |   |   |   |   |   |   |   |   |   |   |      |
| 8. Eunotia praerupta v. bidens |   |   | x | x | x | x | x |   |   |   |   |   |   |   |   |   |   |   |      |
| 9. Fragilaria brevispira |   | x | x |   | x |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 10. Fragilaria construens |   | x |   |   | x |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 11. Gomphonema sarcophagus | x | x | x | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 12. Melosira italica |   |   | x | x | x | x |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 13. Navicula americana | x |   | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 14. Navicula seman |   |   | x | x | x | x | x |   |   |   |   |   |   |   |   |   |   |   |      |
| 15. Nitzschia spectabilis v. americana: | x | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 16. Pinnularia lata |   |   | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 17. Pinnularia major |   |   | x | x | x | x | x |   |   |   |   |   |   |   |   |   |   |   |      |
| 18. Pinnularia streptorapha | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 19. Pinnularia viridis |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |
| 20. Tabellaria fenestrata |   |   | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |