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Eugene F. Stoermer  
*Iowa State University*

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## Notes on Iowa Diatoms II. Species Distribution in a Subaerial Habitat.<sup>1</sup>

EUGENE F. STOERMER<sup>2</sup>

**Abstract.** A collection made near the base of a small waterfall in Marion County, Iowa, was examined. A total of 22,294, specimens of diatoms were studied and found to include 40 species and varieties representing 13 genera. It was found that approximately half of the entities determined are well represented in the local aquatic flora. The remainder comprise entities described by previous authors as being characteristically found in northern, alpine, or aerial environments. In the case of five of the entities no specific determination was made.

The collections from which this study was made were obtained from the vicinity of a small waterfall, locally known as South Falls, located in Section 21, Township 76 N, Range 18 W; near the town of Pella in Marion County, Iowa. Material was collected from a gelatinous growth of diatoms and bluegreen algae that extended about one meter upwards on the undercut rock face of the falls from the small pool at its base. This area is evidently furnished with considerable moisture as spray from the falls and seepage water from the rock strata.

After collection the material was cleaned and mounted by standard methods. These involve the oxidation of organic matter by treatment with 30% H<sub>2</sub>O<sub>2</sub> and potassium dichromate and mounting in Hyrax, a mounting medium of high refractive index.

In order to determine the distribution of species present in this rather specialized habitat the following procedure was used. A slide with an evenly distributed population was prepared from the cleaned material and observed under oil immersion (11-25X). A series of traverses were made across the slide by means of the mechanical stage on the microscope. All specimens that fell within the field of view were identified and counted. Five

<sup>1</sup> The project of which this investigation is a part receives support from the National Institutes of Health, Division of Water Supply and Pollution Control.

<sup>2</sup> Department of Botany and Plant Pathology, Iowa State University, Ames, Iowa

“rows” were examined in this way and 22,294 individuals were cataloged. The distribution of these species is given in Table 1. Forty species representing thirteen genera were included in this total. A brief discussion of their ecology is given following the table.

Table 1. Numerical Distribution Within a Sample of Diatom Species Collected from a Subaerial Habiatt.

Species	No. of times occurring
<i>Achnanthes lanceolata</i> . . . . .	11390
<i>Navicula fragilariodes</i> var. ? . . . . .	2690
<i>Nitzschia linearis</i> . . . . .	1916
<i>Achnanthes exigua</i> . . . . .	1677
<i>Melosira roeseana</i> . . . . .	1290
<i>Achnanthes exigua</i> var. <i>heterovalvata</i> . . . . .	838
<i>Caloneis bacillum</i> . . . . .	745
<i>Stauroneis smithii</i> . . . . .	740
<i>Achnanthes (Achnanthidium) coarctata</i> . . . . .	210
<i>Navicula contenta</i> fo. <i>biceps</i> . . . . .	150
<i>Navicula tenelloides</i> . . . . .	148
<i>Frustulia vulgaris</i> . . . . .	94
<i>Amphora ovalis</i> . . . . .	65
<i>Navicula minima</i> var. <i>atomoides</i> . . . . .	62
<i>Navicula dicephala</i> var. <i>subcapitata</i> . . . . .	52
<i>Stauroneis kreigeri</i> . . . . .	45
<i>Amphora ovalis</i> var. <i>pediculus</i> . . . . .	41
<i>Diploneis ovalis</i> . . . . .	31
<i>Navicula dicephala</i> var. <i>abiskoensis</i> . . . . .	17
<i>Navicula lagerstedtii</i> . . . . .	16
<i>Navicula bryophila</i> . . . . .	11
<i>Pinnularia microstauron</i> . . . . .	11
<i>Navicula dicephala</i> . . . . .	8
<i>Achnanthes minutissima</i> . . . . .	8
<i>Neidium</i> sp. . . . .	7
<i>Navicula gastrum</i> var. <i>exigua</i> . . . . .	6
<i>Pinnularia</i> sp. . . . .	4
<i>Stauroneis smithii</i> var. <i>incisa</i> . . . . .	3
<i>Gomphonema parvulum</i> . . . . .	3
<i>Navicula fritschii</i> . . . . .	3
<i>Diploneis</i> sp. . . . .	2
<i>Nitzschia tryblionella</i> var. <i>debilis</i> . . . . .	2
<i>Surirella ovata</i> var. <i>pinnata</i> . . . . .	2
<i>Surirella</i> sp. . . . .	2
<i>Diploneis oculata</i> . . . . .	1
<i>Gomphonema</i> sp. . . . .	1
<i>Navicula minuscula</i> . . . . .	1
<i>Navicula graciloides</i> . . . . .	1
<i>Navicula</i> sp. . . . .	1
<i>Hantzschia amphioxyis</i> var. <i>major</i> . . . . .	1

CENTRALES

*Melosira*

1. *Melosira roeseana* Rahb.

This large and quite characteristic *Melosira* is reported by Hustedt (1930) to be a form characteristic of moist, subaerial habitats such as mosses and rocks which are irrigated by see-

page water or spray. He states this species is especially common in the mountains.

This species has been observed rather commonly in habitats as described above in different localities in this state. It is one of the few centric diatoms that commonly occurs in such habitats. Several workers have observed that the most common diatoms in aerial and subaerial habitats are those pennate forms which have a raphe and are capable of movement. Thus, the question arises as to what, if any, special adaptation *M. roeseana* had made to life under these specialized conditions. The answer to this question is, as far as I know, unknown.

PENNALES

*Monoraphidineae*

*Achnanthes*

1. *Achnanthes lanceolata* Breb.

This is a very widespread and common species which is evidently tolerant of varied conditions. Hustedt (1930) observes that this species is common throughout central Europe, but prefers streams and springs. Like most members of this genus it generally prefers habitats where oxygen is abundant.

2. *Achnanthes exigua* Grun.

Patrick, in Hutchinson *et al.* (1956), states that this species "Prefers somewhat alkaline water; indifferent to chlorides of low concentration; can live in warm water; widely distributed in north-central and midwestern United States." It has been collected from various habitats in this state.

3. *Achnanthes exigua* var. *heterovalvata* Krasske

This species evidently has a wide distribution. According to Hustedt (1930) it is common over all of central Europe, and has been collected from various habitats in this state. It seems to occur in nearly all waters which are not acid and which contain abundant oxygen.

5. *Achnanthes* (*Achnanthidium*) *coarctata* Breb.

This species is rather uncommon in this state. Hustedt (1930) states that it is common on moistened rocks in the mountains of central Europe. It is restricted, as far as we have been able to determine, to damp, shaded, subaerial habitats in this region.

Biraphidineae

Naviculaceae

*Diploneis*

1. *Diploneis ovalis* (Hilse) Cleve.

This species is not uncommon in the hard waters of this state. It has been collected from Lake West Okoboji, Silver Lake Fen, and various other areas. Hustedt (1930) says this species is widespread and common in central Europe in fresh, or slightly

salty (high chloride) water. He mentions that it occurs in springs and on moistened rocks.

2. *Diploneis oculata* (Breb.) Cleve

Commonly collected in hard water in this area. This species, although it appears to be rather widespread, is seldom collected in large numbers, more often occurring as isolated individuals.

3. *Diploneis* sp.

The correct taxonomic position of this entity is very difficult to determine. It much resembles and may, in fact, belong to *D. antiqua* A. Cleve, which was originally reported as a fossil. As the material at hand does not allow determination of the variation in the entity being dealt with, I hesitate to assign it to that taxon as it differs in some respects from the measurements given by Cleve-Euler (1953) for *D. antiqua*.

*Frustulia*

1. *Frustulia vulgaris* Thwaites

This species appears to be rather widely distributed. Some members of the genus are rather closely restricted to soft water but *F. vulgaris* seems to tolerate rather hard water conditions. It has been collected from various other locations in the state.

The cells of this species are usually contained in a rather broad gelatinous tube.

*Neidium*

1. *Neidium* sp.

This species belongs to the group of forms that are included in *N. bisulcatum* (Lagerstedt) Cleve and its varieties. It resembles in many respects *N. bisulcatum* var. *baicalensis* (Skv. & Meyer) Reimer. Reimer (1959) describes this variety as having "sides convex, not parallel." In my specimens this feature is quite variable. The marginal outline varies from convex through parallel to slightly concave in some of the larger individuals.

The nominate variety of *N. bisulcatum* is described as being primarily a mountain species. *N. bisulcatum* var. *baicalensis* was originally described from Lake Baikal and only recently has been reported from the United States (Reimer, 1959).

*Stauroneis*

1. *Stauroneis Kreigeri* Patr.

From the United States distribution records given by Reimer (1961) it appears that this species is most commonly found in small streams and springs. It was originally described from a "Hochmoor" in Germany.

2. *Stauroneis smithii* Grun.

This species seems to be of rather wide occurrence, however, it is seldom found in large quantity as is the case in this collection.

3. *Stauroneis smithii* var. *incisa* Pant.

This variety only recently has been reported from the United States (Reimer, 1961). It is reported as occurring with the species, in collections from Europe.

*Caloneis*1. *Caloneis bacillum* (Grun.) Meresch.

This rather small and polymorphic *Caloneis* is widely distributed and evidently rather tolerant of varying environmental conditions. It very rarely comprises as large a part of the total diatom population as it does in these collections, more usually occurring as isolated individuals or a few individuals in a collection. It has been collected from several different localities in this state.

*Navicula*1. *Navicula contenta* fo. *biceps* Arnott.

This species is said to be (Hustedt, 1930) particularly common in mountainous regions of Europe, where it often occurs in great quantities on "irrigated" rocks. It has been collected from numerous different localities in the state.

2. *Navicula fragilaroides* Krasske var.?

This very unusual species is described by Hustedt as being common and often dominant on moistened rocks in mountainous areas in Europe. It has, to my knowledge, never before been collected in this state.

The specimens in this collection differ somewhat from Hustedt's (1930) description of the species in that the sides are slightly more parallel and the striae somewhat coarser. It may belong to a different variety.

3. *Navicula minima* var. *atomoides* (Grun.) Cleve.

This species is widely distributed and evidently rather tolerant. It has been collected from various different localities in this state.

4. *Navicula minuscula* Grun.

This is another species that is described by Hustedt as being common on "irrigated" rocks. It has been collected from various different localities in the state. It is probably rather widely distributed but is rather easy to overlook due to its small size and fine structure.

5. *Navicula tenelloides* Hust.

This species was originally described from the tropics. (Hustedt, 1937/39). In a later publication the same author states that it has been found to be a widely distributed aerophilic form also found in the flora of northwestern Germany where it commonly occurs in collections from club mosses and liverworts

(Hustedt, 1942). I have not been able to find any other records of its occurrence in Iowa.

6. *Navicula lagerstedtii* Cleve

This species has usually been described from northern or arctic habitats (Cleve-Euler, 1953). Apparently rare in Iowa, it has been found in no other locations in our collections.

7. *Navicula bryophila* J. B. Peterson

Hustedt (1961) states that this species is cosmopolitan in fresh water and especially common on wet mosses and other aerophytic habitats. He describes the ecology of the species as follows; oligohalobe (indifferent) aerophile, pH indifferent (pH 4.2 to over 8). It has not appeared in any of our other collections from this state.

8. *Navicula fritschii* Lund

This species was originally described from soil by Lund (1946). Apparently it is most common on soils of relatively high calcium content. This is the first time this entity has appeared in our collections from Iowa.

9. *Navicula graciloides* A. Mayer

This species is rather widely distributed and commonly occurs in collections made from the hard water lakes of this state.

10. *Navicula dicephala* (Ehr.) Wm. Smith

This species is widely distributed, but seldom occurs in large numbers. It has been collected from various habitats in this state.

11. *Navicula dicephala* var. *abiskoensis* (Hust.) A. Cleve.

Published descriptions indicate that this variety tends to be more restricted to northern and alpine regions than does the species. It has been collected from West Lake Okoboji in Iowa.

12. *Navicula dicephala* var. *subcapitata* Grun.

This variety appears to have much the same distribution as the species. It has not occurred before in our collections from Iowa.

13. *Navicula gastrum* var. *exigua* (Greg.) Grun.

This species has been reported from a number of areas and unfortunately, apparently under a number of different names. The taxonomic confusion in this group makes it difficult to ascertain its true range. It has not appeared before in our collections from the state.

14. *Navicula* sp.

Even the generic identity of this single specimen is open to doubt. It has some features of both *Navicula* and *Stauroneis*. As I have been able to find only the one valve, final determination of its true taxonomic position must be reserved.

*Pinnularia*1. *Pinnularia microstauron* (Erh.) Cleve

This species is said to be widespread in Europe. It has seldom appeared in our collections from this state, but was reported from soil by Hayek and Hulbary, (1956) and Lund, (1954).

2. *Pinnularia* sp.

The position of this entity is uncertain. It belongs to the series of forms that are included in *P. appendiculata* (Agardh) Cleve and its varieties by Cleve-Euler. It much resembles *P. appendiculata* fo. *pumila* A. Cl. but differs from that entity in that it has somewhat finer striae.

*Amphora*1. *Amphora ovalis* Kutz.

This species is most generally collected from the litoral zone of lakes. It has been collected from various different areas in this state and has been described as being generally distributed by other authors.

2. *Amphora ovalis* var. *pediculus* Kutz.

This species commonly grows epiphytic on other algae and is commonly found on some of the larger species of diatoms. It is quite generally distributed and has appeared in collections from other parts of the state.

*Gomphonema*1. *Gomphonema parvulum* (Kutz.) Grun.

This species is very widely distributed and is common in a number of different habitats. It is evidently a rather tolerant species and is found in greater or lesser numbers in nearly all collections we have made from this state except those from acid waters.

2. *Gomphonema* sp.

This single specimen is more than likely an abnormal valve, perhaps of *G. parvulum*.

## Nitzschiaceae

*Nitzschia*1. *Nitzschia linearis* Wm. Smith

This species is widespread and common. It differs from many species of the genus in that it appears to occur more commonly in cold water which has a low organic nutrient level. Hustedt (1930) mentions that this species is especially common in springs in central Europe. It is a common member of the winter flora of Lake West Okoboji, and has been collected from other localities in the state.

2. *Nitzschia tryblionella* var. *debilis* (Arnott) A. Mayer

Hustedt (1931) says that this species is most common in



“slightly salty” water, and that its varieties have more or less the same distribution. It was reported from soil by Lund (1954). It has seldom appeared from our other collections from the state, and is common only in the Des Moines River.

#### *Hantzschia*

##### 1. *Hantzschia amphioxys* var. *major* Grun.

This species is quite widespread and common in many collections. It tends to be found most often in small, shallow ponds and pools and soil. The large varieties are said to be most common in springs. Both the species and the variety are common in our collections from Iowa.

#### Surirellaceae

##### *Surirella*

##### 1. *Surirella ovata* var. *pinnata* (Wm. Smith) Hust.

This species is common and widely distributed. It is of wide spread occurrence in our collections from this state, but seldom is dominant in the flora.

##### 2. *Surirella* sp.

These specimens may represent an aberrant growth form of *Surirella ovata*. The valves are hyaline and nearly structureless aside from rather poorly developed marginal alae. Inspection of the rest of the slide, outside the counted area, has however, revealed a number of these forms. They are quite constant in form, which would lead one to believe that they belong to a separate genetic entity.

#### *Discussion*

There are a number of interesting features of the species distribution in this specialized habitat. Probably the most striking feature is the paucity of non-motile forms. In the population observed there is only one centric diatom and the *Araphidineae* section of the pennate diatoms is not even represented. These two groups usually make up an important part of the flora of aquatic habitats. Evidently motility has considerable selective advantage in aerial and subaerial habitats such as this one. This concept has been discussed by numerous workers, among them Hayek and Hulbary (1956).

A second feature worthy of note is the relatively large number of species which are considered to have northern and alpine distribution. This serves to illustrate a point that only recently has been fully realized. There are apparently very few truly endemic species of diatoms although a large number of species are ecologically limited and hence habitat specific. Thus it is not too surprising to find species common in northern and alpine environments occurring in a limited area where local conditions closely approximate those found at considerably higher elevations

or latitudes. Although we do not have records to prove that such a situation exists in the habitat sampled, it is not illogical to suppose that the mean summer temperature is considerably lower than that for the surrounding area.

It is also apparent that there are a number of species in this collection which are of wide distribution and evidently quite tolerant of varying environmental conditions. The major dominant, *Achnanthes lanceolata*, is of almost universal occurrence, except in acid or badly polluted waters. It is notable that many of the tolerant species which occur in abundance here are usually present in far fewer relative numbers in the more "normal" aquatic habitat. (*Achnanthes lanceolata*, *A. exigua*, *Caloneis bacillum*, etc.) On the other hand some species which are often common to dominant in other habitats are poorly represented here. (*Gomphonema parvulum*, *Navicula graciloides*). The reasons for this are problematic. However, one would suspect that the high level of oxygen favors the dominance of the *Achnanthes* species. It has been commonly observed that the species of this genus flourish in habitats high in oxygen.

It is possible to characterize the conditions of the water in this environment by the flora that is present. The species present indicate hard water, moderately high in chloride and low in organic material.

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## Notes on Iowa Diatoms

### III. Occurrence of the Genus *Pleurosigma* in the Des Moines River<sup>1</sup>

RYAN W. DRUM<sup>2</sup>

*Abstract.* A member of the diatom genus *Pleurosigma* was collected from the Des Moines River from 12 stations. Earlier investigators did not report it. This organism may be suitable as an ecological indicator, since most members of the genus occur in salt or brackish water. Positive identification was not made, the organism is probably a variety of *P. delicatulum* Wm. Smith.

A member of the diatom genus *Pleurosigma* was first collected from the Des Moines River by E. F. Stoermer in the fall of 1959 at the Ledges State Park, Iowa. Since that time the organism has been identified in plankton samples and bottom sediments collected by the author from twelve stations between the headwaters of the West Fork at Lake Shetek, Minnesota, and Farmington, Iowa, a distance of 450 miles of river: from this, the widespread distribution of the organism is clearly indicated. The peculiar significance of a member of the diatom genus *Pleurosigma* occurring in the Des Moines River exists in the relationship of this phenomenon to a generally accepted hypothesis that the members of this genus are found primarily in brackish-water and marine environments. According to Hustedt (1), all species are saltwater forms, but some are regularly found in salterns and other salty waters of the inland. Smith (2) modified this viewpoint, indicating that, although most species of *Pleurosigma* are found in salt or brackish-water, there are two species found in freshwater in this country, *P. boyeri* Keeley and *P. delicatulum* Wm. Smith. In his study of the diatoms of Nebraska, Elmore (3) identified as *P. delicatulum* specimens found in creeks and rivers such as the Crete, Julian, and North Platte. From these references we conclude that, while neither frequent nor abundant, the genus *Pleurosigma* is not necessarily a stranger to freshwater habitats.

The Des Moines River begins in southern Minnesota; the

<sup>1</sup> This work was supported by a grant from the National Institutes of Health, Division of Water Supply and Pollution Control.

<sup>2</sup> Department of Botany and Plant Pathology, Iowa State University, Ames, Iowa