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Notes on Autumn Collections of Diatoms from Brewer's Creek, Hamilton County, Iowa¹

MICHAEL EDWARDS and C. L. CHRISTENSEN²

SYNOPSIS: Biweekly diatom collections and chemical analyses were made in the autumn of 1970 from sites on Brewer's Creek, a small central Iowa stream, and the Boone River. Eight diatom collection sites and five chemical analysis sites were used. Diatom

population data and chemical data both indicate that this is a high alkaline, eutrophic stream. The creek water has a high conductivity which may, in part, explain why diatoms considered to be mesohalobous are present in the collections.

INTRODUCTION

Diatom studies and water analyses have been conducted on small Iowa streams in the past. A study of Dugout Creek was made by Shobe et al. (1962) in the northwestern part of the state. E. J. Fee (1967) completed a more intensive study in Dutch Creek in east-central Iowa. This study was made on a small stream in central Iowa about midway between the other creeks studied. Chemical analyses of water and diatom populations were reported in these papers, but not correlated. We made similar observations and have attempted to show a relationship between the two.

STUDY AREA

The stream selected for study was Brewer's Creek in Hamilton County, Iowa. It meanders for about one and one-half miles through Freedom, Fremont and Independence Townships (T-88-N; R-36 W). It originates in farmland made up of Clarion-Webster glacial till. The last mile of the stream flows through Webster City where it enters the Boone River. The creek bottom is mud in its upper reaches, changing to sand and gravel in the central area, finally becoming extremely rocky in the last 100 yards before the river.

TABLE 1a. CHEMICAL DATA BREWER'S CREEK

Date	Alk ppm CaCO ₃	Total Hardness		Total ppm CaCO ₃	Ortho PO ₄	Turb. JTU	NH ₄ ppmN	NO ₃ ppmN	NO ₂ ppmN
		Mg	Ca						
Sept. 28, 1970									
Station #1	250	70	260	330	1.00	50	0.40	17.6	0.175
#2	200	60	170	330	0.30	32	0.45	22.0	0.182
#5	290	100	260	360	0.02	5	0.54	22.0	0.281
Boone) #7	230	115	200	315	0.60	45	0.62	10.6	0.017
River) #8	235	120	180	300	0.50	42	0.70	13.2	0.017
Oct. 7, 1970									
Station #1	300	200	180	380	0.23	90	2.65	59.4	0.026
#2	280	230	110	340	0.21	38	4.60	38.7	0.109
#5	310	140	250	390	0.50	15	0.61	8.8	0.003
Boone) #7	230	130	170	300	0.85	30	0.53	13.2	0.017
River) #8	245	210	100	310	0.70	28	0.10	8.8	0.017
Oct. 21, 1970									
Station #1	305	160	285	445	0.55	20	0.62	37.4	0.396
#2	305	185	195	380	0.75	7	0.40	35.2	0.241
#5	330	170	270	440	0.48	0	0.14	48.4	0.198
Boone) #7	285	170	210	380	0.40	8	0.44	17.6	0.059
River) #8	300	130	245	375	0.75	12	0.38	26.2	0.073
Nov. 4, 1970									
Station #1	345	170	310	480	2.00	20	0.12	66.0	0.185
#2	315	140	300	440	0.90	15	0.20	66.0	0.149
#5	325	170	275	445	0.50	10	0.20	66.0	0.145
Boone) #7	295	160	230	390	0.60	0	0.15	44.0	0.026
River) #8	310	150	260	410	0.60	5	0.08	52.8	0.043
Nov. 18, 1970									
Station #1	321	190	300	490	0.50	22	0.25	83.6	0.066
#2	283	155	325	480	0.50	12	0.20	61.6	0.049
#5	284	155	310	465	0.76	5	0.10	83.6	0.059
Boone) #7	283	125	305	430	0.50	9	0.12	52.8	0.059
River) #8	293	155	290	445	0.30	15	0.15	55.0	0.036

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² Webster City, Iowa

TABLE 1b. CHEMICAL DATA BREWER'S CREEK

Date	SO ₄	Mn	Cl	SiO ₂	Cu	Fe	Disso O ₂	pH	Temp.
Sept. 28, 1970									
Station #1	145	8.0	55	6.6	0.01	0.14	10	8.50	17.5°C
#2	150	4.7	50	3.8	0.08	0.12	12	8.75	23.5
#5	200	13.6	40	6.4	0.10	0.02	8	8.48	14.5
Boone) #7	220	9.0	40	4.2	0.22	0.10	7	8.50	18.5
River) #8	225	5.7	40	4.2	0.15	0.21	13	8.70	19.5
Oct. 7, 1970									
Station #1	265	10.0	35	3.0	0.15	0.62	10	7.50	17.5
#2	115	12.0	60	9.8	0.15	0.20	9	8.25	17.5
#5	130	18.5	45	4.9	0.15	0.05	5.5	8.10	17.5
Boone) #7	155	5.0	45	5.8	0.15	0.13	9	8.90	20.5
River) #8	145	8.0	50	3.4	0.11	0.20	6	8.10	19.5
Oct. 21, 1970									
Station #1	130	17.0	32	5.0	0.17	0.09	9	8.45	14.0
#2	150	10.5	32	4.0	0.15	0.06	14	8.63	17.0
#5	125	16.0	40	5.0	0.15	0.08	12	8.40	12.0
Boone) #7	125	17.0	28	3.8	0.13	0.04	12	8.45	15.0
River) #8	125	11.5	32	3.3	0.13	0.08	12	8.40	15.0
Nov. 4, 1970									
Station #1	135	16.0	57	3.8	0.10	0.80	10	8.48	7.0
#2	120	17.5	45	4.6	0.09	0.08	12	8.48	9.0
#5	125	15.5	55	5.0	0.05	0.04	10	8.52	7.0
Boone) #7	110	15.5	40	3.9	0.15	0.02	9	8.40	7.0
River) #8	125	17.0	40	2.9	0.14	0.05	11	8.43	6.0
Nov. 18, 1970									
Station #1	125	14.5	55	4.2	0.22	0.11	7	8.60	5.0
#2	160	12.0	42	3.4	0.18	0.05	8	8.55	5.0
#5	135	20.0	50	4.8	0.13	0.04	8	8.55	5.0
Boone) #7	120	13.1	42	4.8	0.13	0.05	9	8.60	4.0
River) #8	128	14.5	40	3.3	0.14	0.02	11	8.55	4.0

METHODS AND MATERIALS

Chemical and physical parameters were determined on a biweekly basis from September 28 to November 18, 1970. This information was collected near the stream's origin (station 1), about midway downstream (station 2) and near the mouth (station 5). The same conditions were measured on the Boone River: one just above the mouth of the stream (station 7) and one just below (station 8). A Hach Engineers Portable Water Testing Laboratory (model Dr-El) was used. All collections and tests were made in the afternoon hours.

Diatom collection stations were selected at random at six points (1-6) along the stream and two places (7-8) on the river (Table 3). Rock and plant scrapings and bottom samples were made at each station on a biweekly basis. Higher plant forms were scarce in the collecting areas but filamentous algal mats were common. The diatom collections were cleaned by using the hydrogen peroxide-potassium dichromate method (Van der Werff, 1953). Burned mounts were also made from each collection, and it was these slides that were used for identification and counting. Uncleaned material from each collection was preserved in formalin-acetic acid-alcohol (FAA) and retained by the senior author.

The cleaned material was placed on #1 cover slips, air dried, then burned for one and one-half hours (Christensen, 1971) and mounted in Hyrax on microscope slides. These slides have been catalogued and numbered 1a-2e2a to 1a-8e5a. Most of the diatom identification specimens have been

circled with a diamond marker (Table 2). A duplicate set of slides has been deposited at the Iowa Lakeside Laboratory Diatom Herbarium, Milford, Iowa.

Relative abundance was first determined by completing genera counts of 500 frustules on each slide under oil immersion (Table 3). The slides were then scanned to identify all taxa present.

RESULTS

The chemical data are contained in table 1a-1b. The water is hard and of relatively high pH (7.5-8.9). This is considered normal for natural waters in this area of the state and in agreement with other Iowa stream studies. It is evident from the table that both calcium and total hardness tend to be greater in the stream than in the river.

Total alkalinity shows an increase as the stream passes over the limestone outcroppings between stations 2 and 5. The results of the tests indicate that total alkalinity is higher in the stream than in the Boone river. It is from these results that the stream's high conductivity can be implied.

The stream water gradually cleared as autumn progressed. Turbidity was always highest over the muddy bottom and lowest in the rocky area near the mouth of the stream. Nitrate readings during this same period tended to increase. The studies also show consistently higher nitrate and nitrite readings in the creek. The low chloride readings in October are perhaps a reflection of the dilution factor resulting from heavy rains during the month.

The stream, in general, reflected environmental changes

more rapidly and to a greater degree than the larger Boone river. Even though temperature readings became lower during the study, the readings tended to remain higher in the stream than in the river.

TABLE 2. DIATOM TAXA IDENTIFIED, BREWER'S CREEK

Achanthes hauckiana Grun.
A. lanceolata (Bréb.) Grun.
Amphora ovalis var. *affinis* (Kütz.) V.H.
A. ovalis var. *pediculus* Kütz.
Anomoeoneis sphaerophora (Ehr.) Pfitzer
Caloneis amphisbaena (Bory) Cleve
C. bacillum (Grun.) Cleve
C. lewisii Patr.
C. lewisii var. *inflata* (Schultze) Patr.
Cocconeis pediculus Ehr.
C. placentula var. *euglypta* (Ehr.) Cleve
Cyclotella atomos Hust.
C. meneghiniana Kütz.
Cylindrotheca gracilis (Bréb.) Grun.
Cymatopleura cochlea J. Brun
C. solea (Bréb.) W. Sm.
Cymbella ventricosa Kütz.
Diatoma vulgare Bory
Diploneis puella (Schumann) Cleve
Epithemia turgida (Ehr.) Kütz.
Eunotia curvata (Kütz.) Lagerst
Fragilaria vaucheriae (Kütz.) Peters
Frustulia vulgaris Thwaites
Gomphonema acuminatum var. *coronata* (Ehr.) W. Sm.
G. acuminatum var. *turris* (Ehr.) Cleve
G. lanceolatum var. *insignis* (Greg.) Cleve
G. olivaceum (Lyngbye) Kütz.
G. parvulum (Kütz.) Grun.
Gyrosigma acuminatum (Kütz.) Rabh.
Melosira varians Agardh
Meridion circulaire Agardh
Navicula capitata Ehr.
N. cuspidata (Kütz.) Kütz.
N. decussis Østr.
N. gastrum (Ehr.) Kütz.
N. lanceolata (Agardh) Kütz.
N. luzonensis Hust.
N. pupula Kütz.
N. pupula var. *rectangularis* (Greg.)
N. pygmaea Kütz.
N. tripunctata (O. F. Mull.) Bory
N. viridula var. *rostellata* (Kütz.) Cleve
Neidium affine (Ehr.) Cleve
Nitzschia acicularis (Kütz.) W. Sm.
N. amphibia Grun.
N. angustata (W. Sm.) Grun.
N. apiculata (Greg.) Grun.
N. vitrea var. *salinarum* Grun.
N. fonticola Grun. in V. H.
N. frustulum var. *perminuta* Grun.
N. hungarica Grun.
N. linearis (Agardh.) W. Sm.
N. longissima var. *reversa* Grun.
N. palea (Kütz.) W. Sm.
N. sigmoidea (Nitzsch.) W. Sm.
Pinnularia brebissonii (Kütz.) Rehb.
P. iridis (Nitzsch.) Ehr.
Rhoicosphenia curvata (Kütz.) Grun.

Rhopalodia gibba (Ehr.) O. Mull.
R. gibberula (Ehr.) O. Mull.
Stauroneis acuta W. Sm.
S. phoenicenteron (Nitzsch.) Ehr.
S. smithii Grun.
Surirella angusta Kütz.
S. brightwellii W. Sm.
S. ovata Kütz.
S. tenera Greg.
Synedra rumpens Kütz.
S. ulna (Nitzsch.) Ehr.

We identified 69 diatom taxa from 28 genera (Table 2), including 20 genera with a raphe in both valves and eight with a raphe in only one valve or lacking a raphe. *Navicula* and *Nitzschia* constituted the largest part of the populations in most collections. Results show that the *Navicula*, in general, represented a larger percent of the stream populations than those of the river. *Surirella* and *Synedra* became more numerous in late autumn; *Amphora* and *Cyclotella* species, on the other hand, almost disappear.

DISCUSSION

Our data reveal that the water in this stream is hard. The high phosphate and nitrogen readings indicate a eutrophic condition. The stream also shows high pH and alkalinity readings which reflect the high conductivity present in the water.

The diatom flora of Brewer's creek reflects the high pH. The forms encountered have been classified from pH-indifferent through alkaliphilous to alkalibiontic. *Anomoeoneis sphaerophora* and *Gyrosigma acuminatum* are examples of alkalibiontic taxa as reported by Foged (1954) and Hustedt (1930).

Plankton forms of diatoms were collected only from small, calm, backwater pools. They represent only a minority of the total population. Species of floating forms of diatoms observed included: *Cyclotella atomos*, *C. meneghiniana*, *Epithemia turgida*, *Fragilaria vaucheriae*, *Gomphonema acuminatum* var. *coronata*, *Melosira varians*, *Navicula gastrum*, *N. lanceolata*, *Nitzschia acicularis* and *Synedra rumpens*.

Anomoeoneis sphaerophora, *Caloneis amphisbaena* and *Cyclotella meneghiniana* are listed (Foged, 1951) as halophilous diatoms (0-5% salt). *Cylindrotheca gracilis*, *Achnanthes hauckiana*, *Navicula pygmaea* and *Nitzschia apiculata* are considered (Foged, 1951) to be mesohalobous diatoms (5-20% salt). Various authors have indicated that these diatoms are brackish water forms. We suggest that the presence of these diatoms in this and other small Iowa streams are an indication of their environmental requirement for high conductivity in the water rather than their need for chloride ions (Christensen-Reimer, 1968).

The majority of species in the diatom population indicate, by their presence in this stream, an alkaline, eutrophic condition in the water. This correlates well with the chemical data. Indicator species observed for high alkalinity and eutrophic conditions are *Gyrosigma acuminatum*, *Nitzschia palea*, *Gomphonema acuminatum* and *Anomoeoneis sphaerophora* (Foged, 1951).

TABLE 3a DIATOM POPULATIONS IN %, BREWER'S CREEK

	Achnanthes	Amphora	Anomooneis	Caloneis	Cocconeis	Cyclotella	Cylindrotheca	Cymatopleura	Cymbella	Diatoma	Diploneis	Epithemia
Sept. 28, '70												
Station #1	6.0	2.6				+	1.0	x	x		+	
2	1.6	x				1.0			+		x	
3	1.6	+		x	x	2.2	x	x	+		x	
4	1.2	+			x	1.0	x		+		x	
5	1.4	1.6		x		4.8	x		+		+	
6	1.0	1.2				9.2			x		+	
Boone)	+	+		x	x	72.4		x	x			
River)	+	x		x	x	55.8		x	+			
Oct. 7, '70												
Station #1	+	1.7	x			+	x	x	+			x
2	1.5	+		+	x	1.9	x	x	x	x	x	
3	+	2.8	x	x	x	+	x	x	+	x	+	
4	3.6	+			x	2.6			+			1.6
5	2.5	11.2		+	+	6.5		+	+			2.5
6	2.8	4.0		+	+	8.0		x	+	x	+	
Boone)	1.8	x		x	x	52.2		x	x			
River)	+	+		x	x	44.9		+			+	
Oct. 18, '70												
Station #1	+	3.5		+	+	1.1	x	+	x			x
2	1.0	+		+		+	x		+			x
3	+	+				+	x		x	x		
4	1.2	+		x	x	x		x	+			x
5	+	1.0		+	x	2.2		x	x		+	
6	+	+	x	x	+	1.2		x	+	x	x	x
Boone)	+	+		x	x	16.4		+	x	x	x	
River)	+	x	x	x	x	3.4	x	x	x			x
Nov. 4, '70												
Station #1	x	+			x	x	x	+	x			x
2	+	x		+		x	x		+			
3	1.4	+				+	+		+			
4	+	+		+		+		x	x			
5	+	x		x		+			+			x
6	+	+		x	x	+		x	+			x
Boone)	+	x		x	x	3.2		x			+	
River)	3.0	x		x	x	2.2		x	x			
Nov. 18, '70												
Station #1	1.2	+			x	1.0	x		+			
2	1.8	x		+		+			x	x		
3	+	x		x		+	x		+	x		
4	2.4	x		+					+			
5	1.2	x		+	x	x			+			x
6	+	x		x		+		+	+			
Boone)		x	x	x		+		x				x
River)	5.6	x		x		x		x				

+ = less than 1%
x = present

AUTUMN COLLECTIONS OF DIATOMS

TABLE 3b DIATOM POPULATIONS IN %, BREWER'S CREEK

	Fragilaria	Gomphonema	Gyrosigma	Melosira	Navicula	Nitzschia	Pinnularia	Rhoicosphenia	Rhopalodia	Stauroneis	Surirella	Synedra
Sept. 28, '70												
Station #1		x	+	1.6	62.6	23.8	+				+	
2		1.4	x		49.2	45.6	1.0				+	
3		+	x		38.6	56.2	+				+	
4		+	x	x	65.8	29.8		+			+	+
5		+	x	+	20.6	50.0		+			+	x
6		+	x	+	40.0	45.4		1.0			+	+
Boone) 7		+	+	1.0	5.4	19.6		+	+		x	+
River) 8		+	+	+	15.6	25.8		+	+		+	+
Oct. 7, '70												
Station #1		+	+	x	50.3	44.2	x			x	+	+
2			4.7	x	26.3	59.9		+	x		1.1	x
3	1.6		1.6	x	38.2	53.0	+				+	
4	+		1.2	x	41.8	44.8	x	2.0			1.0	
5			+	+	40.4	33.1		1.1	x		+	+
6			3.0	x	40.2	31.4	x	8.2	x		+	+
Boone) 7			2.8	x	13.4	29.0			+		+	x
River) 8			2.1	x	22.8	26.2		x			x	+
Oct. 18, '70												
Station #1	+	12.8	1.2	+	31.7	40.9	x	+			2.5	3.5
2		4.4	+	x	27.6	63.6	x	x			1.2	+
3		4.8	x	+	39.0	53.4	x				+	+
4		+	+	x	38.6	57.6	x	+	x		+	+
5		x	+	x	27.2	67.2	x	+	x		+	+
6		3.9	x	x	28.8	61.6		x		x	1.6	+
Boone) 7		+	+		9.2	74.4	x	+	x		+	x
River) 8		x	+	x	17.6	79.8	x				+	+
Nov. 4, '70												
Station #1	+	+	+	x	16.6	51.0					15.4	14.8
2	+	9.8			25.4	57.8	x				2.8	2.4
3		1.0	x	x	24.4	68.6	+		x		2.2	+
4		+	+		27.2	61.3	x				5.8	2.7
5		1.8	x	x	3.9	90.0					+	2.5
6		+	x	x	15.0	80.6			x		2.2	+
Boone) 7		x	x	x	8.0	88.0			x		+	
River) 8		1.6	x	x	19.8	73.6					1.6	4.2
Nov. 18, '70												
Station #1	1.4	x	+	x	5.8	24.2		+			46.0	19.0
2	+	7.8	+	+	23.4	49.2	+				10.6	4.4
3	x	2.0	+	x	26.0	49.2	+				14.8	6.4
4		+	x	x	22.4	46.8		+	x		22.6	3.8
5		+	x	x	9.0	79.6					4.8	4.2
6	+	+	x	x	14.0	67.6			x		15.4	1.2
Boone) 7		x	x		2.6	97.2	x				x	
River) 8		3.8	x		24.2	61.2					4.2	1.0

+ = less than 1%

x = present

Several species and varieties encountered during this investigation do not yet appear in the published record for Iowa. The majority of these are probably of common occurrence in the state as they are listed in various unpublished theses in the library of Iowa State University. We include the following taxa as previously unpublished for the state: *Achnanthes hauchiana*, *A. lanceolata*, *Amphora ovalis* var. *affinis*, *Diploneis puella*, *Fragilaria vaucheriae*, *Gomphonema acuminatum* var. *coronata*, *G. lanceolatum* var. *insignis*, *Navicula capitata*, *N. luzonensis*, *N. viridula* var. *rostellata*, *Nitzschia angustata*, *N. vitrea* var. *salinarum*, *N. longissima* var. *reversa* and *Surirella brightwellii*. These three entities appear to be new records for the state: *Diploneis puella* (Schum.) Cl., *Nitzschia vitrea* var. *salinarum* Grun. and *Nitzschia longissima* var. *reversa* Grun.

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