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Notes on the Diatom *Cylindrotheca gracilis* (Breb. ex Kutz) Grun: Its Ecology and Distribution

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Abstract. The diatom *Cylindrotheca gracilis* (Bréb. ex Kütz) Grun., considered by some as a "Brackish water" species, was found as a massive growth in isolated pools along Dugout Creek, Dickinson County, Iowa. Chemical analyses show the water to be high in SO_4, Mg., Ca., and low in Cl ions. Comparative data from other waters in the United States containing this species shows similar pattern of high conductivity suggesting that factors other than chlorides might be more critical for growth.

United States distribution for this diatom includes: Maryland (brackish water), Ohio (fresh water) and Iowa (fresh water).

The presence in Iowa of a diatom frequently referred to as a "brackish water" species seemed, to the authors, a somewhat unusual event which needed some investigation. The study, although originally intended as a single report on *Cylindrotheca gracilis* (Bréb. ex Kütz) Grun. and its physico-chemical environment, includes other United States distribution records together with additional water chemistry data.

The spasmatic reporting of this diatom in time and location has produced some conflicting reports and thoughts about its ecology. The authors, thus, have assembled in this paper views expressed in the literature about this taxon and have added several environmental measurements that have not previously been reported.

C. gracilis (Fam. Nitzschiaceae) is a diatom with rather weakly silicified frustules. When dried the walls collapse. During normal cleaning procedure they become distorted or actually dissolve away. Thus, because of its delicate nature it can best be studied only in fresh condition or in carefully prepared "burned mounts." The cells are spindle shaped, elongate-linear, and show evidence of a torsion of about 2½ twists. The ends are protracted and appear sub-capitate when viewed from the proper angle. The keel is spirally arranged, having about 20 keel puncta in 10 microns. Length 60-230 mu. Breadth 4-5 mu.

Early taxonomic problems led to the introduction of several names for this taxon, but study indicates that the authors were all considering this species. Indeed, this diatom is morphologically quite distinct, lending some weight to the ecological data accompanying distribution reports (Reimer, 1965).

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Hustedt (1928) has given the only good accounting of this species since the original description of the genus by Rabenhorst (1859).

Methods

Diatom collections were made from Dougout Creek, which cuts through the Excelsior Fen-complex (Section 15, Excelsior Township, Dickinson County, Iowa), and a small pool beside this creek, on August 12, 1966, and again on August 16, 1967. *C. gracilis* was rare to occasional (.01 - 2.0 percent of sample) in the creek collections, but was massive in the pool collections (50 - 100 percent of sample). The area of the pool from which chemical samples were taken was 210 sq. cm. The depth was 3 cm. The pool was about 4 cm. from the stream proper. Chemical samples were made with a Modified Hach Portable Water Laboratory. Results are recorded in Table 2.

In addition to this data previously unpublished, reports of this diatom from the United States are included. The first is from the Ottawa River (Ohio) collected in 1955. Here the diatom appeared in several samples with a frequency in some collections of about 30 percent. The second is from the Patuxent River (Maryland) collected in 1965. Here, *C. gracilis* is reported as being common to massive (30 - 80 percent) on the intertidal flats. Chemical data were obtained from these two localities by the survey team of the Limnology Department of the Academy of Natural Sciences according to the procedure outlined in Standard Methods (1960). The results are presented in Table 2.

Table 1 records ecological remarks made about *C. gracilis* in the literature.

Results and Discussion

Two points are clear from Table 1: (1) there is no specific mention of this diatom being frequent or dominant in fresh water; (2) actual measurements of water chemistry are either lacking or very meager. Both points of information are considered here.

The data presented in Table 2 indicate that *C. gracilis* is capable of living under both high and low chloride concentrations. It *has* shown up with greater frequency in aestuaries. This seems to have led to the assumption that its optimal habitat involves the presence of some brackish water (i.e., relatively high chloride content). A check of the type locality should have thrown some suspicion on this assumption (Table 1). There have also been a few other recordings of this diatom from fresh water habitats.

The pH readings strengthen the assumption that *C. gracilis* is an alkaliphilic species. Dissolved oxygen data show that it was present under moderately high O_2 concentrations. Total hardness was high in all cases and this may well be a factor to consider carefully in any attempt to enumerate limiting factors for its growth.

Table 1

Ecological Remarks About *Cylindrotheca gracilis*

Author and Name Used	Ecological Remarks
deBrébisson (ex Kütz.) 1849 (*Ceratoneis gracilis* Bréb.)	In aqua dulci circa Falaise (FRANCE)
Wm. Smith 1853 (*Nitzschia taenia* W.Sm.)	Brackish water near Lewes (ENGLAND)
L. Rabenhorst 1859 (*Cylindrotheca gerstenbergeri* Rabh.)	In einem Graben im Peissengrunde..... bei Dresden..(GERMANY)
H. vanHeurck 1896 (*Cylindrotheca gracilis* (Bréb.) Grun.)	Fresh water..Brussels ..Antwerp (BELGIUM)
F. Hustedt 1928 (*Cylindrotheca gracilis* (Bréb.) Grun.)	..stark eutrophierte, auch schwach salzige Gewässer mit stehendem Wasser (GERMANY)
F. Hustedt 1930 (as above)	..halophile, besonders in schwach salzigem Wasser...(EUROPE)
F. Hustedt 1939) (as above)	ziemlich verbreitet und nicht selten...Mesohalob und euryhalin. (GERMANY)
C. Brockman 1950 (as above)	...kommt in jeder salzkonzentration vom Süsswasser bis zum voll salzigen Meerwasser vor... anscheinend aerophil.. (GERMANY)
A. Cl. Euler 1951 (*Cylindrotheca gracilis* "alpha" *major* Cl.Eu.) (*C. gracilis* "beta" *minor* Cl.Eul.)	Marine- br. W., Pelagisch-neritisch (FINLAND, SWEDEN) Süss-W.(V.H.) Im Gebiet *nicht* gefunden
F. Hustedt 1957 (*Cylindrotheca gracilis* (Bréb.) Grun.)	In der Tidenhubzone ziemlich häufig... Mesohalob-euryhalin (.5-4% Cl-Salz); pH "indifferent," wahrscheinlich oligooxybiont...(GERMANY)
N. Foged 1958 (as above)	...rare..River..foot of waterfall..alkaliphilous, halophilous. pH 7.9. (GREENLAND)
R. Patrick 1959 (as above)	...seems to prefer waters of fairly high ionic content (U.S.A.)
R. Patrick and L. R. Freese 1961 (as above)	rare...Fresh water.. scraping from pebbles in drainage ditch.. pH 8.6. (ALASKA)
R. Hendey 1964 (as above)	..a brackish-marine species frequent in aestuaries and along the English Channel (ENGLAND)

Table 2

Water Chemistry Data for Collecting Sites of *C. gracilis*

State:	Ohio	Maryland				Iowa			
River:	Ottawa	Patuxent				Dutch	Dugout		
Date:	VII/55	VIII/65				IX/65	VIII/66	VIII/67	
		low tide		high tide					
H_2O Temp.	32° C.	28° C.	29° C.	28° C.	29° C.	19° C.	20° C.	19° C.	20° C.
Alk. (MO)	244	36	42	40	41	260	305	285	—
D.O.	9.0	5.4	6.1	5.2	6.9	—	5.5	—	—
Cl.	16.8	1300	1900	1700	2200	—	4.5	—	—
pH	7.8	7.1	7.3	7.1	7.6	8.5	8.2	7.6	8.4
Hardness (Tl)	416	426	620	495	688	250	—	2010	1020
Ca. (as: $CaCO_3$)	83	90	130	109	135	150	—	230	330
Fe	0.0	0.04	0.06	0.04	0.05	—	—	0.26	0.30
NO_2	0.005	—	—	—	—	0.028	—	0.004	—
NO_3	0.157	0.385	0.587	0.356	0.382	9.2	—	8.0	8.0
NH_3	0.051	—	—	—	—	—	—	—	—
PO_4	0.405	0.029	0.044	0.040	0.060	0.350	2.0	0.30	0.65
SO_4	228	155	255	188	290	18	350	850	850
Turbidity	9.5	103	255	45	92	5JTU	—	—	—
SiO_4	7.9	1.6	2.2	1.3	2.2	16	28	27	30
Cond. (MHO)	—	.0042	.0053	.0049	.0066	—	—	—	—

(Figures in ppm except where indicated.)

In this connection, the matter of total conductivity must not be discarded. Our figures are meager for this measurement, but high conductivity is indicated. It is even possible that sulfates or carbonates may be more specifically limiting (in combination with Ca and/or Mg?) and our data is suggestive of this, but more records are necessary before we can reliably implicate one or a combination of these factors.

It thus appears that *C. gracilis* thrives under mesohalobic-euryhaline conditions, but that this does not quite describe the ecological valence of the species. The Iowa and Ohio data would indicate that water low in chlorides can support substantial growth of this diatom.

C. gracilis has been reported from Iowa previous to this by Drum (1964 unpublished thesis) who listed it as "rare" in collections from the Des Moines River. Fee (1967) finds frequencies of 1 - 10 percent in collections made from Dutch Creek in east central Iowa. His chemical data are included in Table 2.

Conclusions

1. *C. gracilis* is reported for the United States from the following localities: Patuxent River, Prince Georges County, Maryland (brackish water); Ottawa River, Allen County, Ohio (fresh water); Dugout Creek, Dickinson County, Iowa (fresh water).

2. Chemical data of waters in which large populations of this diatom were growing suggest the possibility that factors such as total conductivity, concentration of sulfates, magnesium, calcium, or some intercombination of same may be more critical to the growth and distribution of this diatom than the chloride or sodium ions.

3. Our information supports the reports from the literature insofar as this diatom is shown to be capable of existing as well in inland (fresh, hard water, high ionic content) waters as in brackish water. This further complicates designation of this species as "mesohalob" for, in the sense of chloride content, this diatom cannot be considered as a "salt-water" form even though it could stand as "euryhaline" (Hustedt, 1957).

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