

THE PLANKTON AND BENTHOS OF ABBEY POND, 1970 AND 1971¹

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ABSTRACT

Plankton and benthos were sampled for a two-year period in Abbey Pond. Phytoplankton was dominated by two diatoms and one blue-green alga during both years. Total population numbers ranged from 2.5×10^3 to 1.0×10^6 organisms per liter in 1970 and from 4.8×10^3 to 2.0×10^6 organisms per liter in 1971. Chironomids, ceratopogonids, and oligochaetes dominated the benthos. Peaks in yearly populations occurred in spring and late fall in 1970 and 1971. Total zooplankton counts ranged from 1.1 to 498.8 organisms per liter in 1970 and from 10.0 to 305.2 organisms per liter in 1971. Populations appeared similar to diamic populations described by Hutchinson (1967).

INTRODUCTION

The increased demands placed on our lakes and streams by an expanding population, coupled with an accelerated rate of eutrophication, makes the description of aquatic ecosystems essential if we are to properly conserve and manage our water resources. Knowledge gained in the study of ponds and small impoundments may be applied to larger ecosystems because ponds often represent microcosms of larger systems, containing many of the same components and functioning with similar processes, but in a more limited space. Abbey Pond may represent a microcosm of eastern South Dakota lakes.

POND DESCRIPTION

Abbey Pond is a 1.62 ha-impoundment on the eastern edge of the Coteau des Prairie in Grand County, South Dakota. The watershed is a mixture of crop land and pasture with all adjacent land having vegetative cover. The principle source of water for the pond is runoff.

Based on measurements made during the fall of 1970, the pond had a volume of 46,920 m³ of water, a maximum depth of 6.09 m, and a shore development of 1.7. Secchi disc visibility, which approximates the depth to which 5 percent of the incident sunlight is transmitted, varied from 90 to 400 cm on the sampling dates, with a mean of 187 cm.

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The pond undergoes periods of thermal and chemical stratification. Physical and chemical limnological characteristics are comparable to values found by Schmidt (1967) for eastern South Dakota lakes.

The eight species of fish (Table 1) found in the pond constitute a more diverse population than is normally encountered in South Dakota ponds and probably influenced plankton and benthos population dynamics.

TABLE 1
ESTIMATED NUMBERS OF FISH AND STANDARD ERROR OF
ESTIMATES IN ABBEY POND, 1970

Species	Estimated Number of Fish in Pond	Standard Error
Perch	2090.6	± 92
Bluegill	1910.8	±315
Largemouth bass	461.8	± 15
Black crappie	851.9	±120
Yellow bullhead	341.0	±109
Black bullhead	130.0	± 74
Pumpkinseed	61.0	± 17
White crappie	21.0	± 4

METHODS

Samples of zooplankton, phytoplankton, and benthos were collected in 1970 and 1971. Intervals between sampling dates were 10 days or 14 days depending upon the time of year.

Zooplankton samples were collected with a metered Miller sampler (Miller, 1961) fitted with a No. 10 net. A single horizontal pull was made on each sampling date in 1970. A double oblique tow was made on each sampling date in 1971. Samples were preserved in a 10 percent solution of formalin. Numbers of microcrustaceans were determined by counting three subsamples in a counting wheel (Ward, 1955).

Phytoplankton samples were collected using a vertical pull with a Wisconsin plankton net fitted with a No. 20 net. Three

random samples were taken on each sampling date. Samples were preserved in Lugol's solution. Numbers of organisms were determined by counting two subsamples from each sample in a Sedgwick-Rafter counting chamber at 150 X.

Estimates of benthos populations were made by taking three random samples on each sampling date with an Ekman dredge (14.8 x 15.0 cm). Material collected in 1970 was preserved in 10 percent formalin. In 1971 collected material was refrigerated and analysis completed within 24 hours. Organisms were separated from detritus using a sugar floatation technique (Anderson, 1959).

Population estimates for each species of fish were determined using a method described by Schnabel (1938). Fish for these estimates were collected by electrofishing with a boom-type, DC electro-shocker.

RESULTS AND DISCUSSION

Zooplankton

Total zooplankton populations ranged from 1.1 to 498.8 organisms per liter in 1970 and from 10.0 to 305.2 organisms per liter in 1971 (Tables 2 and 3). Maxima in early summer and again in autumn indicated the populations were similar to diamic populations described by Hutchinson (1967). During both 1970 and 1971, June and July peaks were dominated by *Daphnia galeata* Sars *mendotae* Birge while the fall peak was dominated by *Bosmina longirostris* (O. F. Muller), a eutrophic species not usually associated with fall pulses (Figures 1 and 2). It appears that the greater filtering efficiency of *Daphnia galeata* allows it to outcompete *Daphnia parvula* (Fordyce) and *Daphnia ambigua* (Scourfield). Copepods made up a substantial portion of the total population during the spring and fall pulses. Cyclopoid copepods were more numerous than calanoid copepods which occurred irregularly and in trace amounts.

Utilization of the larger zooplankters by fish increased as the zooplankton became more available (Gengerke, 1972). That fish are able to discriminate when feeding has also been suggested by Galbraith (1967). The phenomenon of selecting large zooplankters when smaller zooplankters are present and more numerous was also observed by Gerking (1954), Hall (1964), and Cramer and Marzolf (1970). This high utilization contributed to the decline of zooplankton populations. Consistent utilization by black crappies contributed to the suppression of zooplankton populations.

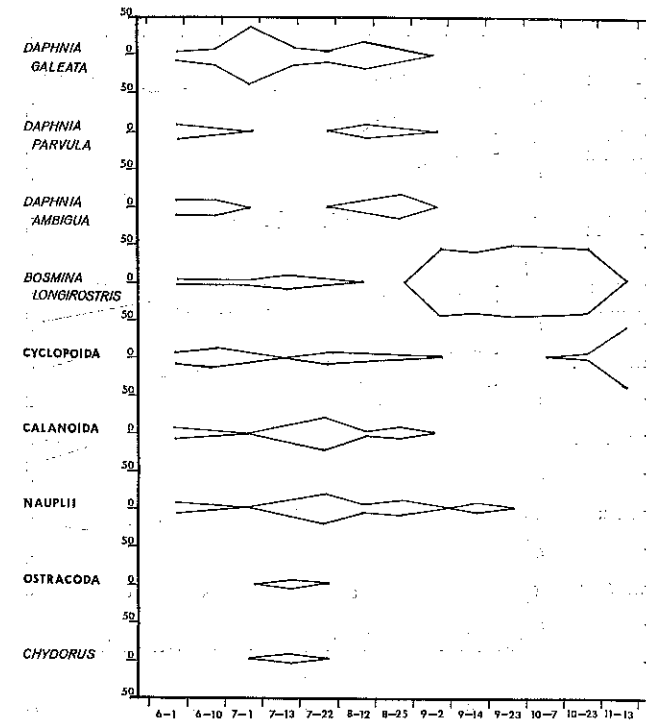


Figure 1. Zooplankton populations of Abbey Pond during 1970, expressed as percent of total population.

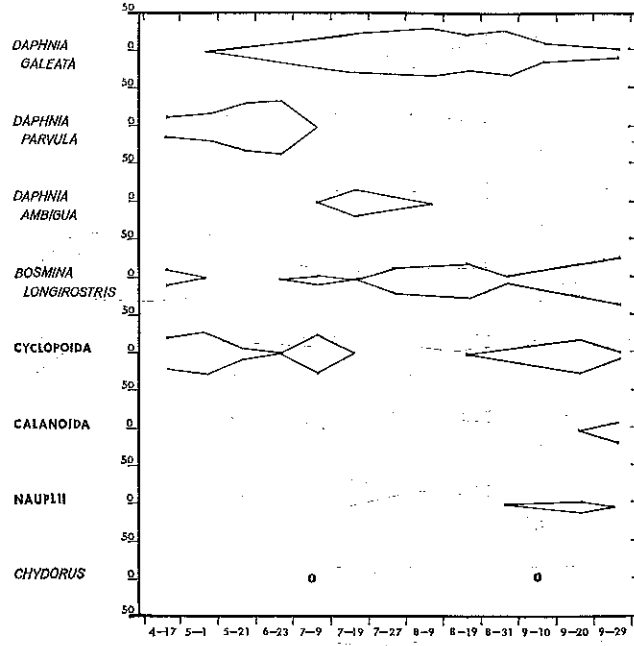


Figure 2. Zooplankton populations of Abbey Pond during 1971, expressed as percent of total population.

TABLE 2
Density Per Liter and Percent Occurrence (In Parentheses) of Zooplankton
In Abbey Pond During 1970

	6-1	6-10	7-1	7-13	7-22	8-12	8-25	9-2	9-14	9-23	10-7	10-23	11-13
Crustacea													
Cladocera													
<i>Daphnia galeata</i>	12.3 (9.8)	101.6 (20.3)	201.9 (74.9)	1.6 (29.8)	0.9 (19.2)	0.4 (35.1)	0.2 (16.0)	T (T)	0.1 (T)	1.5 (1.0)	0.5 (1.0)	0.7 (4.1)	0.5 (1.9)
<i>Daphnia parvula</i>	27.2 (21.7)	85.2 (17.0)	0.6 (T)			0.2 (15.7)	0.1 (5.6)		0.2 (T)		0.1 (T)	0.1 (1.0)	0.1 (1.9)
<i>Daphnia ambigua</i>	26.2 (20.9)	102.7 (20.5)	1.2 (T)			0.2 (15.7)	0.3 (27.3)		1.2 (3.1)	0.8 (1.0)	1.1 (1.4)	0.8 (4.7)	
<i>Bosmina longirostris</i>	10.4 (8.3)	18.6 (3.7)	18.5 (6.8)	1.0 (17.9)	0.4 (8.4)	0.1 (5.5)	0.1 (4.7)	3.2 (86.7)	29.9 (80.2)	191.2 (98.2)	68.5 (93.3)	13.4 (83.7)	1.3 (5.0)
<i>Chydorus</i>	3.0 (2.3)	0.5 (T) ¹	0.6 (0.2)	0.2 (3.7)		T ² (1.0)		0.2 (4.5)	0.1 (T)		0.2 (T)		
Copepoda													
Cyclopoidea	21.2 (16.9)	119.1 (23.8)	38.8 (14.4)	0.3 (4.9)	0.4 (8.4)	0.1 (8.3)	0.1 (11.3)	0.2 (4.0)	1.7 (3.1)	0.3 (T)	2.0 (2.7)	0.8 (5.1)	20.8 (81.3)
Calanoidea	6.4 (5.1)	33.9 (6.7)	6.0 (2.2)	1.4 (27.4)	1.5 (30.1)	0.1 (5.5)	0.1 (10.3)	0.1 (1.6)	0.3 (1.0)	0.6 (1.0)	0.2 (1.0)	0.2 (1.0)	1.2 (4.7)
Nauplii	18.3 (14.6)	37.1 (7.4)	1.8 (1.0)	0.5 (9.2)	1.7 (34.0)	10.0 (9.2)	0.2 (21.6)	0.1 (1.6)	3.8 (10.1)	0.5 (1.0)	0.5 (1.0)	0.1 (1.0)	1.7 (6.7)
Ostracoda													
TOTAL	124.9	498.8	269.3	5.3	4.9	1.1	1.1	3.7	37.2	153.9	73.4	16.0	25.5

¹Less than 1%

²Less than 0.1 organism per liter

TABLE 3
Density Per Liter and Percent Occurrence (In Parentheses) of Zooplankton
In Abbey Pond During 1971

	Date												
	4-17	5-1	5-21	6-23	7-9	7-19	7-27	8-9	8-19	8-31	9-10	9-20	9-29
Crustacea													
Cladocera													
<i>Daphnia galeata</i>	0.5 (T) ¹	5.1 (1.6)	5.6 (10.9)	23.8 (25.7)	10.3 (28.2)	122.9 (58.8)	67.4 (54.7)	65.7 (60.0)	49.9 (50.3)	22.4 (57.9)	8.6 (33.9)	1.3 (12.9)	0.8 (4.0)
<i>Daphnia parvula</i>	29.8 (24.4)	115.6 (37.8)	35.0 (68.2)	65.9 (71.4)	1.4 (3.9)					0.2 (T)			
<i>Daphnia ambigua</i>	1.5 (1.2)	0.9 (T)			0.9 (2.3)	69.0 (33.0)	10.7 (8.6)						
<i>Bosmina longirostris</i>	26.2 (21.5)	8.6 (2.8)	2.8 (5.3)	1.3 (1.3)	2.2 (5.9)	4.3 (2.0)	40.9 (33.2)	40.5 (37.0)	44.7 (45.1)	8.6 (22.0)	7.2 (28.5)	4.0 (39.5)	12.0 (60.6)
Chydorus					0.5 (1.3)						0.3 (1.0)		
Copepoda													
Cyclopoida	56.0 (45.9)	174.6 (57.2)	7.4 (14.3)	1.1 (1.1)	18.8 (51.5)	12.4 (5.9)	1.7 (1.4)	2.8 (2.5)	4.4 (4.4)	6.3 (16.3)	8.4 (33.2)	4.1 (40.5)	2.2 (10.9)
Calanoida	0.5 (T)	0.4 (T)			0.2 (1.0)					0.1 (T)			
Nauplii	6.1 (5.0)		0.2 (T)	0.2 (T)	0.1 (T)		1.8 (1.4)	0.3 (T)		1.2 (3.0)	0.7 (2.8)	0.7 (6.9)	
Ostracoda			0.3 (1.0)		2.1 (5.6)	0.2 (T)	0.4 (T)						
TOTAL	121.9	305.2	51.3	92.3	36.4	208.9	123.1	109.4	99.0	38.8	25.3	10.0	19.8

¹Less than 1%

²Less than 0.1 organism/liter

Phytoplankton

Phytoplankton populations were dominated by two diatoms (*Fragilaria crotonensis* and *Melosira granulata*) and one blue-green alga (*Aphanizomenon flosaquae*) (Tables 4 and 5). Populations ranged from 2.5×10^3 to 1.0×10^6 cells per liter in 1970 and from 4.9×10^3 to 2.0×10^6 cells per liter in 1971. Diatoms predominated in June and from the middle of September through November in 1970, while blue-green algae dominated in July and August, 1970. Diatoms were dominant throughout 1971 except for a brief period of blue-green dominance in September (Figures 3 and 4). Although many interrelated biological, biochemical, and physical factors are responsible for spring and fall pulses of diatoms and for periods of blue-green dominance it is obvious that at least vernal maxima may be attributed to increased illumination at a time of high nutrient availability.

Melosira granulata, which is characteristic of lakes that produce important blue-green maxima (Hutchinson, 1967) peaked prior to the pulse and after the decline of the *Aphanizomenon* population in 1971.

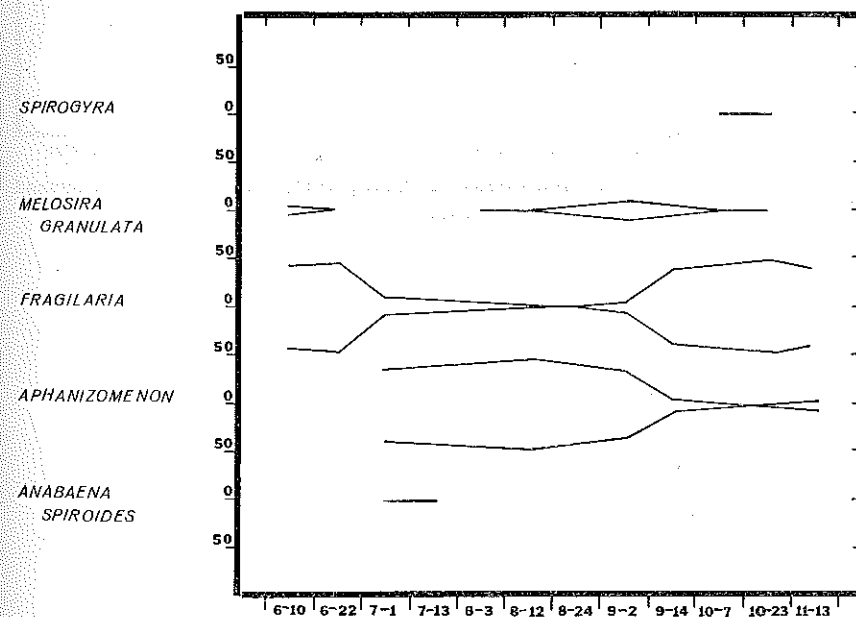


Figure 3. Phytoplankton populations of Abbey Pond during 1970, expressed as percent of total population.

Organisms which made up < 1.0 percent of the total population included *Pediastrum duplex*, *Mougeotia*, *Closterium*, *Ceratium hirundinella*, *Navicula*, and the sedimentary diatom *Cymatopleura*.

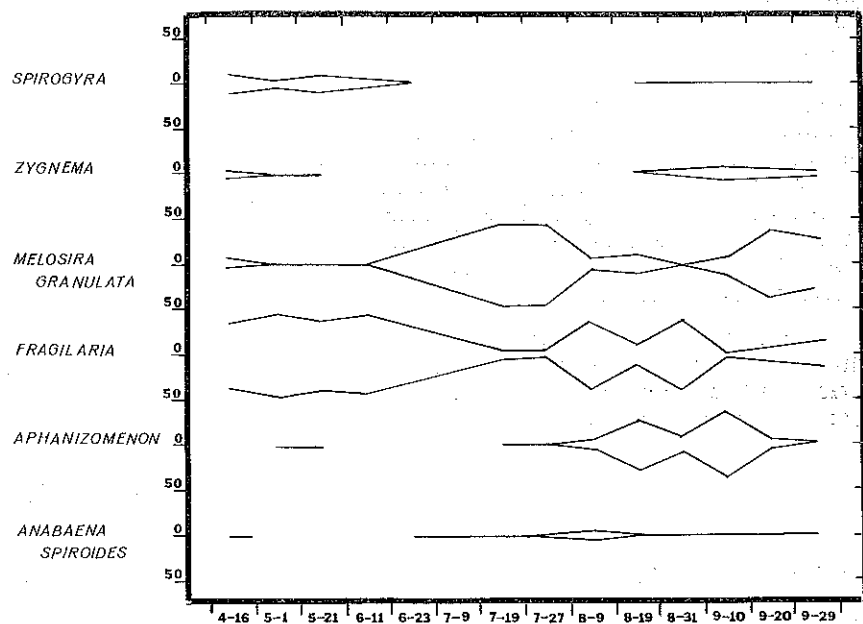


Figure 4. Phytoplankton populations of Abbey Pond during 1971, expressed as percent of total population.

TABLE 4
Phytoplankton¹ Density Expressed As Cells x 10⁶/Liter and Percent Composition
(In Parentheses) in Abbey Pond During 1970

	6-10	6-22	7-1	7-13	8-3	8-12	8-24	9-2	9-14	10-7	10-23	11-13
Chlorophyta												
Spirogyra										T	(T)	0.1
Chrysophyta												
Melosira		T ²										
granulata	1.2	(4.0)			0.2	T	10.7	18.6	2.9	T	T	T
Fragilaria	28.9	10.2	3.0	5.7	0.6	3.3	1.4	7.0	57.6	4.8	26.4	2.3
	(95.9)	(99.6)	(13.9)	(6.0)	(1.8)	(T)	(T)	(5.6)	(84.6)	(89.3)	(99.4)	(91.6)
Cyanophyta												
Aphanizomenon			18.1	88.0	30.5	1083.6	574.5	97.4	7.5	0.4	T	0.2
			(85.4)	(93.0)	(97.2)	(95.6)	(97.9)	(79.1)	(11.0)	(8.0)	(T)	(8.3)
Anabaena			T	T								
spiroides			(T)	(T)								
TOTAL	30.1	10.2	21.2	94.6	31.4	1087.0	586.7	123.1	68.1	5.4	26.6	2.5

¹Organisms making up < 1.0 percent of the total population (*Pediastrum duplex*, *Mougeotia*, *Closterium*, *Ceratium hirundinella*, *Navicula*, and *Cymatopleura*) were omitted from this table.

²Less than 100 organisms/liter

³Less than 1%

TABLE 5
Phytoplankton¹ Density Expressed As Cells x 10⁶/Liter and Percent Composition
(In Parentheses) in Abbey Pond During 1971

	Date													
	4-16	5-1	5-21	6-11	6-23	7-9	7-19	7-27	8-9	8-19	8-31	9-10	9-20	9-29
Chlorophyta														
Spirogyra	2.4 (17.2)	0.1 (2.8)	0.6 (11.5)	0.3 (5.1)	1.0 (T)					0.4 (1.4)	0.4 (T)	T (T)	0.2 (T)	0.1 (T)
Zygnema	0.2 (1.5)		T (T)							T (T)	1.7 (1.9)	2.0 (5.7)	5.2 (1.7)	2.2 (3.6)
Chrysophyta														
Melosira granulata	0.3 (2.1)			T (T)	39.6 (38.7)	8.6 (57.2)	125.8 (93.8)	1933.9 (96.4)	3.0 (14.9)	4.5 (16.1)	0.8 (T)	6.5 (18.5)	260.3 (87.3)	46.5 (78.3)
Fragilaria	10.9 (78.7)	4.7 (96.3)	4.4 (87.3)	5.1 (94.6)	61.5 (60.2)	6.4 (42.6)	7.8 (5.7)	60.3 (3.0)	15.0 (75.3)	8.9 (32.1)	69.3 (77.9)	0.8 (2.1)	17.8 (5.9)	9.2 (15.4)
Cyanophyta														
Aphanizomenon		T (T)	T (T)				T (T)		1.7 (8.4)	13.6 (49.0)	16.5 (18.6)	25.7 (73.1)	14.6 (4.8)	1.4 (2.3)
Anabaena spiroides	T ² (T) ³						0.4 (T)	10.2 (T)	0.3 (1.2)	0.2 (T)	0.2 (T)	T (T)	T (T)	T (T)
TOTAL	13.8	4.9	5.0	5.4	102.2	15.1	134.0	2004.4	19.9	27.8	88.9	35.1	298.1	59.4

¹Organisms making up < 1.0 percent of the total population (Pediastrum duplex, Mougeotia, Closterium, Ceratium hirundinella, Navicula, and Cymatopleura) were omitted from this table.

²Less than 100 organisms/liter

³Less than 1%

Benthos

Benthos populations were dominated by chironomids, ceratopogonids, and oligochaetes. Other organisms such as those found in the taxa Coleoptera, Ephemeroptera, Neuroptera, Hemiptera, Arachnida, Amphipoda, and Hirudinea occurred in low numbers or irregularly during the study. Total numbers of organisms per square meter ranged from 375 to 5751 in 1970 and from 796 to 3964 in 1971. Peaks in yearly populations occurred in spring and late fall in 1970 and 1971 (Figure 5; Tables 6 and 7). Population levels fluctuated very little throughout the rest of the study. Differences in habitat requirements, seasonal movements, behavioural adaptations, and mobility made satisfactory quantification infeasible for those organisms which occurred in low numbers or irregularly.

The benthic community was heavily utilized as a food resource by fish during all sampling periods (Gengerke, 1972).

With reference to benthic communities, Abbey Pond appears to be similar to Jonasson's (1969) description of an unpolluted eutrophic lake.

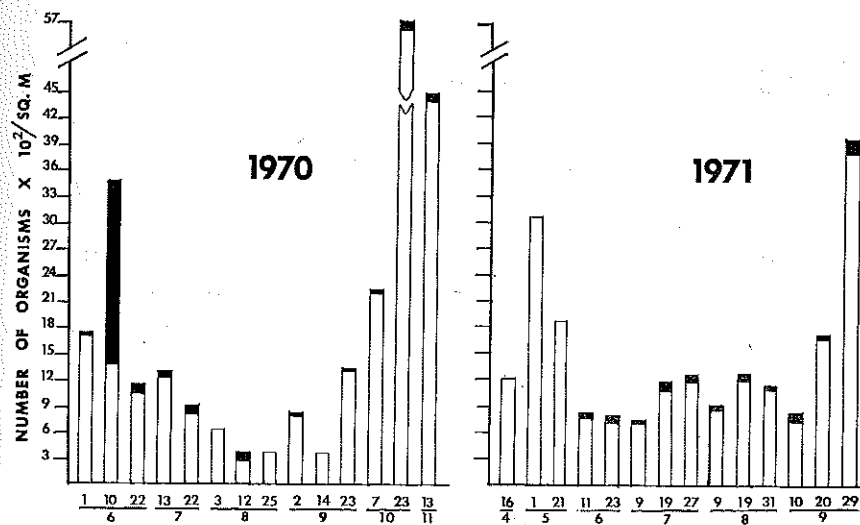


Figure 5. Total number of organisms obtained in Ekman dredge samples from Abbey Pond. Unshaded area indicates percent of total made up by the taxa Chironomidae, Ceratopogonidae, and Oligochaeta.

TABLE 6
Benthos Standing Crop Expressed As Number of Organisms Per Square Meter and
Percentage of Total (Parentheses) in Abbey Pond During 1970

	Date													
	6-1	6-10	6-22	7-13	7-22	8-3	8-12	8-25	9-2	9-14	9-23	10-7	10-23	11-13
Mollusca		90 (2.6)												30 (1.0)
Arthropoda														
Insecta														
Diptera Chironomidae	1036 (62.7)	540 (15.7)	360 (32.4)	360 (28.5)	90 (10.3)	165 (24.4)	60 (16.0)	15 (3.8)	195 (23.6)	151 (38.6)	1291 (96.6)	1892 (84.3)	5270 (91.6)	4369 (96.9)
Ceratopogonidae	616 (37.2)	901 (26.3)	450 (40.5)	270 (21.4)	616 (70.7)	420 (62.2)	195 (52.0)	375 (96.1)	180 (21.7)	60 (15.3)	45 (3.3)	330 (14.7)	405 (7.0)	90 (1.9)
Coleoptera		90 (2.6)		15 (1.1)	15 (1.7)									
Ephemeroptera		811 (23.6)			15 (1.7)		15 (4.0)							15 (T) ¹
Hemiptera				15 (1.1)										
Neuroptera							15 (4.0)							
Arachnida			15 (1.3)	15 (1.1)	30 (3.4)		90 (24.0)						30 (1.0)	
Crustacea														
Amphipoda						496 (14.4)								
Annelida						45 (1.3)								
Hirudinea														
Oligochaeta			285 (25.6)	586 (46.4)	105 (12.0)	90 (13.3)	375	390	450 (54.4)	180 (46.0)	1336	30 (1.3)	30 (1.0)	15 (T)
TOTAL	1652	3423	1111	1261	871	675	375	390	826	391	1336	2242	5751	4504

¹Less than 1%

TABLE 7
Benthos Standing Crop Expressed As Number of Organisms Per Square Meter and Percentage of
Total (Parentheses) in Abbey Pond During 1971

	Date													
	4-16	5-1	5-21	6-11	6-23	7-9	7-19	7-27	8-9	8-19	8-31	9-10	9-20	9-29
Mollusca					60 (6.7)	15 (1.8)								
Annelida														
Oligochaeta	225 (17.4)	15 (T) ¹	15 (1.0)	45 (5.0)		165 (20.3)	255 (18.8)	255 (17.3)	60 (7.5)		330 (28.1)	465 (55.2)	180 (10.2)	
Arthropoda														
Insecta														
Diptera Chironomidae	1036 (80.2)	2686 (86.0)	1321 (70.3)	826 (93.2)	766 (86.4)	375 (46.2)	796 (58.9)	1111 (75.5)	691 (86.8)	1261 (96.5)	811 (69.2)	315 (37.4)	1516 (86.3)	3799 (95.8)
Ceratopogonidae	30 (2.3)	240 (7.6)	540 (28.7)	15 (1.6)	45 (5.0)	255 (31.4)	270 (19.9)	90 (6.1)	30 (3.7)	45 (3.4)	30 (2.5)	30 (3.5)	60 (3.4)	15 (T)
Coleoptera					15 (1.6)		15 (1.1)							
Arachnida							15 (1.1)	15 (1.0)	15 (1.8)		30 (3.5)			15 (T)
Crustacea														
Amphipoda														15 (T)
TOTAL	1291	3123	1877	886	886	811	1351	1471	796	1306	1171	841	1756	3964

¹Less than 1%

SUMMARY

Abbey Pond was dominated by two diatoms (*Fragilaria crotonensis* and *Melosira granulata*) and one blue-green alga (*Aphanizomenon flosaquiae*). The pond contains relatively high populations of zooplankton with diversity similar to lakes of the surrounding region. The benthic community contained a variety of organisms, but was dominated by chironomids, ceratopogonids, and oligochaetes. With reference to plankton and benthos populations, Abbey Pond appears to represent a microcosm of eastern South Dakota lakes.

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