

A DIATOM POPULATION AND NUTRIENT SURVEY
IN THE MISSISSIPPI RIVER
AT LOCK 7 AND LOCK 8

A Thesis
Presented to the
Graduate School
Wisconsin State University, La Crosse, Wisconsin

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
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July 1969

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ABSTRACT

The purpose of this study is twofold: (1) to obtain information which may be used to determine to what extent diatoms can be used as water quality indicators; (2) to supplement baseline data on annual plankton standing crops of the upper Mississippi River.

This survey began 3 October, 1967, and continued through 30 September, 1968. Three samples were taken every two weeks: one in Pool 7 above Lock and Dam No. 7, one in the channel at Lock and Dam No. 7, and one in the channel at Lock and Dam No. 8. A water nutrient analysis was done in addition to the diatom survey.

Sixty seven species of diatoms are identified in this survey. The data includes only the ten species which made up 5% or more of each sample. Species domination, timing of annual maximum standing crops, and per cent occurrence-per cent volume relationships are compared to the Department of Health, Education, and Welfare's Water Pollution Surveillance System reports (1957-1967). Correlations of standing crop and physiochemical factors are discussed.

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INTRODUCTION

The purpose of this study is twofold: (1) to obtain information which may be used to determine to what extent diatoms can be used as water quality indicators; (2) to supplement baseline data on annual plankton standing crops of the upper Mississippi River.

The upper Mississippi River habitat is being studied by the U.S. Public Health Service at five points, each approximately 150 miles apart. This program (Water Pollution Surveillance System) provides fundamental information on the quality of the nation's water. This study should prove valuable, in the near future, as part of a comparative standard for this part of the river.

Diatoms are one of the most widely spread members of the Algae. Their wide range of chemical and physical tolerances in different species enable them to grow in almost every type of water. A species with a wide tolerance range may be found in many varied water systems, while a species with a narrow tolerance range has a limited existence.

Most diatom studies have been done on lakes and ponds. These communities are more stable habitats, whereas rivers provide habitats which are less stable. They are subject to faster changes along their length: changes associated with depth, rate of flow, geology of the land surface and of the stream bed, salt concentrations, turbidity, temperature, etc.

All these are further complicated by seasonal changes.

Schroder (1899), from the results of work on the Oder River, proposed the theory that the amount of plankton in a river is inversely proportional to the slope of the river. The lock system on the Mississippi limits this theory.

The river bed changes as the rock strata changes. All three sampling stations are located in basically the same type of terrain. Limestone bluffs border the channel, varying in height and distance from the channel. The height varies from less than 100 feet to over 600 feet. The channel approaches the base of the bluff as close as 50 feet to over a mile away. The bluffs, acting as barriers, limit the wind currents and minimize radical local weather changes.

LITERATURE REVIEW

What plankton studies have been done on the Upper Mississippi River? Galtsoff (1924) made a study in the summer of 1921 from Hastings, Minnesota, to Alexandria, Missouri. He determined the composition, amount, and distribution of plankton in various parts of the river and in the pools, with special reference to the fisheries and to the changed conditions created by the Keokuk Dam.

H. R. Crohurst of the United States Public Health Service undertook studies of the river during 1926 and 1927. His reports (unpublished) were mostly views of a sanitary engineer, containing very little biological information.

Wiebe (1928) made a biological survey of this same area for the United States Bureau of Fisheries. His results related to bottom fauna, the plankton, and the fish life of the river. The field work covered a period of six weeks in August and September of 1926.

Reinhard (1931) made a plankton study between Minneapolis and Winona, Minnesota. He took samples every two weeks at 12 sampling stations covering 130 miles of river. His results were shown as averages of all plankton found.

The United States Department of Health, Education, and Welfare has initiated a Public Health Service Program for providing information on the quality of the nation's water

supply. The Water Pollution Surveillance System program started October 1, 1957, with 50 sampling stations. By September 30, 1963, the number had grown to 128. Of these 128 sampling stations, 5 are in the Upper Mississippi River Basin (Figure 1). This part of the Mississippi, from Cape Girardeau, Missouri, up to Lock and Dam No. 3 at St. Paul, Minnesota, covers 737 miles. The three sampling stations between these two points are Dubuque, Iowa, Burlington, Iowa, and East St. Louis, Illinois. There is approximately 150 miles between sampling stations.

Every two weeks at each station a plankton and chemical analysis is made. An annual report is compiled and published.

Williams and Scott (1962) studied the diatom populations of the major waterways of the United States. Their samples were taken at the sampling stations of the Water Pollution Surveillance System. In the Upper Mississippi River Basin the four sampling stations were located at Red Wing, Minnesota, Dubuque, Iowa, Burlington, Iowa, and East St. Louis, Illinois.

Williams (1964) studied the possible relationships between plankton-diatom species numbers and water quality estimates. In the Upper Mississippi River Basin he took a water sample every two weeks from four stations, starting at St. Paul, Minnesota, and ending at East St. Louis, Illinois, via Dubuque, Iowa, and Burlington, Iowa.

What chemical information is available on the Upper Mississippi River? Reinhard summarized the chemical data obtained in his study thus reducing its value to this study.

The Water Pollution Surveillance System has complete chemical analysis, bimonthly, starting in 1957 up to the present.

METHODS AND MATERIALS

Three sampling stations were selected to sample plankton diatoms (Figures 2 and 3). Station 1 was located above Lock 7, in Lake Onalaska (upper N.W. $\frac{1}{4}$ S 35, T-17N, R8W, La Crosse County). Upon leaving the public boat landing at the north end of French Island by boat, travel north by northwest until the radar tower on the Minnesota bluff is directly over the small round island. This island lies north west of Red Oak Island. The east-west vector is a straight line from the northern edge of Bell Island to the square-faced bluff on the Minnesota side of the lake. Station 2 was in the channel just above flood gate 1 of Lock 7, Dresbach, Minnesota (S.W. $\frac{1}{4}$ S 14, T-16N, R8W, La Crosse County). Station 3 was in the channel just above flood gate 1 of Lock 8, Genoa, Wisconsin (S.E. $\frac{1}{4}$ S 29, T-13N, R7W, Vernon County).

Sampling began October 3, 1967, and proceeded every two weeks thereafter to include October 17 and 30, November 13 and 27, December 11 and 25, 1967, January 8 and 22, February 5 and 19, March 4 and 18, April 1, 15, and 29, May 13 and 27, June 10 and 24, July 8 and 22, August 5 and 19, and September 2, 16, and 30, 1968. Water samples were collected from the top meter of the water column with a Kemmerer water sampler. Samples were transported to the laboratory in one-liter Erlenmeyer flasks.

For quantitative purposes, 250 ml of each sample was filtered through a 960 sq. mm Millipore filter (pore size 8μ), within 6 hours of collection, with 15 lbs. vacuum. The membrane filters were then air dried and individually stored in capped vials. Membrane filters were mounted in cedar wood oil on a numbered glass slide corresponding to the collection date and station. Overhanging edges were then trimmed. A number one glass cover slip, 24x50mm, was placed on top of the filter.

Enumeration of the plankton diatoms was done by random count method. Ten fields from each slide were counted as the criterion in the present investigation. Observations of the slides were made under a 100x oil objective with 10x ocular filled with a calibrated ocular micrometer. The objective was also calibrated for total area in sq. mm using a stage micrometer.

Results are given for numbers as cells per liter and volume as microliters per liter. A factor was calculated so that diatoms per liter could be quickly determined for each species. This factor was obtained by dividing the total area of the Millipore filter by the area of the objective.

$$\text{Number of cells/liter} = \frac{(\Pi r^2)_1}{(\Pi r^2)_2} \times 4$$

$(\Pi r^2)_1$ = area of the Millipore filter

$(\Pi r^2)_2$ = area of the objective field

This resulted in a figure of 177,285 per liter. The total number of plankton diatoms could then be easily determined by multiplying the average number per 1 mm objective field by 177,285.

The standing crop of plankton diatoms was calculated by averaging 10 field counts. This system was used to reduce inconsistencies arising from only one cell of a species. Only those species comprising 5 per cent or more of the standing crop were used in the averaging of counts of that particular species to indicate a "bloom".

Cell volume of plankton diatom species was calculated by averaging the volume, expressed as cubic microns, calculated on the basis of the closest geometric figure of 10 randomly selected individuals. This volume was converted to microliters per liter ($\mu\text{l}/\text{l}$) by multiplying by 10^{-9} (Cowell, 1960). The resulting volume multiplied by the number of diatoms of each species exhibiting a "bloom" at each station and date resulted in the volume occupied by that particular species. Total volume was calculated by adding the volume of each species exhibiting a "bloom".

Qualitative samples were obtained by concentrating 500 ml of each sample. Formalin, to make a 5-10 per cent solution was added as a preservative. The samples were concentrated to approximately 10-15 ml after settling of the sample and subsequent decanting. The samples were then

transferred to 10 ml screw cap vials. It was from these concentrations that specimens were secured for identification on the species level. Burnt mount slides using hydrax as the mounting medium were prepared for each station and date for identification purposes. Excess hydrax was removed with a razor blade and Xylene was used as the final cleansing agent.

The physiochemical data were obtained using a Hach DR-EL kit, substituting the dissolved oxygen test with the modified Winkler method. Two 300 ml flint B.O.D. bottles were filled at each station for analysis.

The Hach kit tests and methods were as follows:

<u>ION</u>	<u>UNIT</u>	<u>METHOD</u>
Alkalinity	ppm	phenolphthalein
Hardness, calcium	ppm	orthotolidine
Nitrate, total	ppm	cadmium reduction
pH		colormetric
Phosphate	ppm	stannous reduction
Silica	ppm	heteropoly blue

Temperature data were obtained with a mercury thermometer. Water transparency was measured by means of a Secchi disc. All analysis took place within 12 hours of collection.

All population data and physiochemical data were analyzed by computer. Each item of physiochemical data was correlated with population numbers and total volume. Items of high correlation were further analyzed by linear correlation.

RESULTS AND DISCUSSION

Sixty seven species were identified during the present one year survey. Only 10 species made up 5% or more of each sample. These are (alphabetically) Asterionella formosa (Figure 22, Table 10), Cyclotella glomerata (Figure 17, Table 8), Cyclotella meneghiniana (Figure 20, Table 9), Diatoma elongata (Figure 24, Table 11), Fragilaria construens (Figure 16, Table 7), Melosira ambigua (Figure 6, Table 2), Melosira granulata (Figure 10, Table 4), Melosira varians (Figure 14, Table 6), Stephanodiscus hantzschii (Figure 8, Table 3), and Stephanodiscus niagare (Figure 12, Table 5).

The annual report of the Department of Health, Education, and Welfare's Water Pollution Surveillance System (1963) lists 10 dominant species (5% or more of each sampling) found at St. Paul, Minnesota. Included are five species not considered dominant in this study. At the Dubuque, Iowa, station, the report lists 14 dominant species. Five of these are not considered dominant in this study. This study provides information which substantiates the data collected by the WPSS.

The four most dominant species, in the present study, based on total number present are Stephanodiscus hantzschii, Melosira ambigua, Fragilaria construens, and Melosira granulata. Reihard (1931) lists the five most dominant diatom species found in the upper Mississippi River above Lock and Dam No. 5 in this order: Cyclotella meneghiniana, Asterionella formosa,

Melosira granulata, Synedra delectatissima, and Stephanodiscus niagare. Williams and Scott (1962), (Red Wing, Minnesota) list the order of dominant species as Stephanodiscus hantzschii, Cyclotella meneghiniana, and Melosira ambigua. At Dubuque, Iowa, the dominance shifted to Melosira ambigua, Stephanodiscus hantzschii, and Melosira granulata.

The dominant, Stephanodiscus hantzschii, was not in the top five 40 years ago. No record of dominance was kept by the WPSS from 1957 to 1960, but were recorded subsequent to 1960. The St. Paul, Minnesota, station recorded Stephanodiscus hantzschii as the dominant while at Dubuque, Iowa, Melosira ambigua and Stephanodiscus hantzschii were sharing dominance.

Unpublished reports (1963 through 1967) list the dominant species at St. Paul, Minnesota, and Dubuque, Iowa, as Stephanodiscus hantzschii.

Figure 1 shows the total number of cells per liter of all species. Although station 1 has some physical characteristics of a lentic habitat, the maximum standing crop was found in the spring instead of the winter. Maximum standing crop data fluctuate without a pattern. A few correlations can be made from the data collected by the WPSS from 1957 through 1964. At Lock and Dam No. 5 (St. Paul, Minnesota), the diatoms peaked at least once a year and sometimes twice. An arbitrary number of 20 million per liter was used to constitute a peak. During the seven year period

the maximum standing crop appeared three times in April, once in May, July, and October, and three times in December. In 1960-1961, the diatom population exceeded 20 million/L on 11 out of 23 sampling dates, the highest standing crop occurring in July with 46 million.

In Dubuque, Iowa, only one peak per year appeared. The dates were somewhat consistent. The peaks were confined to March, April, and May.

The river channel stations 2 and 3 exhibited increases in December and January but maximum standing crop of this study was also in April. The minimum standing crop was reached as the water temperature reached the maximum (24-25°C), on 8 June.

It is interesting to note that when comparing per cent occurrence to per cent volume, Stephanodiscus hantzschii (Figure 7), the dominant species, made up less than 50% of the total occurrence ten times. But, only two times was it less than 50% of the total volume. These two instances were during the fall peak at station 2 and 16 September. Four species of diatoms contributed to the peak on these dates: Melosira ambigua, Melosira granulata, Cyclotella meneghiniana, and Stephanodiscus hantzschii. On 2 September, station 2, Melosira granulata (Figure 9) made up 18.5% of the total number but 31% of the total volume. On 16 September, it had a 35.9% occurrence with 46% of the total volume. On these two dates, Cyclotella meneghiniana (Figure 19) made up 5.2% and 4.3%,

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respectively, while contributing 16.5% and 10.6%, respectively, to the volume.

An opposite trend is found in Fragilaria construens (Figure 15). On 18 March, station 2, this species made up 82.2% of the total number but shared only 39.8% of the total volume.

The most prominent example is Stephanodiscus niagare (Figure 11). This large "pill-like" diatom may be sparse but dominate the volume. On 3 October, station 3, just 7.6% of the total number was Stephanodiscus niagare, but one fourth of the total volume was credited to this species.

The chemical data deemed significant in this study have a correlation coefficient above $\pm .5$ at all three sampling stations.

Six of the chemical and physical factors measured fall into the above category. All have a direct or indirect part in photosynthetic process.

Water temperature (Table 12) and calcium (Table 14) show a high correlation (Figure 26) indirectly related to plant production. Calcium, not usually considered a limiting factor, is one of the principal cations in the alkalinity relationship (Figure 25, Table 13). Diatoms of equal numbers can be found in waters of either high or low calcium content (Lund 1950).

Temperature is one of the most important factors in the

environment. It controls reaction rate and gas solubility, among other things. As the water temperature drops the calcium content increases (Figure 26). The low water temperature holds more dissolved CO_2 which increases the alkalinity. The diatom populations (Figures 4 and 25) show a gradual increase until spring. Then the increased photoperiod initiates a population peak. As the water temperature increases the alkalinity decreases. This decrease could induce a reduction in the solubility of CO_2 . The CO_2 could be reduced as a result of increased biological activity of the maximum standing crop.

Silica (Table 17) and nitrate (Table 15) show high correlation in Figure 27. The silica is one of the main constituents of the frustule wall. The nitrate ion is one of the main sources of nitrogen needed by all photosynthesizing plant life.

In January, when the population is low, the silica and nitrate begin to increase (Figure 27). Both ions peak in late January or early February as the population begins to climb. The increasing population intersects with the decreasing silica and nitrate levels in March. The standing crop peak is reached in March and April. In May, the dissolved silica and nitrate decrease to a minimum. Then as the population decreases in the summer the silica and nitrate levels rise.

The pH values interfere with, or promote, the

uptake of nutrients. In most cases it is not known exactly how it influences diatom growth. The sudden drop in pH on 29 April (Figure 28) is followed by a similar drop in silica and nitrate. On the following sampling date, 27 May, the population decreases sharply. It is difficult to say which is cause and which is effect.

The chemical and physical environment of the flowing water habitat of diatoms contains so many continuously changing factors that all adjustments are unexplainable at the present time. The more information compiled and correlated, the nearer is complete understanding.

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SUMMARY AND CONCLUSIONS

1. The diatom population and water nutrients, at Lock and Dam No. 7 and 8 in the Mississippi River, were investigated during a period from 3 October, 1967, through 30 September, 1968.
2. Ten species were dominant (5% or more of each sample) from the 67 species identified. These are: (alphabetically) Asterionella formosa, Cyclotella glomerata, Cyclotella meneghiniana, Diatoma elongata, Fragilaria construens, Melosira ambigua, Melosira granulata, Melosira varians, Stephanodiscus hantzschii, and Stephanodiscus niagare.
3. The order of domination, based on total number present, was Stephanodiscus hantzschii, Melosira ambigua, Fragilaria construens, and Melosira granulata.
4. The dominant species, Stephanodiscus hantzschii, was over 80% of the total diatom count. This species was not recorded in the upper Mississippi River in 1931.
5. The maximum standing crop was reached in April at all three stations. Stations 1 and 2 recorded 80 million cells per liter; station 1 reached 65 million cells per liter.
6. A high per cent occurrence does not indicate a high per cent volume. The individual cell volume of species controls this per cent occurrence-volume relationship. On 18 March, station 2, Fragilaria construens made up 82.2% of the total number but shared only 39.8% of the total volume.

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On 3 October, station 3, Stephanodiscus niagare made up 7.6% of the total number but shared 25% of the total volume.

7. Six chemical and physical factors had correlation coefficients above $\pm.5$ at all three sampling stations. High correlations existed between total number of cells per liter and alkalinity, calcium and water temperature, and silica and nitrate nitrogen.
8. Poor correlation was found between the following combinations:
 - a. Number of cells per liter--calcium.
 - b. Number of cells per liter--temperature.
 - c. Number of cells per liter--silica (stations 2 and 3).
 - d. Number of cells per liter--nitrate (stations 2 and 3).
9. Whereas this investigation did not establish whether diatom species can be used as water quality indicators, the data presented may be useful in determining optimum nutrient levels for growth of specific forms.

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LITERATURE CITED

Cowell, B. 1960. A quantitative study of the winter plankton of Urschel's Quarry. *Ohio Journal Science* 60(3):183-191.

Lund, J. W. G. 1964. The Ecology of the Freshwater Phytoplankton. *Biol. Rev.* (1964), 40:231-293.

National Water Quality Network 1958 Edition.
Annual Compilation of Data, October 1, 1957-
September 30, 1958. Public Health Service Publication
No. 663.

_____ 1959 Edition. Annual Compilation of Data,
October 1, 1958-September 30, 1959.
Public Health Service Publication No. 663.

_____ 1960 Edition. Annual Compilation of Data,
October 1, 1959-September 30, 1960.
Public Health Service Publication No. 663.

_____ 1961 Edition. Annual Compilation of Data,
October 1, 1960-September 30, 1961.
Public Health Service Publication No. 663.

_____ 1962 Edition. Annual Compilation of Data,
October 1, 1961-September 30, 1962.
Public Health Service Publication No. 663.

_____ 1963 Edition. Annual Compilation of Data,
October 1, 1962-September 30, 1963.
Public Health Service Publication No. 663.

Reinhard, Edward G. 1931. Plankton Ecology of the Upper Mississippi. *Ecol. Monogr.* Vol. 1, No. 4. pp. 396-463.

Williams, Louis G. and Scott, Carol. 1962. Principal Diatoms of Major Waterways of the United States. *Limnol. and Oceanogr.* Vol. 7, No. 3. pp. 365-379.

Williams, Louis G. 1964. Possible Relationships between Plankton-Diatom Species Numbers and Water Quality Estimates. *Ecol.*, Vol. 45, No. 4. pp. 809-823.

A P P E N D I X

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TABLE 1. Summary of total seasonal plankton diatom numbers and volume, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	**CELLS/L.	μ L/L
10/3/67	1	16,611,633	12.760
	2	12,604,985	8.224
	3	10,530,747	11.058
10/17/67	1	23,490,303	22.731
	2	18,419,943	17.589
	3	16,008,863	14.447
10/30/67	1	13,704,154	15.011
	2	13,438,226	13.924
	3	15,902,492	14.492
11/13/67	1	16,788,918	19.485
	2	17,551,245	18.794
	3	18,083,101	19.364
11/27/67	1	22,621,605	24.501
	2	29,110,247	31.173
	3	23,880,331	25.572
12/11/67	1	7,906,924	8.467
	2	35,279,776	37.779
	3	30,971,743	33.166
12/25/67	1	11,080,331	11.865
	2	32,655,954	34.970
	3	45,775,067	49.019
1/8/68	1	16,983,932	18.187
	2	38,648,197	41.386
	3	46,785,593	50.100
1/22/68	1	5,726,315	6.132
	2	24,802,214	26.559
	3	35,935,732	38.482
2/5/68	1	4,768,974	5.108
	2	16,469,805	17.637
	3	31,060,386	33.261
2/19/68	1	15,069,251	16.137
	2	24,500,829	26.237
	3	41,626,590	44.576

TABLE 1. cont'd.

DATE	STATION	** CELLS/L.	μL/L
3/4/68	1	29,908,031	32.027
	2	35,013,848	37.495
	3	65,755,121	70.414
3/18/68	1	*-----	-----
	2	77,473,612	24.609
	3	32,691,411	32.722
4/1/68	1	83,040,366	88.924
	2	52,440,948	56.156
	3	70,736,776	75.127
4/15/68	1	53,788,316	57.599
	2	39,428,218	42.222
	3	46,590,538	49.892
4/29/68	1	26,167,288	26.941
	2	39,392,761	37.369
	3	29,464,792	29.749
5/13/68	1	70,878,604	50.871
	2	37,513,538	29.629
	3	39,109,105	31.260
5/27/68	1	4,024,376	3.228
	2	10,176,176	7.430
	3	14,182,824	10.304
6/10/68	1	14,501,925	11.253
	2	14,431,011	10.443
	3	22,267,015	13.367
6/24/68	1	4,467,585	4.784
	2	8,580,601	6.704
	3	12,409,960	12.706
7/8/68	1	4,928,527	3.558
	2	7,339,603	5.654
	3	7,197,777	5.708
7/22/68	1	4,538,499	4.600
	2	8,119,660	7.212
	3	9,006,085	6.989

*-----impossible to collect sample.

TABLE 1. cont'd.

DATE	STATION	**CELLS/L.	μ L/L
8/5/68	1	7,233,234	6.399
	2	13,083,644	9.873
	3	9,963,425	7.702
8/10/68	1	13,331,843	10.571
	2	10,920,765	8.442
	3	18,650,398	12.987
9/2/68	1	16,416,620	16.308
	2	21,274,237	15.458
	3	14,927,423	9.631
9/16/68	1	5,814,958	6.279
	2	13,048,109	12.404
	3	11,204,431	8.715
9/30/68	1	12,374,514	10.457
	2	9,218,836	7.978
	3	12,232,686	10.270

**-----First three digits are significant on all tables.

TABLE 2. Per cent occurrence and volume, cells per liter, and microliters per liter for Melosira ambigua, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
10/3/67	1	5,602,215	33.7	.550	4.3
	2	5,690,858	45.1	.559	6.8
	3	2,481,994	23.6	.244	2.2
10/17/67	1	2,659,279	11.3	.261	1.1
	2	2,357,894	12.8	.232	1.3
	3	2,960,664	18.5	.291	2.0
10/30/67	1	1,843,767	13.5	.181	1.2
	2	3,315,235	24.7	.325	2.3
	3	2,606,094	16.4	.256	1.7
11/13/67	1	868,698	5.2	.085	0.4
	2	*-----	---	---	---
	3	-----	---	---	---
11/27/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/11/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/25/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
2/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

*---not present in samples above 5% level.

TABLE 2. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μL/L	%VOL.
2/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/4/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/18/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/1/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/15/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/29/68	1	1,418,292	5.4	.139	1.6
	2	2,694,736	6.8	.265	.7
	3	1,843,767	6.3	.181	.6
5/13/68	1	3,669,805	10.4	.361	.7
	2	4,857,617	12.9	.477	1.6
	3	460,941	11.8	.045	.1
5/27/68	1	797,783	20.0	.078	2.4
	2	1,826,038	18.0	.179	2.4
	3	4,059,833	28.6	.399	3.9
6/10/68	1	4,396,675	30.3	.432	3.8
	2	3,581,163	24.8	.352	3.4
	3	6,949,584	31.2	.683	5.1
6/24/68	1	-----	---	---	---
	2	2,552,908	29.8	.251	3.7
	3	2,694,736	21.7	.265	2.1
7/8/68	1	1,737,396	35.3	.171	4.8
	2	1,666,481	22.7	.164	2.9
	3	2,056,509	28.6	.202	3.5

TABLE 2. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
7/22/68	1	-----	---	---	---
	2	1,524,653	18.8	.150	2.1
	3	2,730,193	30.3	.268	3.8
8/5/68	1	1,382,825	19.1	.136	2.1
	2	4,361,218	33.4	.429	4.3
	3	3,049,307	10.6	.300	3.9
8/19/68	1	4,077,562	30.6	.401	3.8
	2	3,687,534	33.7	.362	4.2
	3	7,836,010	42.0	.770	5.9
9/2/68	1	1,489,196	9.1	.146	.9
	2	9,537,949	44.8	.937	6.1
	3	6,914,127	46.3	.679	7.0
9/16/68	1	-----	---	---	---
	2	3,049,307	23.4	.300	2.4
	3	4,148,476	37.0	.408	4.7
9/30/68	1	2,872,022	23.2	.282	2.7
	2	2,021,052	21.9	.199	2.4
	3	2,907,479	23.8	.286	2.8

**-----First three digits are significant on all tables.

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TABLE 3. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
3/4/68	1	29,908,031	100.0	32.027	100.0
	2	35,013,848	100.0	37.495	100.0
	3	65,755,121	100.0	70.413	100.0
3/18/68	1	**-----	---	---	---
	2	13,828,254	17.8	14.807	60.2
	3	29,695,289	91.0	31.799	97.2
4/1/68	1	83,040,441	100.0	88.924	100.0
	2	52,440,996	100.0	56.156	100.0
	3	70,736,840	100.0	75.127	100.0
4/15/68	1	53,788,364	100.0	57.599	100.0
	2	39,428,254	100.0	42.222	100.0
	3	46,590,580	100.0	49.892	100.0
4/29/68	1	24,749,029	94.6	26.502	98.4
	2	33,719,666	85.6	36.109	96.6
	3	27,621,052	93.7	29.568	99.4
5/13/68	1	44,534,071	62.8	47.689	93.7
	2	25,139,057	67.0	26.920	90.9
	3	25,706,370	65.7	27.528	87.7
5/27/68	1	2,180,609	54.2	2.335	72.3
	2	4,148,476	40.8	4.442	59.8
	3	7,747,368	54.6	8.296	80.5
6/10/68	1	10,105,262	69.7	10.821	96.2
	2	8,155,124	56.5	8.733	83.6
	3	11,168,974	50.2	11.960	89.5
6/24/68	1	4,467,589	100.0	4.784	100.0
	2	6,027,700	70.2	6.455	96.3
	3	7,800,553	62.9	8.353	65.7
7/8/68	1	3,191,135	64.7	3.417	95.2
	2	5,034,902	68.6	5.392	95.4
	3	5,141,274	71.4	5.506	96.5
7/22/68	1	4,254,847	93.8	4.556	99.0
	2	6,595,013	81.2	7.062	97.9
	3	6,275,900	69.7	6.721	96.2

**---no sample taken.

TABLE 3. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
8/5/68	1	5,850,415	80.0	6.265	97.9
	2	8,013,296	61.2	8.581	86.9
	3	6,914,127	89.4	7.404	96.1
8/19/68	1	7,481,440	56.1	8.012	75.8
	2	4,963,988	45.5	5.316	63.0
	3	6,488,642	34.8	6.948	53.5
9/2/68	1	13,721,883	83.6	14.694	90.1
	2	6,701,384	31.5	7.176	46.4
	3	5,495,844	36.8	5.885	61.1
9/16/68	1	5,460,387	93.9	5.847	93.1
	2	4,751,246	36.4	5.088	41.0
	3	6,453,185	57.6	6.910	79.3
9/30/68	1	9,502,492	76.8	10.176	97.3
	2	6,701,384	72.7	7.176	90.0
	3	9,325,207	76.2	9.986	97.2

**-----First three digits are significant on all tables.

TABLE 4. Per cent occurrence and volume, cells per liter, and microliters per liter for Melosira granulata, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
10/3/67	1	2,925,207	17.6	3.564	27.9
	2	1,772,853	14.1	2.160	26.3
	3	1,896,952	18.0	2.311	20.9
10/17/67	1	1,116,897	4.8	1.361	6.0
	2	1,081,440	5.9	1.318	7.5
	3	1,258,725	7.9	1.534	10.6
10/30/67	1	*-----	---	---	---
	2	514,127	3.8	.626	4.5
	3	-----	---	---	---
11/13/67	1	354,570	2.1	.432	2.2
	2	-----	---	---	---
	3	-----	---	---	---
11/27/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/11/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/25/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
2/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

*---not present in samples above 5% level.

TABLE 4. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
2/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/4/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/18/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/1/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/15/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/29/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/13/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/27/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
6/10/68	1	-----	---	---	---
	2	886,426	6.2	1.080	10.3
	3	-----	---	---	---
6/24/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

TABLE 4. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
7/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
8/5/68	1	-----	---	---	---
	2	709,141	5.4	.864	8.8
	3	-----	---	---	---
8/19/68	1	1,772,853	13.3	2.160	20.4
	2	2,269,252	20.8	2.765	32.8
	3	4,325,761	23.2	5.271	40.6
9/2/68	1	1,205,540	7.3	1.469	9.0
	2	3,935,733	18.5	4.796	31.0
	3	2,517,451	16.9	3.067	31.9
9/16/68	1	354,570	6.1	.432	6.9
	2	4,680,332	35.9	5.703	46.0
	3	-----	---	---	---
9/30/68	1	-----	---	---	---
	2	496,398	5.4	.605	7.6
	3	-----	---	---	---

**-----First three digits are significant on all tables.

TABLE 5. Per cent occurrence and volume, cells per liter, and microliters per liter for Stephanodiscus niagara, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
10/3/67	1	*-----	---	---	---
	2	-----	---	---	---
	3	797,783	7.6	2.772	25.1
10/17/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/30/67	1	886,426	6.5	3.079	20.5
	2	1,116,897	8.3	3.880	27.9
	3	-----	---	---	---
11/13/67	1	957,340	5.7	3.326	17.1
	2	-----	---	---	---
	3	-----	---	---	---
11/27/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/11/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/25/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
2/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

*---not present in samples above 5% level.

TABLE 5. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
2/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/4/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/18/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/1/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/29/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/13/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/27/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
6/10/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
6/24/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

TABLE 5. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		** CELLS/L.	% OCC.	μ L/L	% VOL.
8/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
8/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/2/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/16/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/30/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

**-----First three digits are significant on all tables.

TABLE 6. Per cent occurrence and volume, cells per liter, and microliters per liter for Melosira varians, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	OCCURRENCE		VOLUME	
		*CELLS/L.	%OCC.	μL/L	%VOL.
10/3/67	1	*-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/17/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/30/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/13/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/27/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/11/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/25/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
2/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

*---not present in samples above 5% level.

TABLE 6. cont'd.

DATE	VOLUME	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
2/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/4/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/18/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/1/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/29/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/13/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/27/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
6/10/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
6/24/68	1	-----	---	---	---
	2	-----	---	---	---
	3	1,914,678	15.4	4.089	32.2
7/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

TABLE 6. cont'd.

DATE	VOLUME	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
8/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
8/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/2/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/16/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/30/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

**-----First three digits are significant on all tables.

TABLE 7. Per cent occurrence and volume, cells per liter, and microliters per liter for Fragilaria construens, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μL/L	%VOL.
10/3/67	1	*-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/17/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/30/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/13/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/27/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/11/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/25/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
2/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

*---not present in samples above 5% level.

TABLE 7. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
2/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/4/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/18/68	1	-----	---	---	---
	2	63,645,426	82.2	9.801	39.8
	3	2,996,121	9.0	.923	2.8
4/1/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/29/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/13/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/27/68	1	-----	---	---	---
	2	1,843,767	9.0	.568	7.7
	3	-----	---	---	---
6/10/68	1	-----	---	---	---
	2	904,155	12.5	.278	2.7
	3	1,276,454	11.5	.393	2.9
6/24/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/8/68	1	-----	---	---	---
	2	319,113	8.7	.098	1.7
	3	-----	---	---	---
7/22/68	1	141,828	6.2	.044	1.0
	2	-----	---	---	---
	3	-----	---	---	---

TABLE 7. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
8/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
8/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/2/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/16/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/30/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

**-----First three digits are significant on all tables.

TABLE 8. Per cent occurrence and volume, cells per liter, and microliters per liter of Cyclotella glomerata, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μL/L	%VOL.
10/3/67	1	*-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/17/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/30/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/13/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/27/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/11/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/25/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
2/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

*---not present in samples above 5% level.

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TABLE 8. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
2/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/4/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/18/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/1/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/29/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/13/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/27/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
6/10/68	1	-----	---	---	---
	2	-----	---	---	---
	3	797,333	7.1	.331	2.5
6/24/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

TABLE 8. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
8/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
8/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/2/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/16/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/30/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

**-----First three digits are significant on all tables.

TABLE 9. Per cent occurrence and volume, cells per liter, and microliters per liter of *Cyclotella meneghiniana*, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μL/L	%VOL.
10/3/67	1	*-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/17/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/30/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/13/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/27/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/11/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/25/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
2/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

*---not present in samples above 5% level.

TABLE 9. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
2/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/4/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/18/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/1/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/29/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/13/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/27/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
6/10/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
6/24/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

TABLE 9. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
8/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
8/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/2/68	1	-----	---	---	---
	2	1,099,168	5.2	2.550	16.5
	3	-----	---	---	---
9/16/68	1	-----	---	---	---
	2	567,313	4.3	1.316	10.6
	3	602,770	5.4	1.398	16.0
9/30/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

**-----First three digits are significant on all tables.

TABLE 10. Per cent occurrence and volume, cells per liter, and microliters per liter of *Asterionella formosa*, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
10/3/67	1	*-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/17/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/30/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/13/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/27/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/11/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/25/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
2/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

*---not present in samples above 5% level.

TABLE 10. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
2/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/4/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/18/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/1/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/29/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/13/68	1	9,502,492	26.8	2.822	5.6
	2	7,516,897	20.1	2.232	7.5
	3	2,942,936	7.5	.874	2.8
5/27/68	1	283,656	7.0	.084	2.6
	2	1,365,096	13.4	.405	5.4
	3	1,010,526	7.1	.300	2.9
6/10/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
6/24/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

TABLE 10. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
8/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
8/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/2/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/16/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/30/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

**-----First three digits are significant on all tables.

TABLE 11. Per cent occurrence and volume, cells per liter, and microliters per liter of Diatoma elongata, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μL/L	%VOL.
10/3/67	1	*-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/17/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
10/30/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/13/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
11/27/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/11/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
12/25/67	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
1/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
2/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

*---not present in samples above 5% level.

TABLE 11. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
2/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/4/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
3/18/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/1/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
4/29/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
5/13/68	1	-----	---	---	---
	2	-----	---	---	---
	3	5,850,405	15.0	2.814	9.4
5/27/68	1	762,326	18.8	.731	22.7
	2	1,914,681	18.8	1.836	24.7
	3	1,365,096	9.7	1.309	12.7
6/10/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
6/24/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/8/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
7/22/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

TABLE 11. cont'd.

DATE	STATION	OCCURRENCE		VOLUME	
		**CELLS/L.	%OCC.	μ L/L	%VOL.
8/5/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
8/19/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/2/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/16/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---
9/30/68	1	-----	---	---	---
	2	-----	---	---	---
	3	-----	---	---	---

**-----First three digits are significant on all tables.

TABLE 12. Temperature readings, in centigrade, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	READING	DATE	STATION	READING
10/3/67	1	17	3/4/68	1	3.00
	2	17		2	1.50
	3	17		3	1.00
10/17/67	1	17.5	3/18/68	1	5.5
	2	13.75		2	5.5
	3	14		3	4.0
10/30/67	1	7.5	4/1/68	1	10.0
	2	5.8		2	9.0
	3	6.5		3	9.0
11/13/67	1	5.8	4/15/68	1	10.0
	2	5.0		2	10.0
	3	5.2		3	10.0
11/27/67	1	.25	4/29/68	1	16.0
	2	.25		2	17.0
	3	1.50		3	16.0
12/11/67	1	.25	5/13/68	1	12.0
	2	1.00		2	12.0
	3	1.00		3	12.5
12/25/67	1	1.30	5/27/68	1	21.8
	2	.25		2	21.0
	3	1.00		3	24.5
1/8/68	1	.20	6/10/68	1	21.5
	2	.25		2	21.0
	3	.50		3	21.5
1/22/68	1	.50	6/24/68	1	22.0
	2	.50		2	22.0
	3	.50		3	22.0
2/5/68	1	1.30	7/8/68	1	24.0
	2	1.20		2	24.0
	3	1.20		3	25.0
2/19/68	1	.50	7/22/68	1	20.5
	2	.50		2	23.0
	3	.50		3	21.0

TABLE 12. cont'd.

DATE	STATION	READING
8/5/68	1	23.0
	2	23.5
	3	24.0
8/19/68	1	21.5
	2	21.5
	3	21.0
9/2/68	1	20.0
	2	18.5
	3	18.0
9/16/68	1	17.0
	2	17.5
	3	16.0
9/30/68	1	17.5
	2	17.5
	3	17.0

TABLE 13. Total alkalinity in parts per million, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	READING	DATE	STATION	READING
10/3/67	1	38	3/4/68	1	90
	2	83		2	145
	3	66		3	150
10/17/67	1	65	3/18/68	1	*-----
	2	94		2	130
	3	76		3	125
10/30/67	1	66	4/1/68	1	125
	2	97		2	150
	3	80		3	135
11/13/67	1	86	4/15/68	1	135
	2	88		2	150
	3	90		3	140
11/27/67	1	90	4/29/68	1	65
	2	94		2	120
	3	96		3	90
12/11/67	1	30	5/13/68	1	115
	2	49		2	120
	3	45.5		3	115
12/25/67	1	190	5/27/68	1	60
	2	160		2	90
	3	150		3	80
1/8/68	1	110	6/10/68	1	70
	2	150		2	90
	3	160		3	90
1/22/68	1	70	6/24/68	1	50
	2	130		2	105
	3	140		3	100
2/5/68	1	75	7/8/68	1	60
	2	145		2	90
	3	130		3	70
2/19/68	1	105	7/22/68	1	40
	2	160		2	100
	3	160		3	75

*-----impossible to collect sample.

TABLE 13. cont'd.

DATE	STATION	READING
8/5/68	1	60
	2	120
	3	110
8/19/68	1	105
	2	140
	3	130
9/2/68	1	70
	2	130
	3	125
9/16/68	1	20
	2	130
	3	120
9/30/68	1	120
	2	140
	3	110

TABLE 14. Calcium readings in parts per million, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	READING	DATE	STATION	READING
10/3/67	1	85	3/4/68	1	100
	2	100		2	105
	3	100		3	80
10/17/67	1	80	3/18/68	1	*-----
	2	110		2	95
	3	110		3	90
10/30/67	1	85	4/1/68	1	95
	2	100		2	110
	3	100		3	95
11/13/67	1	80	4/15/68	1	90
	2	110		2	105
	3	105		3	90
11/27/67	1	100	4/29/68	1	45
	2	120		2	85
	3	115		3	60
12/11/67	1	60	5/13/68	1	90
	2	100		2	85
	3	115		3	95
12/25/67	1	120	5/27/68	1	40
	2	150		2	90
	3	160		3	55
1/8/68	1	100	6/10/68	1	50
	2	140		2	70
	3	120		3	65
1/22/68	1	70	6/24/68	1	40
	2	110		2	75
	3	145		3	70
2/5/68	1	75	7/8/68	1	40
	2	110		2	70
	3	100		3	50
2/19/68	1	90	7/22/68	1	30
	2	115		2	80
	3	110		3	60

*-----impossible to collect sample.

TABLE 14. cont'd.

DATE	STATION	READING
8/5/68	1	45
	2	90
	3	80
8/19/68	1	90
	2	110
	3	110
9/2/68	1	50
	2	110
	3	100
9/16/68	1	20
	2	100
	3	100
9/30/68	1	80
	2	110
	3	85

TABLE 15. Nitrate nitrogen in parts per million, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	READING	DATE	STATION	READING
10/3/67	1	1.90	3/4/68	1	1.05
	2	.76		2	1.85
	3	.13		3	1.45
10/16/67	1	.35	3/18/68	1	*-----
	2	.04		2	1.93
	3	.04		3	1.54
10/30/67	1	.17	4/1/68	1	.44
	2	.26		2	1.76
	3	.26		3	1.29
11/13/67	1	.26	4/15/68	1	.66
	2	.17		2	1.54
	3	.17		3	1.13
11/27/67	1	.22	4/29/68	1	.66
	2	.26		2	.84
	3	.08		3	.99
12/11/67	1	1.45	5/13/68	1	.22
	2	.55		2	.22
	3	.11		3	.13
12/25/67	1	.48	5/27/68	1	.61
	2	.04		2	.66
	3	.17		3	.48
1/8/68	1	1.40	6/10/68	1	.48
	2	1.14		2	.79
	3	.17		3	.35
1/22/68	1	2.20	6/24/68	1	.61
	2	1.36		2	1.54
	3	1.36		3	.99
2/5/68	1	2.42	7/8/68	1	.46
	2	1.93		2	1.18
	3	1.76		3	.82
2/19/68	1	2.28	7/22/68	1	1.10
	2	1.72		2	2.33
	3	2.06		3	1.36

*-----impossible to collect sample.

TABLE 15. cont'd.

DATE	STATION	READING
8/5/68	1	.98
	2	2.50
	3	1.82
8/19/68	1	2.10
	2	3.30
	3	2.30
9/2/68	1	.22
	2	1.54
	3	1.05
9/16/68	1	.44
	2	1.70
	3	1.76
9/30/68	1	1.60
	2	2.40
	3	1.67

TABLE 16. pH readings in the Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	READING	DATE	STATION	READING
10/3/67	1	8.65	3/4/68	1	8.60
	2	8.55		2	8.30
	3	8.55		3	8.50
10/16/67	1	8.77	3/18/68	1	*-----
	2	8.70		2	8.35
	3	8.65		3	8.45
10/30/67	1	8.35	4/1/68	1	8.25
	2	8.50		2	8.45
	3	8.45		3	8.40
11/13/67	1	8.20	4/15/68	1	8.
	2	8.75		2	8.20
	3	8.75		3	8.35
11/27/67	1	8.82	4/29/68	1	7.
	2	8.75		2	6.97
	3	8.85		3	6.80
12/11/67	1	7.90	5/13/68	1	8.25
	2	8.65		2	9.75
	3	8.80		3	7.75
12/25/67	1	8.70	5/27/68	1	8.20
	2	8.68		2	8.35
	3	8.70		3	8.15
1/8/68	1	8.30	6/10/68	1	8.35
	2	8.60		2	8.10
	3	8.75		3	7.40
1/22/68	1	7.70	6/24/68	1	7.75
	2	8.35		2	8.20
	3	8.47		3	8.10
2/5/68	1	8.25	7/8/68	1	7.40
	2	8.30		2	6.95
	3	8.35		3	6.95
2/19/68	1	8.37	7/22/68	1	7.
	2	8.20		2	7.50
	3	8.45		3	7.50

*-----impossible to collect sample.

TABLE 16. cont'd.

DATE	STATION	READING
8/5/68	1	7.30
	2	7.90
	3	7.55
8/19/68	1	8.40
	2	8.20
	3	8.55
9/2/68	1	8.20
	2	8.45
	3	8.30
9/16/68	1	7.10
	2	8.20
	3	7.65
9/30/68	1	8.45
	2	8.50
	3	8.35

TABLE 17. Silica readings in parts per million, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

DATE	STATION	READING	DATE	STATION	READING
10/3/67	1	3.0	3/4/68	1	10.0
	2	2.1		2	10.5
	3	3.3		3	9.3
10/16/67	1	1.9	3/18/68	1	*-----
	2	.9		2	11.3
	3	1.7		3	7.3
10/30/67	1	3.2	4/1/68	1	5.0
	2	2.3		2	10.0
	3	.7		3	6.0
11/13/67	1	2.7	4/15/68	1	4.6
	2	1.5		2	8.5
	3	.5		3	5.5
11/27/67	1	2.8	4/29/68	1	4.0
	2	1.0		2	4.5
	3	.5		3	5.5
12/11/67	1	8.7	5/13/68	1	1.3
	2	3.0		2	.5
	3	2.4		3	.7
12/25/67	1	4.0	5/27/68	1	5.8
	2	4.1		2	2.2
	3	3.1		3	3.4
1/8/68	1	10.5	6/10/68	1	4.3
	2	7.3		2	2.4
	3	5.0		3	4.3
1/22/68	1	13.5	6/24/68	1	4.6
	2	8.0		2	5.3
	3	8.0		3	4.3
2/5/68	1	11.8	7/8/68	1	7.3
	2	10.3		2	9.5
	3	9.5		3	7.0
2/19/68	1	12.0	7/22/68	1	6.5
	2	12.5		2	10.0
	3	9.5		3	9.0

*-----impossible to collect sample.

TABLE 17. cont'd.

DATE	STATION	READING
8/5/68	1	9.8
	2	11.8
	3	10.3
8/19/68	1	12.5
	2	16.0
	3	12.0
9/2/68	1	7.3
	2	10.5
	3	8.3
9/16/68	1	7.0
	2	13.8
	3	12.3
9/30/68	1	7.0
	2	12.5
	3	12.5

FIGURE 1. Location of the Water Pollution Surveillance System sampling stations on the upper Mississippi River.

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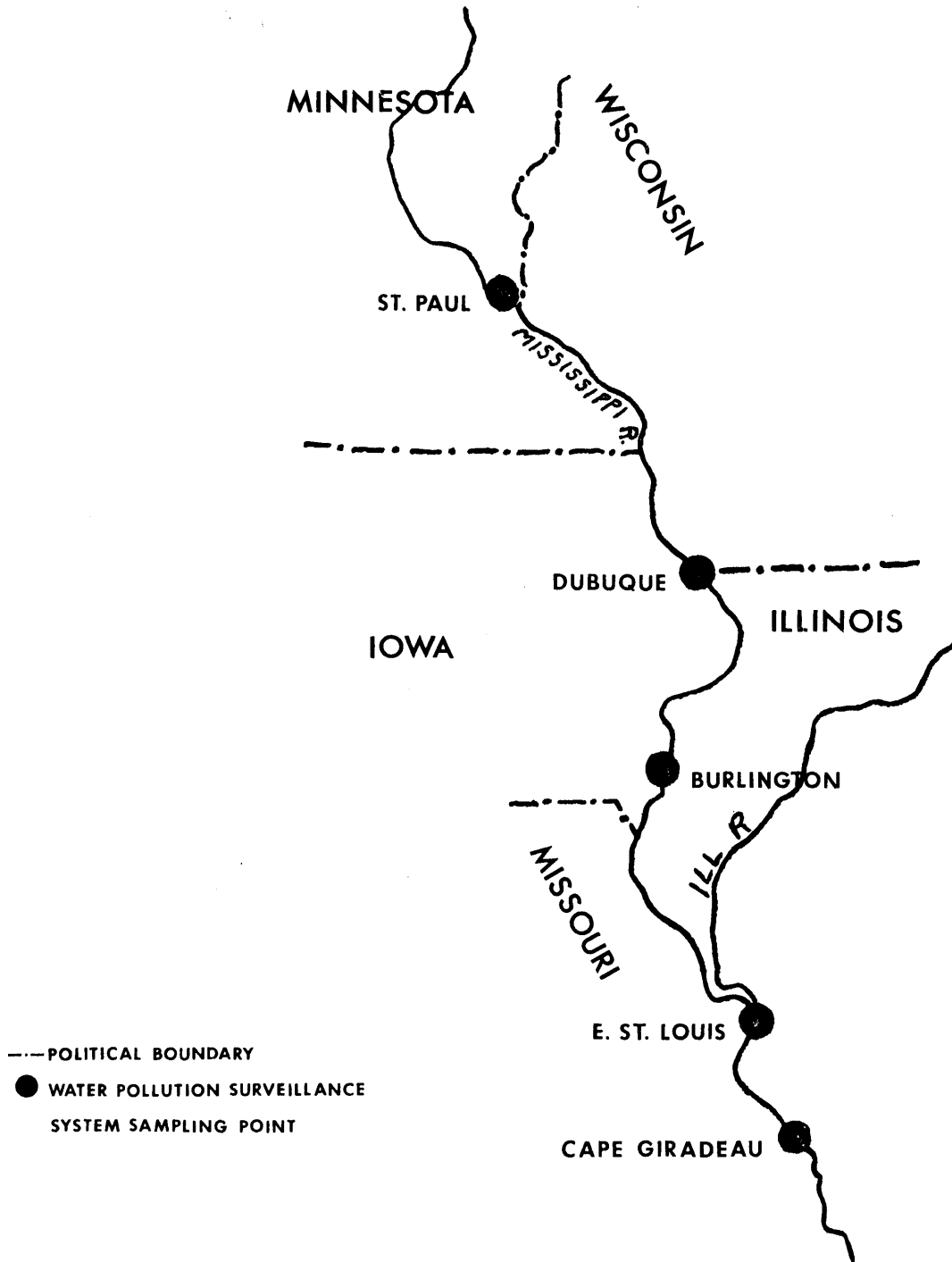


FIGURE 2. Location of sampling station 1 in pool 7,
and sampling station 2 at Lock and Dam No. 7.

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FIGURE 3. Location of sampling station 3 at
Lock and Dam No. 8.

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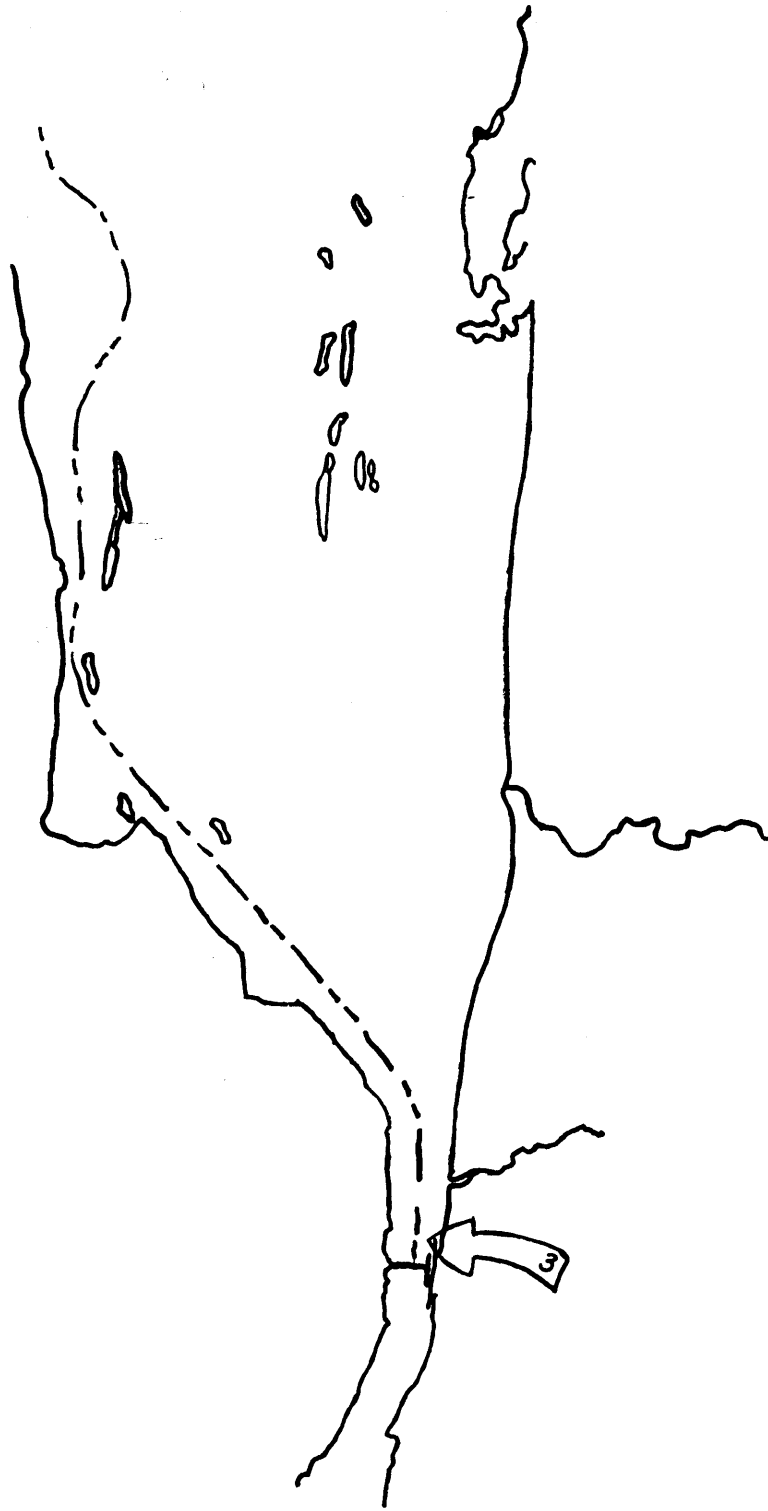


FIGURE 4. Total number and volume of all species at each station.

Station 1. ●number
⊕volume

Station 2. ●number
⊕volume

Station 3. ●number
⊕volume

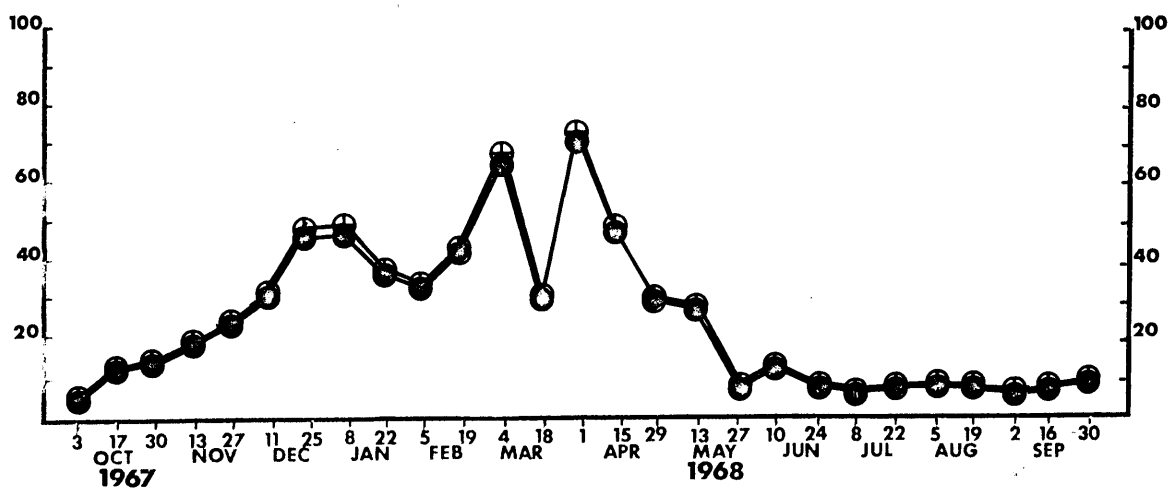
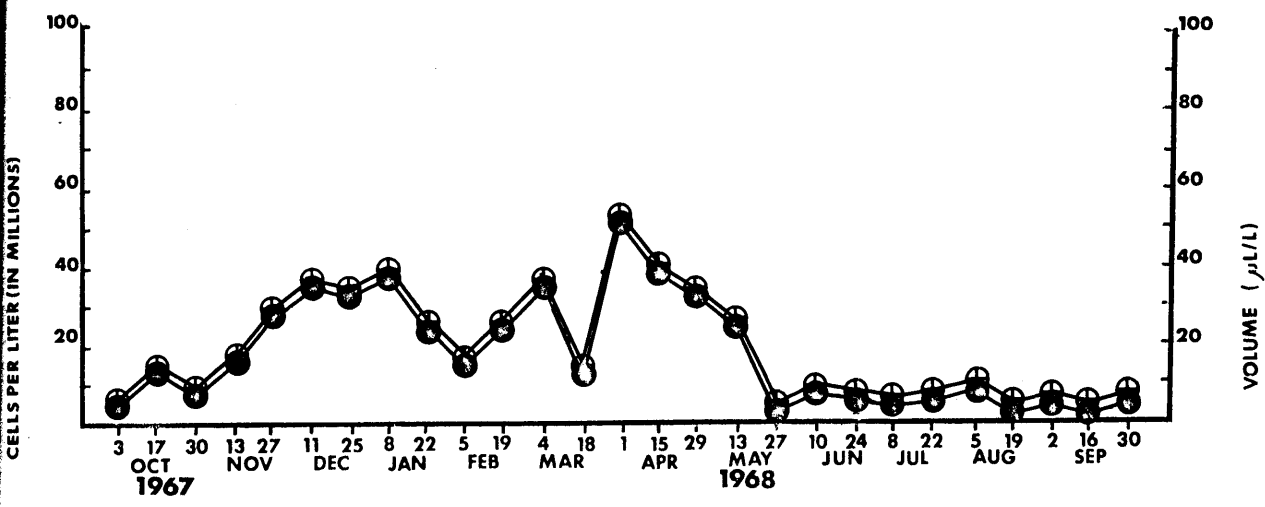
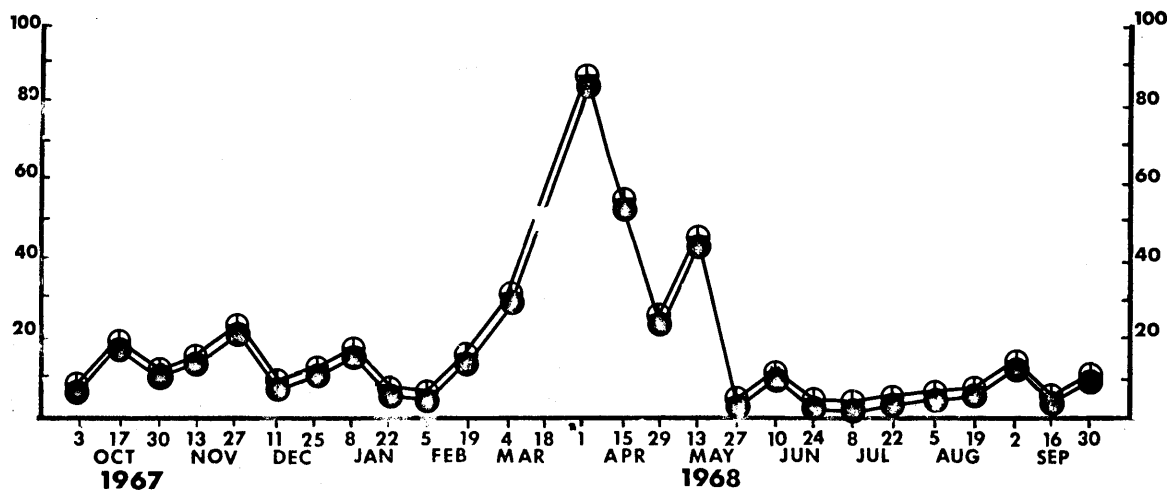


FIGURE 5. Per cent occurrence and volume for
Melosira ambigua.

Station 1. ● occurrence
⊕ volume

Station 2. ● occurrence
⊕ volume

Station 3. ● occurrence
⊕ volume

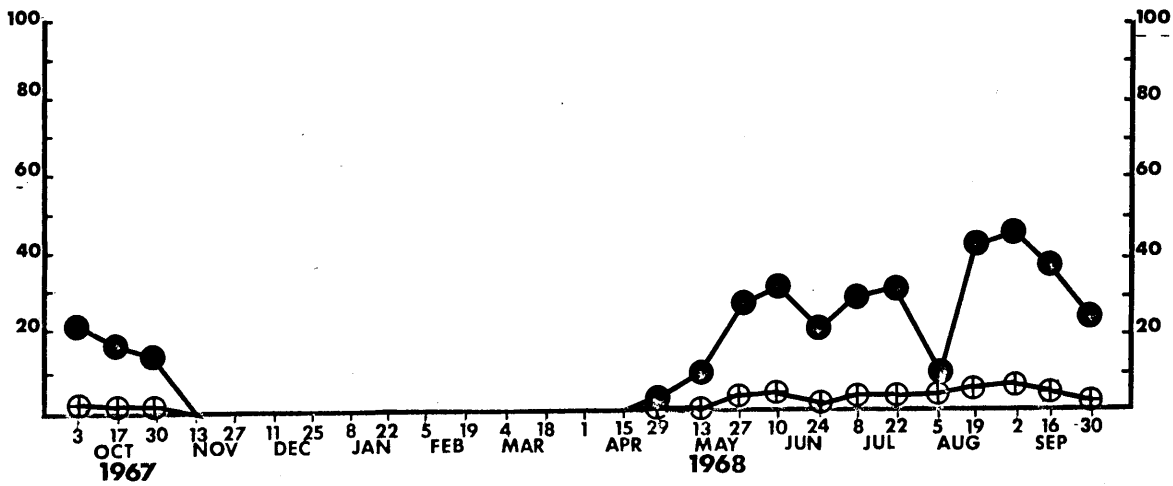
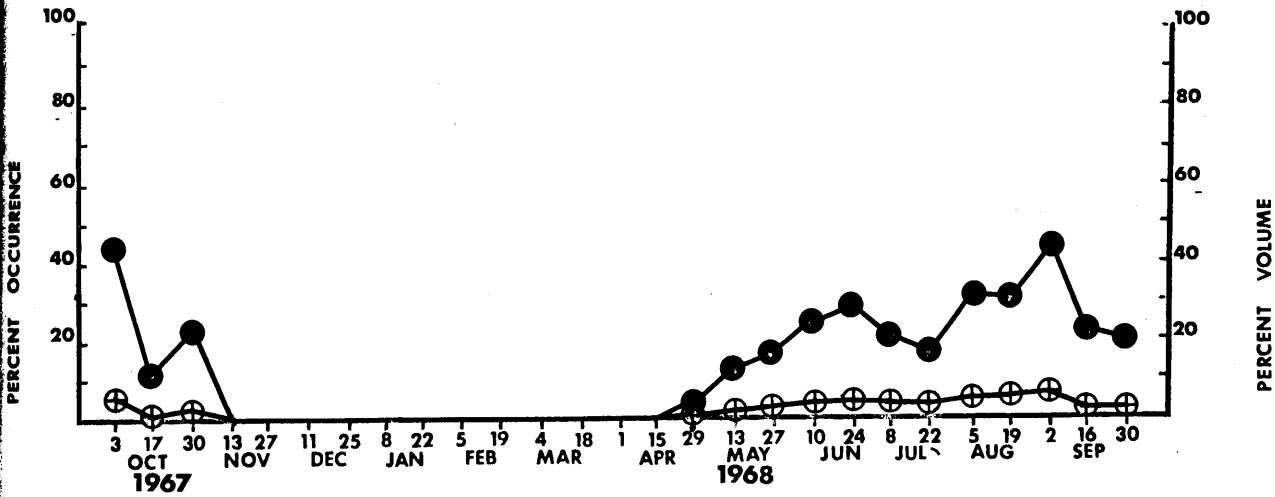
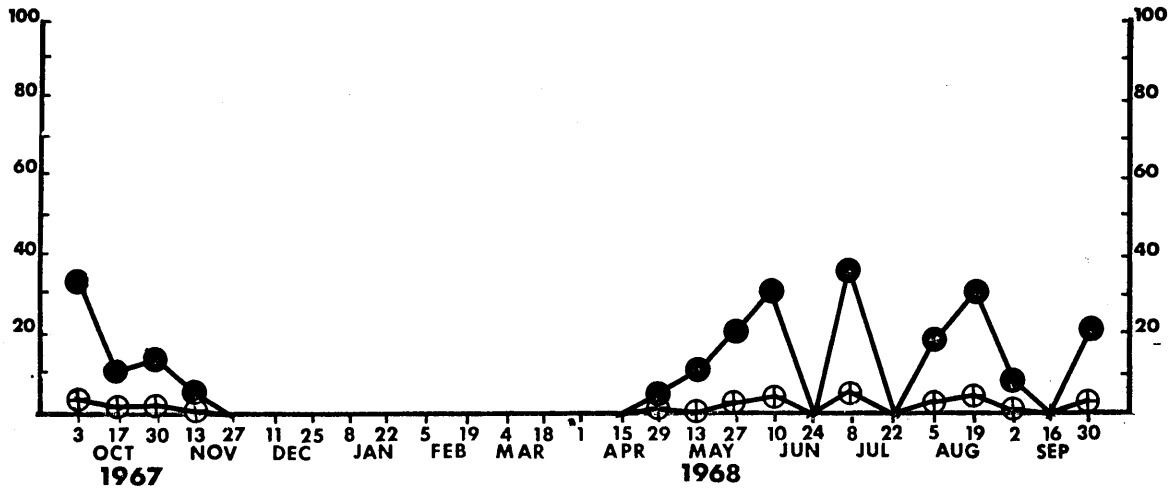


FIGURE 6. Total number and volume for Melosira ambigua.

Station 1. ●number
⊕volume

Station 2. ●number
⊕volume

Station 3. ●number
⊕volume

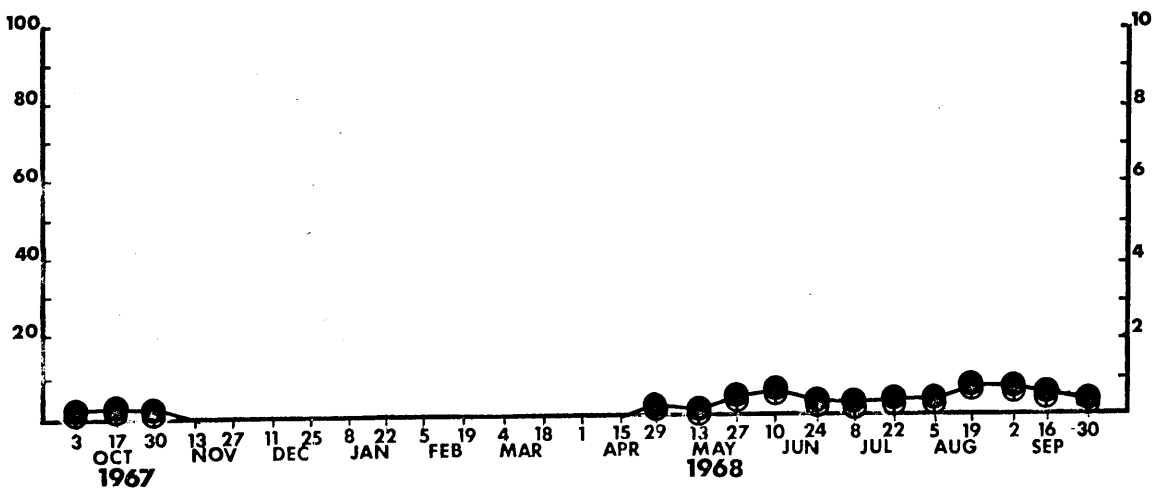
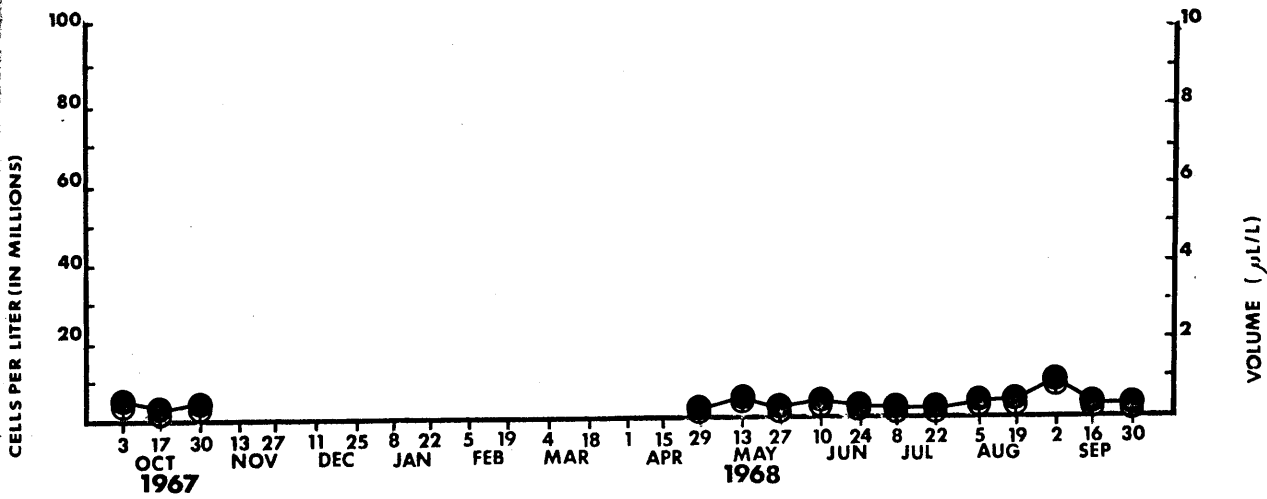
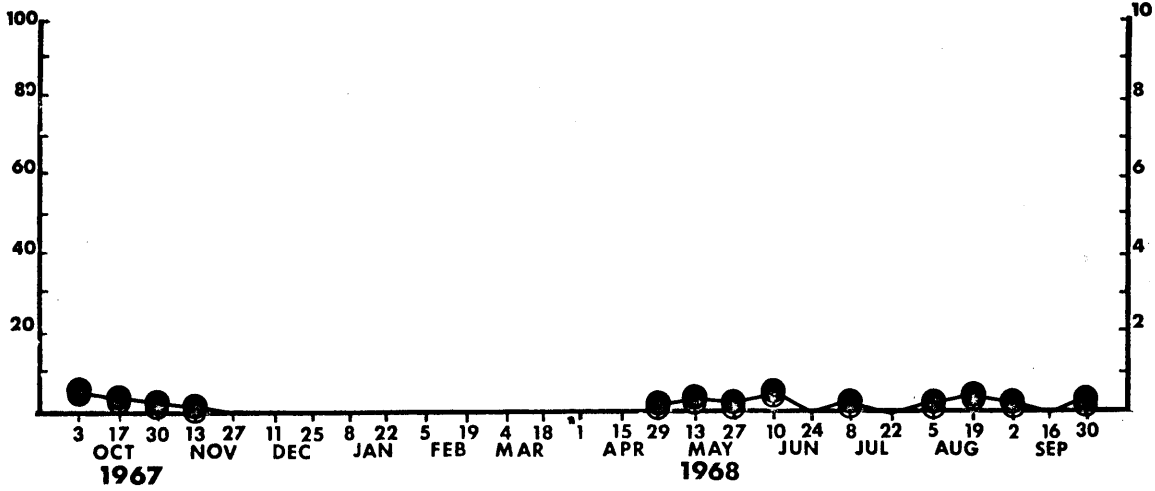


FIGURE 7. Per cent occurrence and volume for
Stephanodiscus hantzschii.

Station 1. ● occurrence
⊕ volume

Station 2. ● occurrence
⊕ volume

Station 3. ● occurrence
⊕ volume

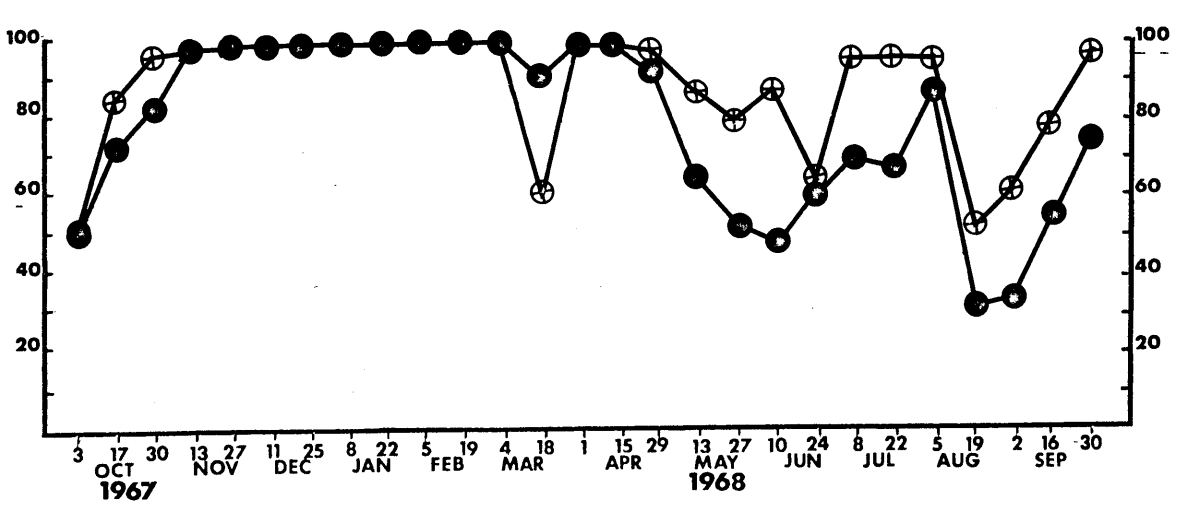
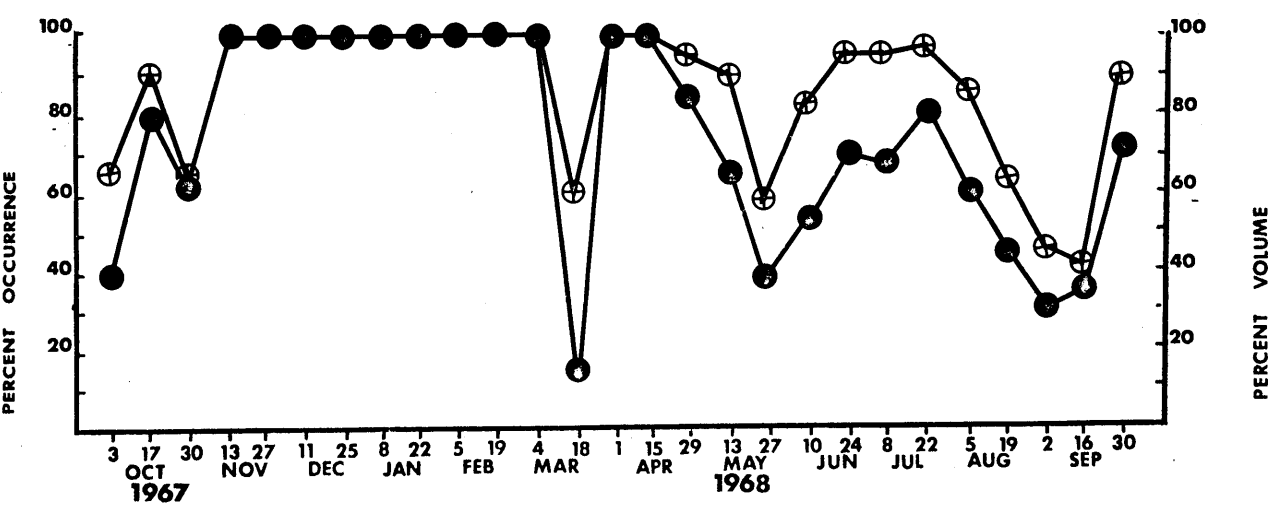
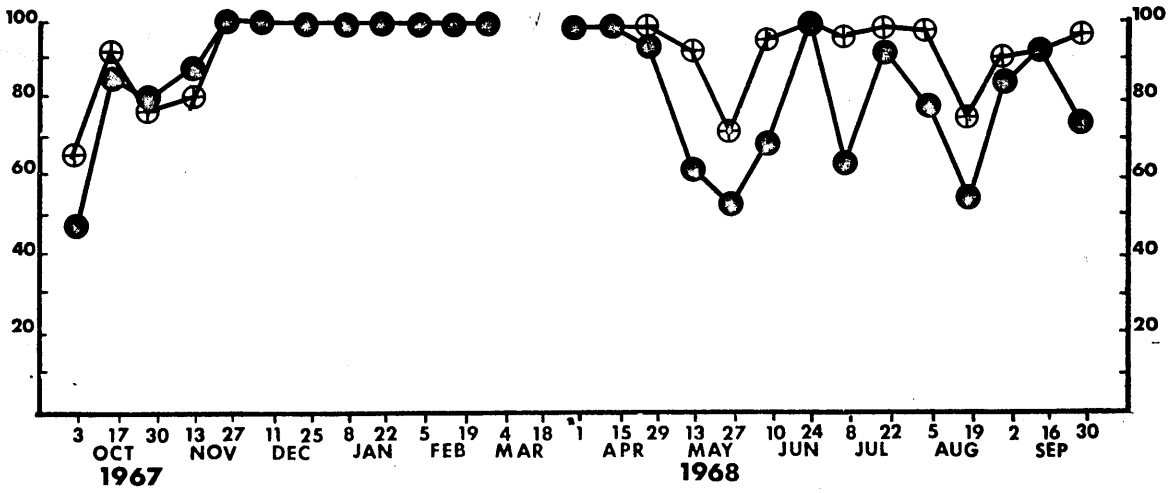


FIGURE 8. Total number and volume for
Stephanodiscus hantzschii.

Station 1. ● number
⊕ volume

Station 2. ● number
⊕ volume

Station 3. ● number
⊕ volume

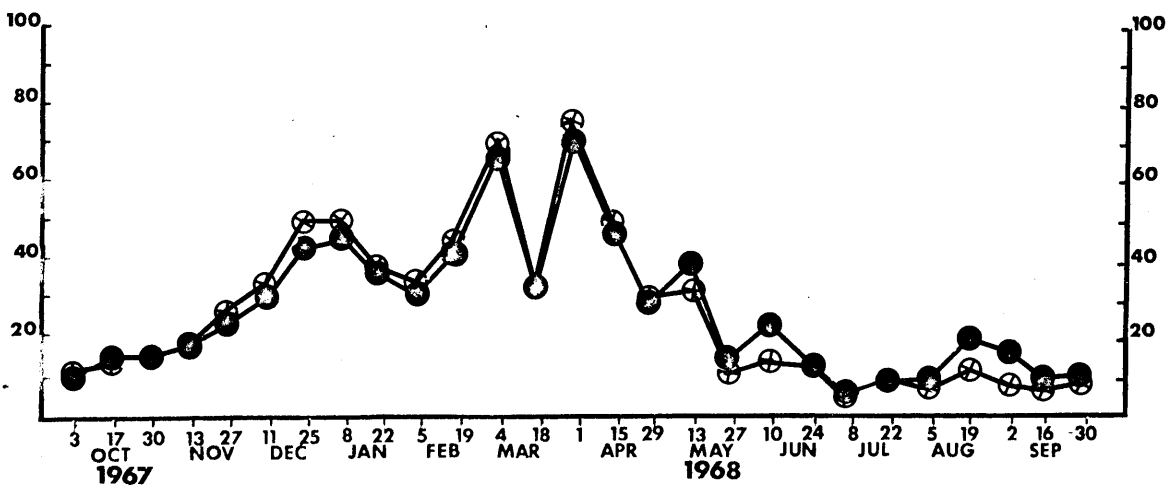
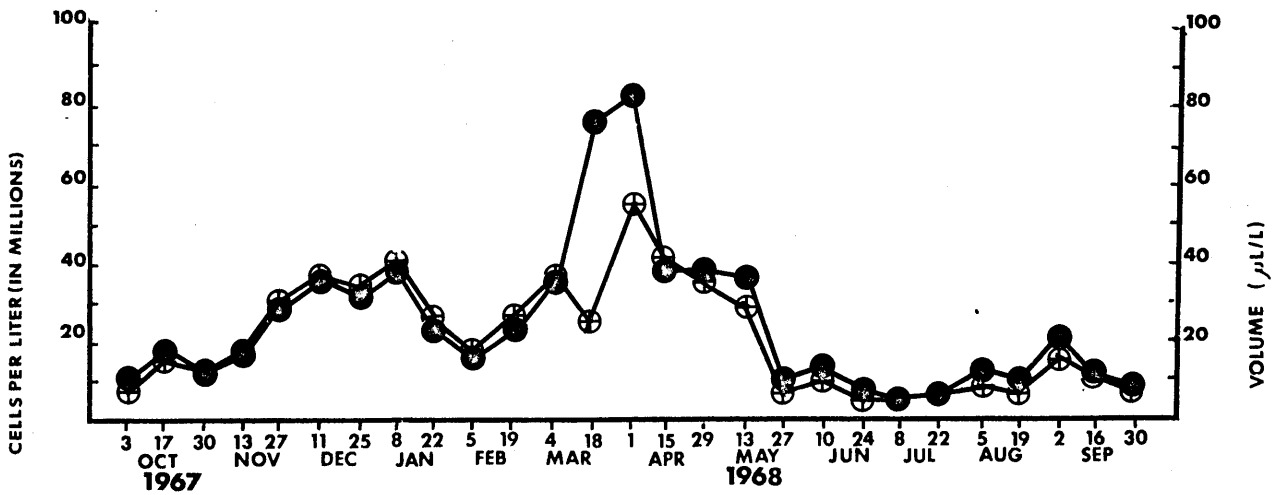
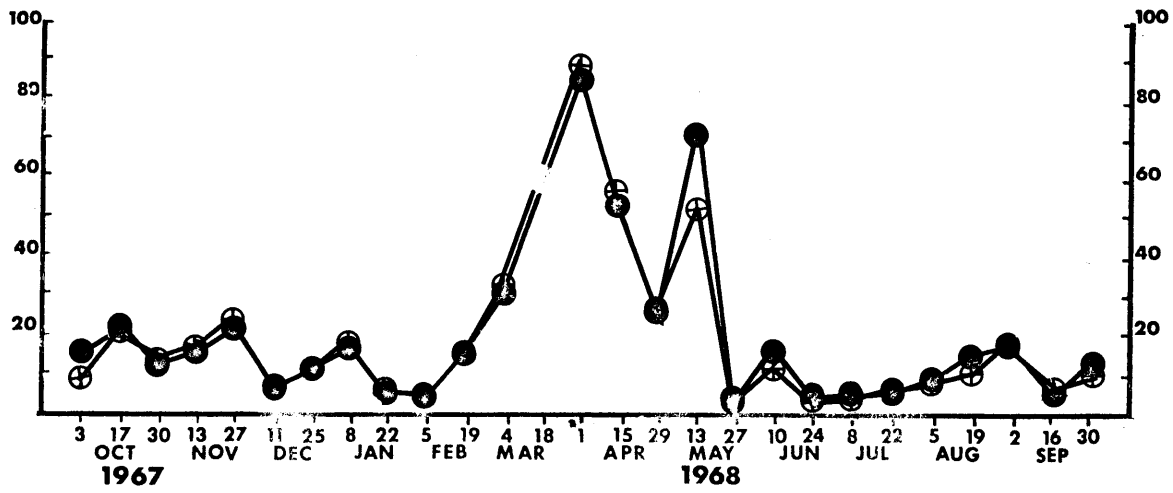


FIGURE 9. Per cent occurrence and volume for
Melosira granulata.

Station 1. ● occurrence
⊕ volume

Station 2. ● occurrence
⊕ volume

Station 3. ● occurrence
⊕ volume

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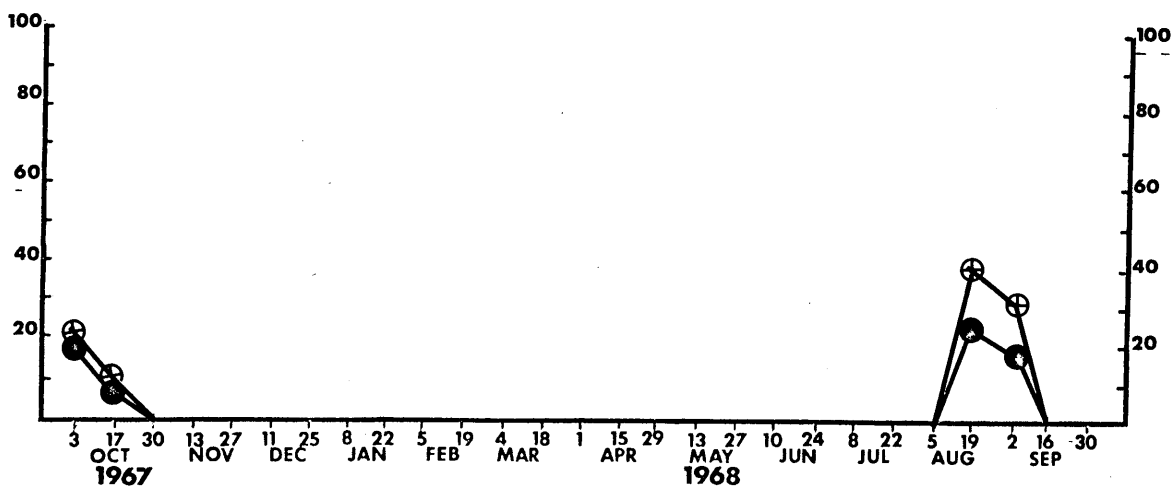
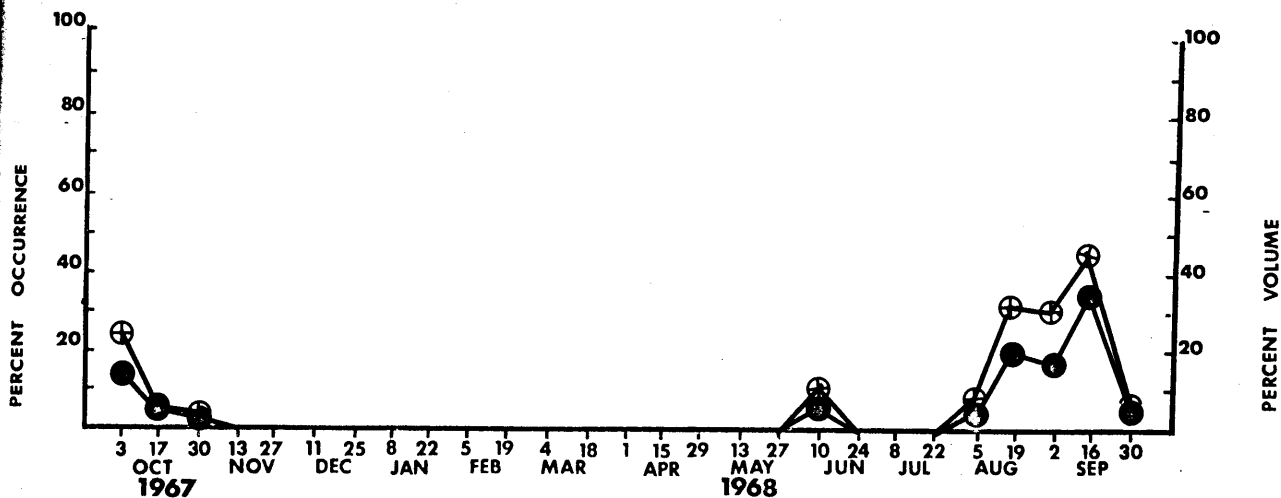
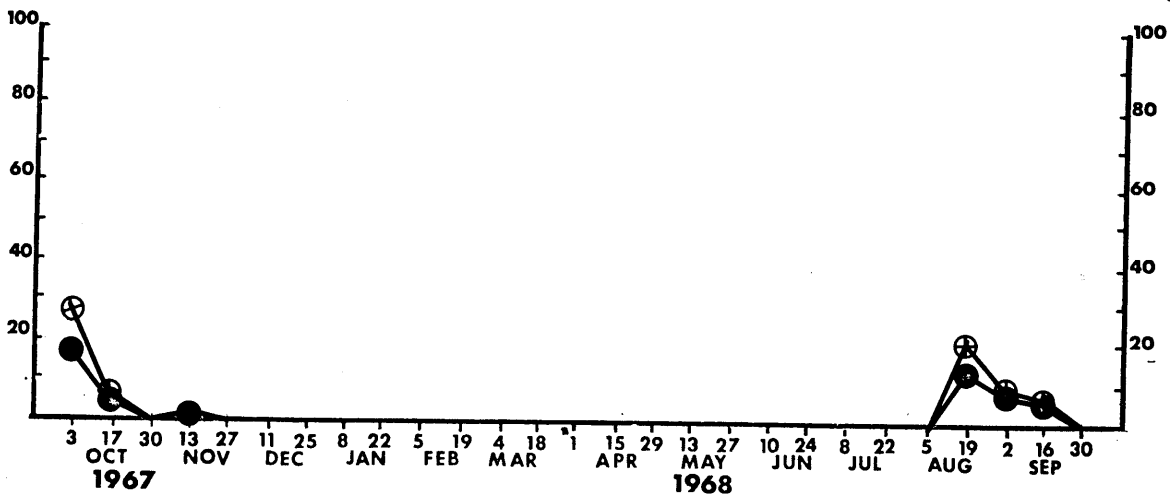


FIGURE 10. Total number and volume for
Melosira granulata.

Station 1. ●number
⊕volume

Station 2. ●number
⊕volume

Station 3. ●number
⊕volume

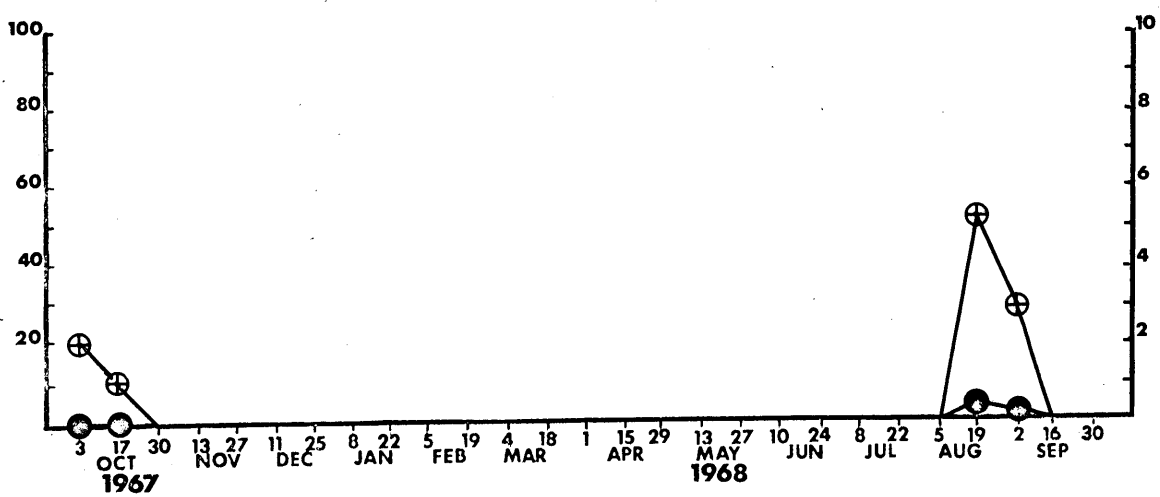
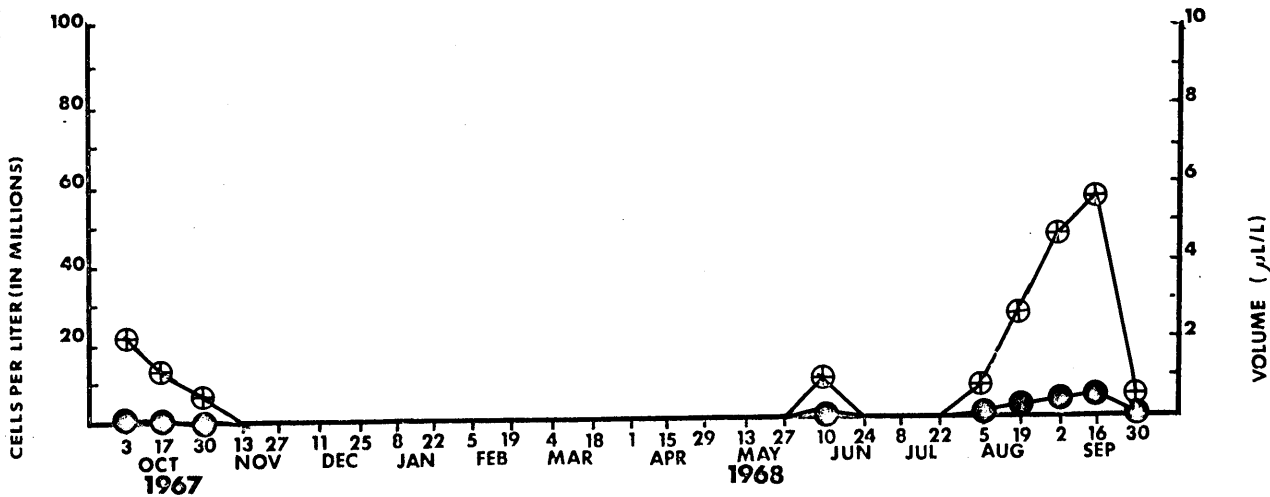
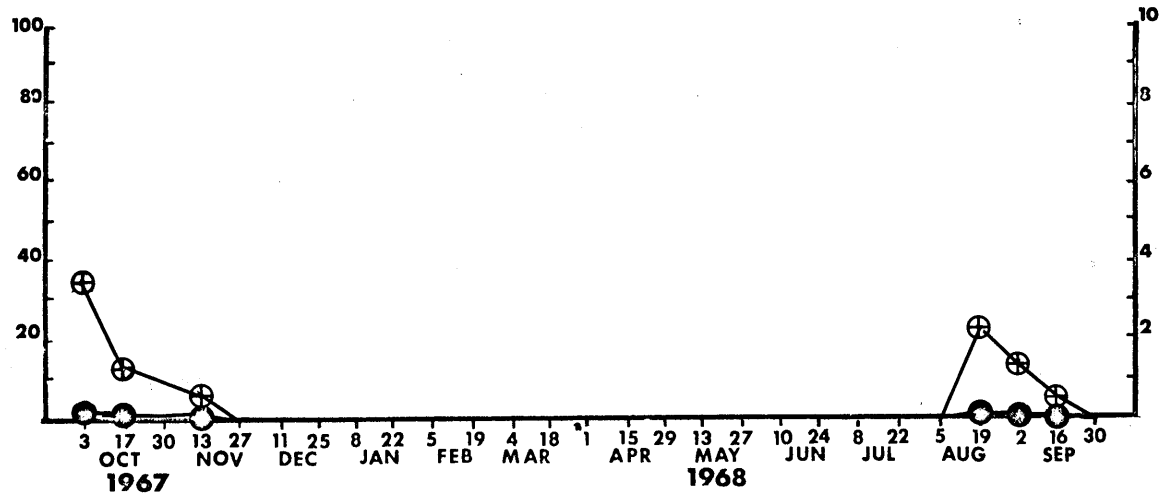


FIGURE 11. Per cent occurrence and volume for
Stephanodiscus niagare.

Station 1. ● occurrence
⊕ volume

Station 2. ● occurrence
⊕ volume

Station 3. ● occurrence
⊕ volume

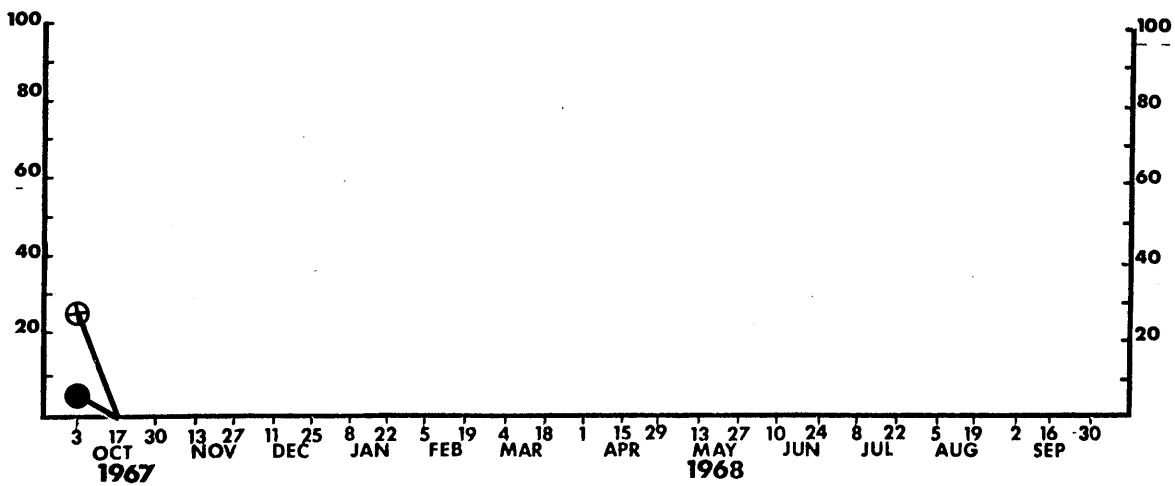
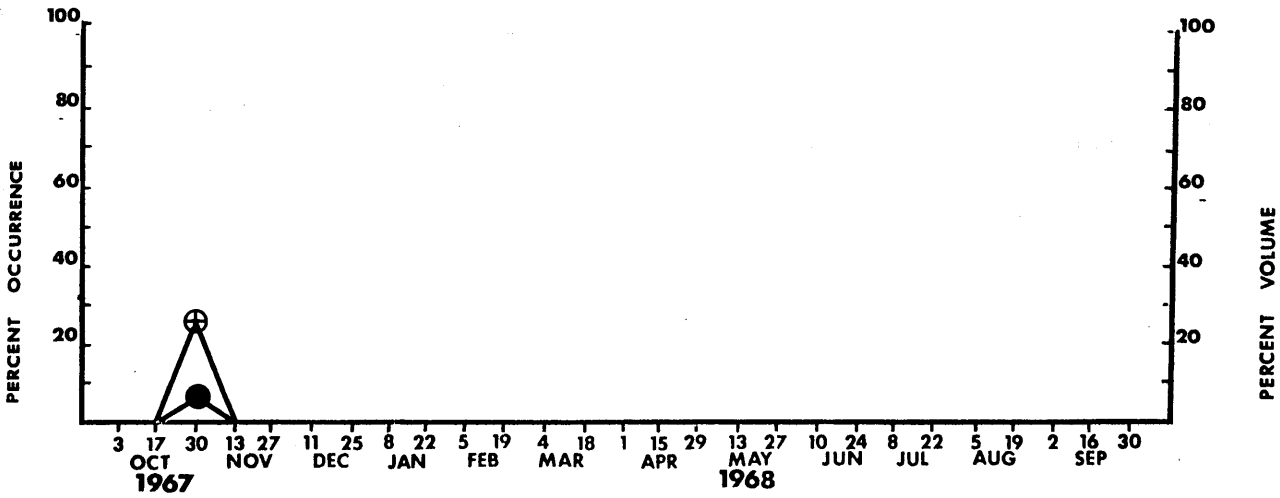
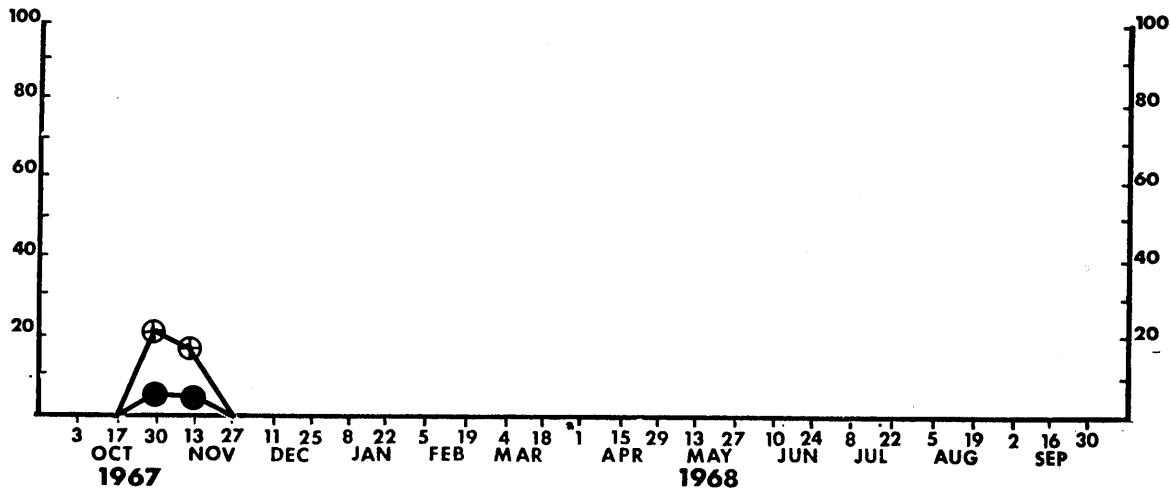


FIGURE 12. Total number and volume for
Stephanodiscus niagare.

Station 1. ● number
⊕ volume

Station 2. ● number
⊕ volume

Station 3. ● number
⊕ volume

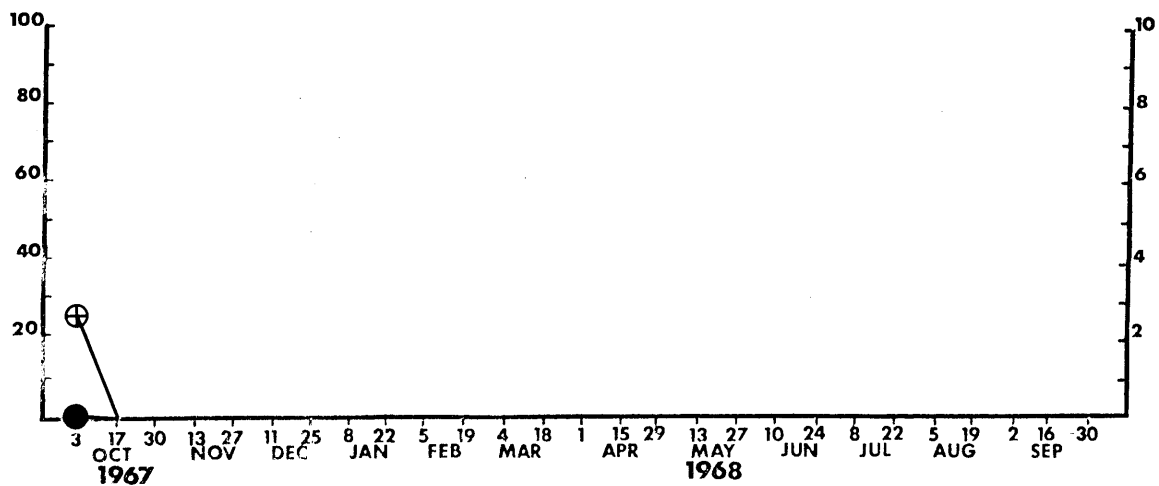
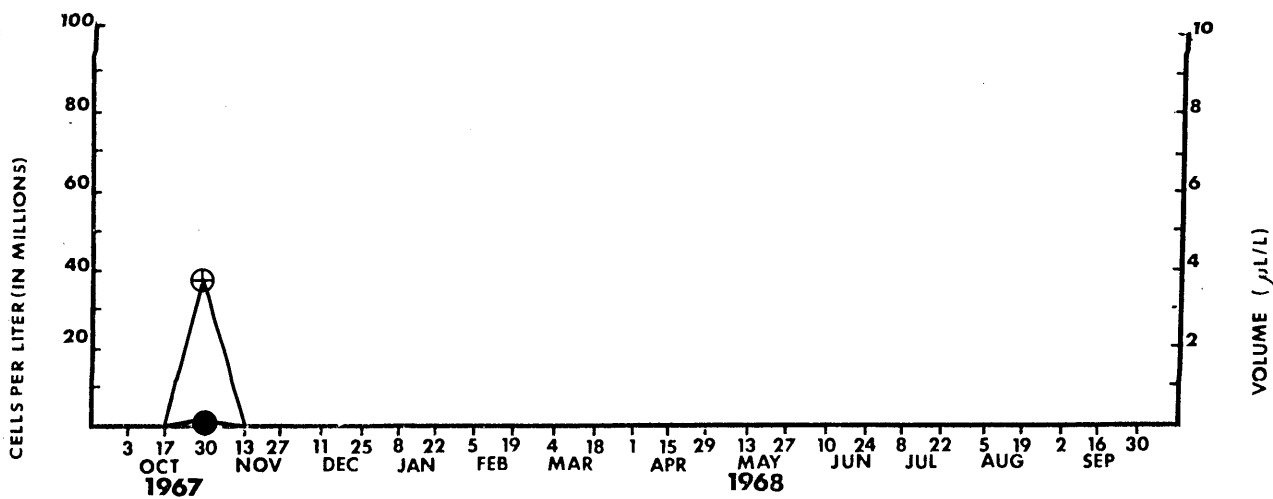
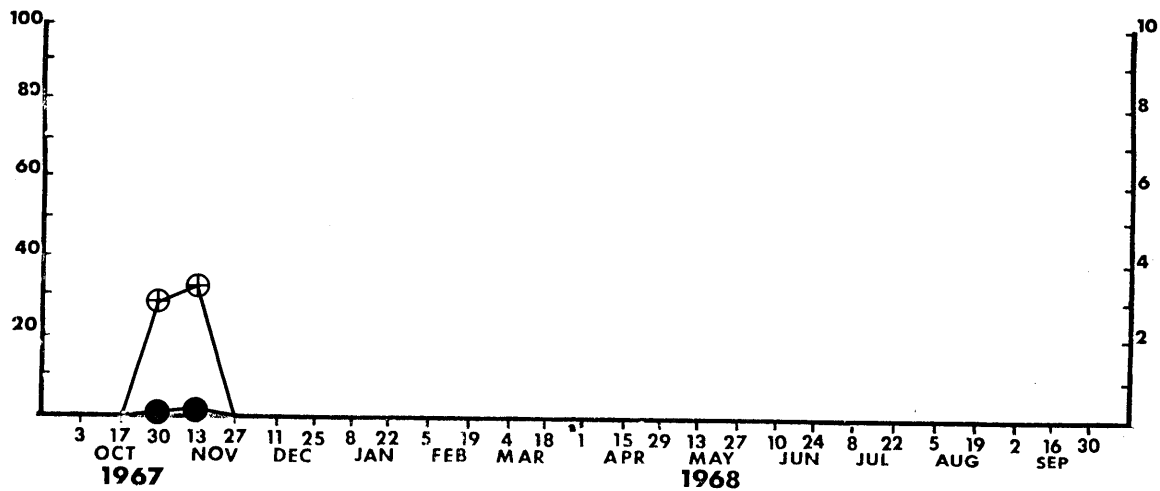


FIGURE 13. Per cent occurrence and volume for Melosira varians.

Station 1. ● occurrence
⊕ volume

Station 2. ● occurrence
⊕ volume

Station 3. ● occurrence
⊕ volume

90

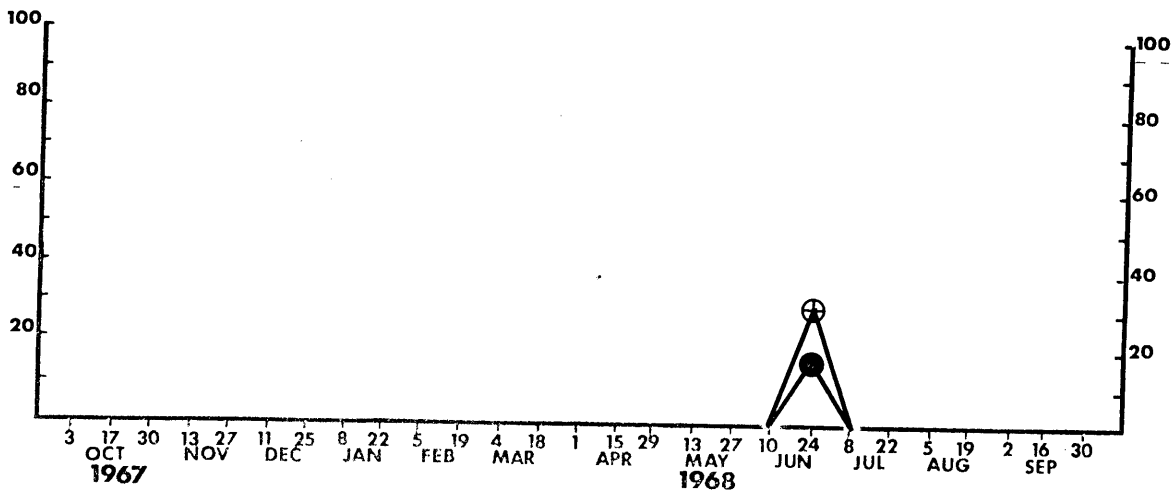
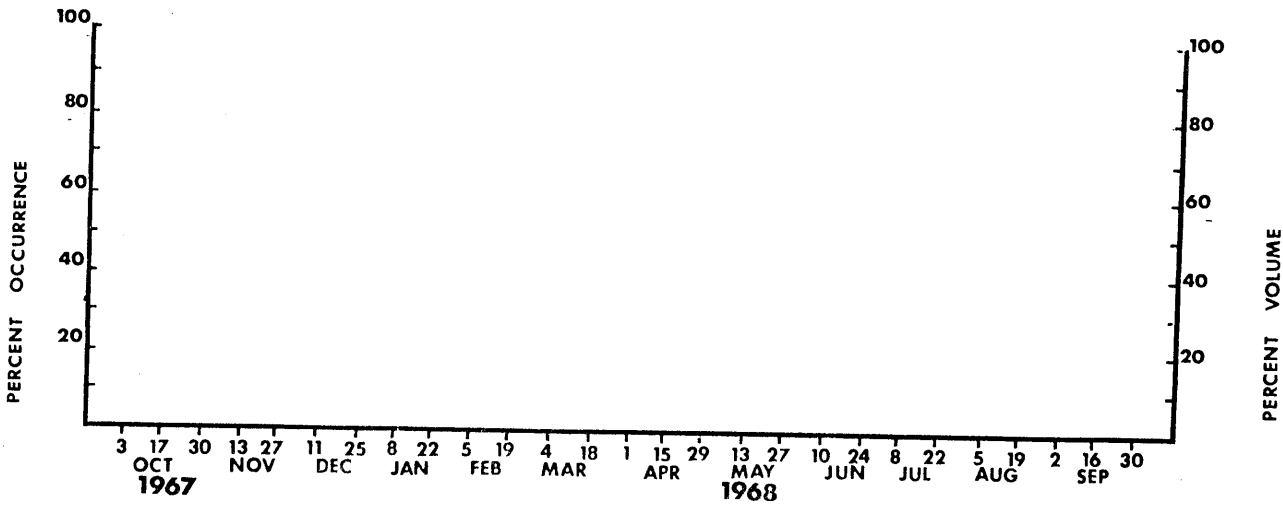
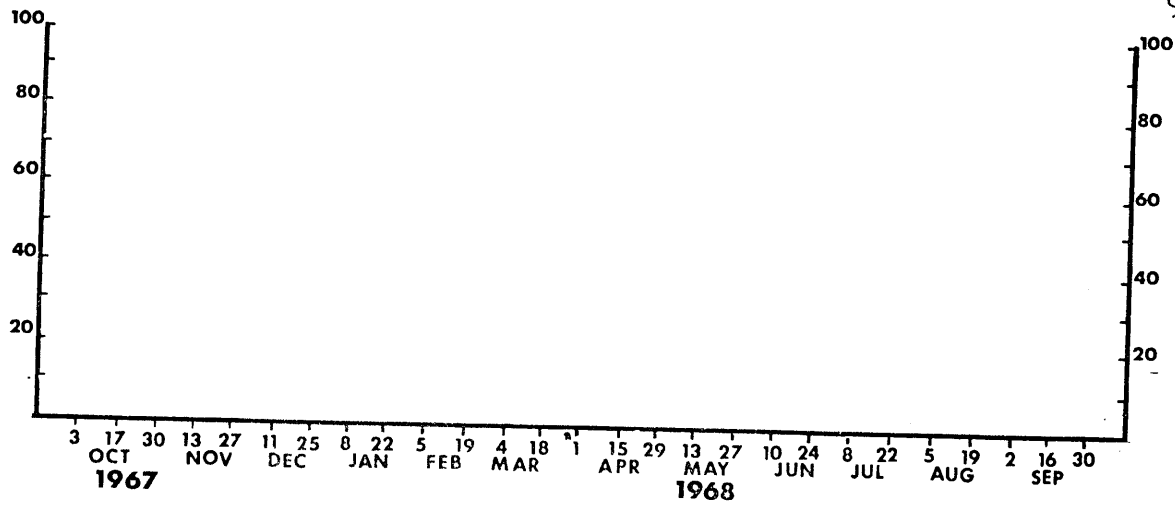


FIGURE 14. Total number and volume for Melosira varians.

Station 1. ● number
⊕ volume

Station 2. ● number
⊕ volume

Station 3. ● number
⊕ volume

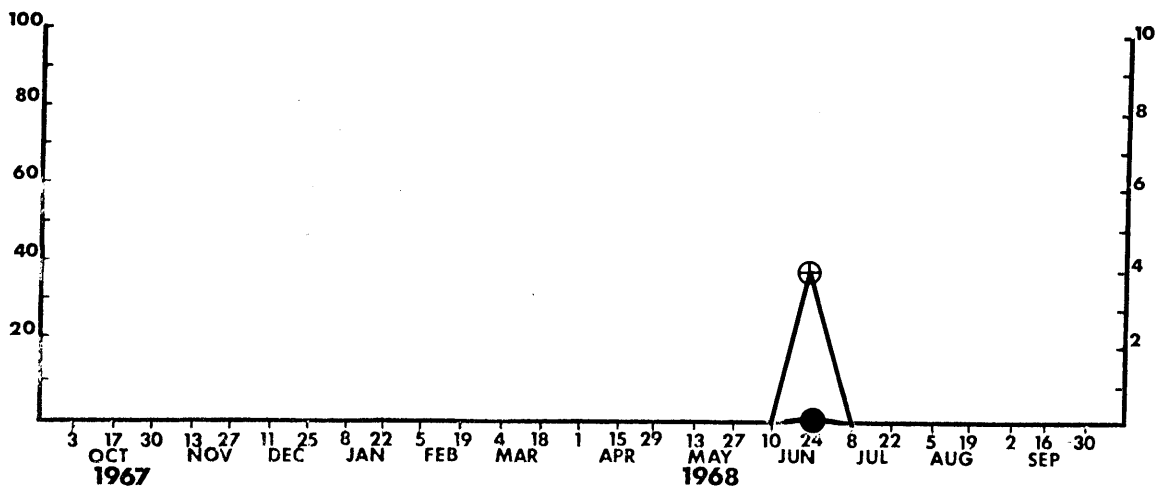
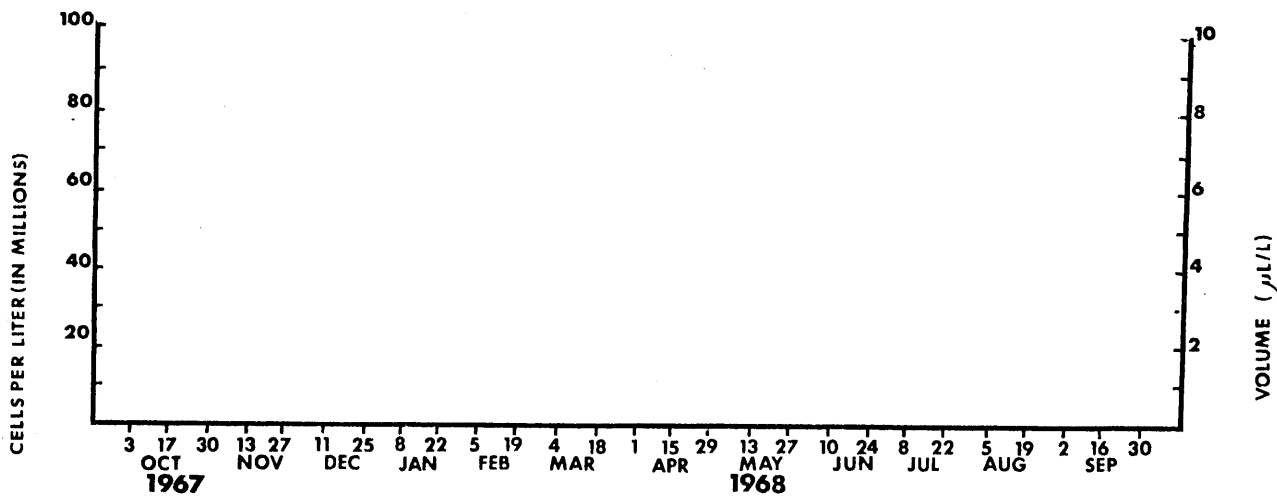
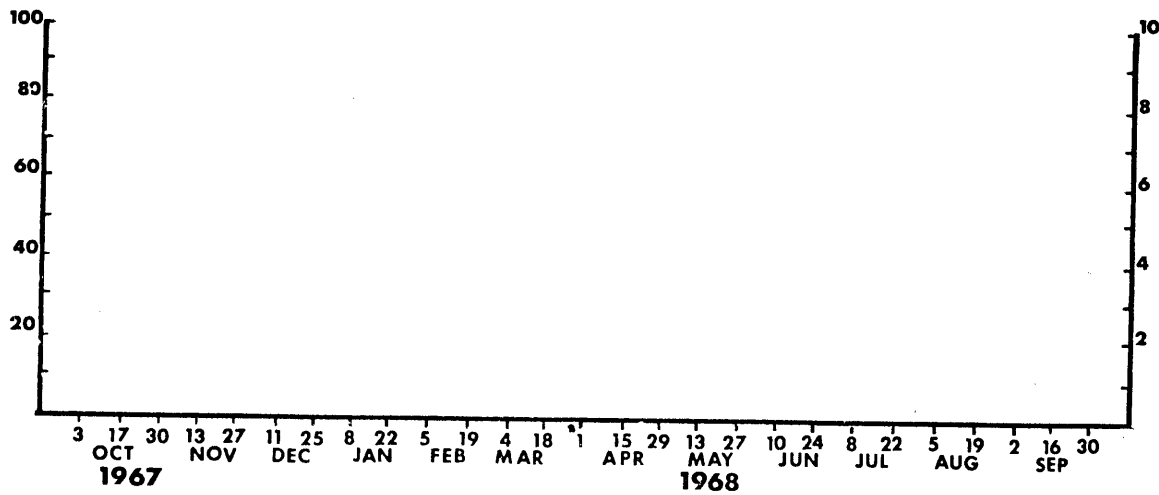


FIGURE 15. Per cent occurrence and volume for Fragilaria construens.

Station 1. ● occurrence
⊕ volume

Station 2. ● occurrence
⊕ volume

Station 3. ● occurrence
⊕ volume



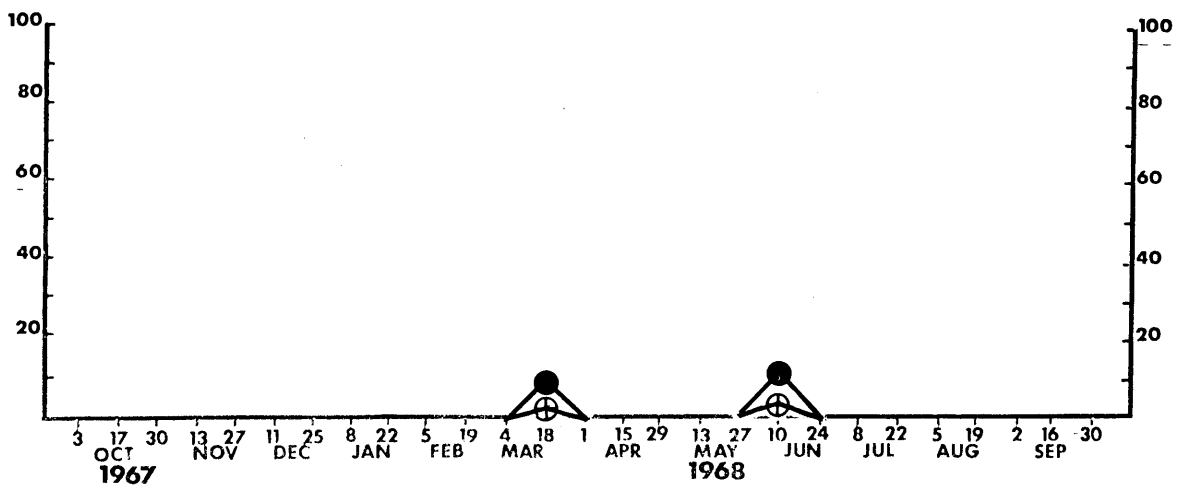
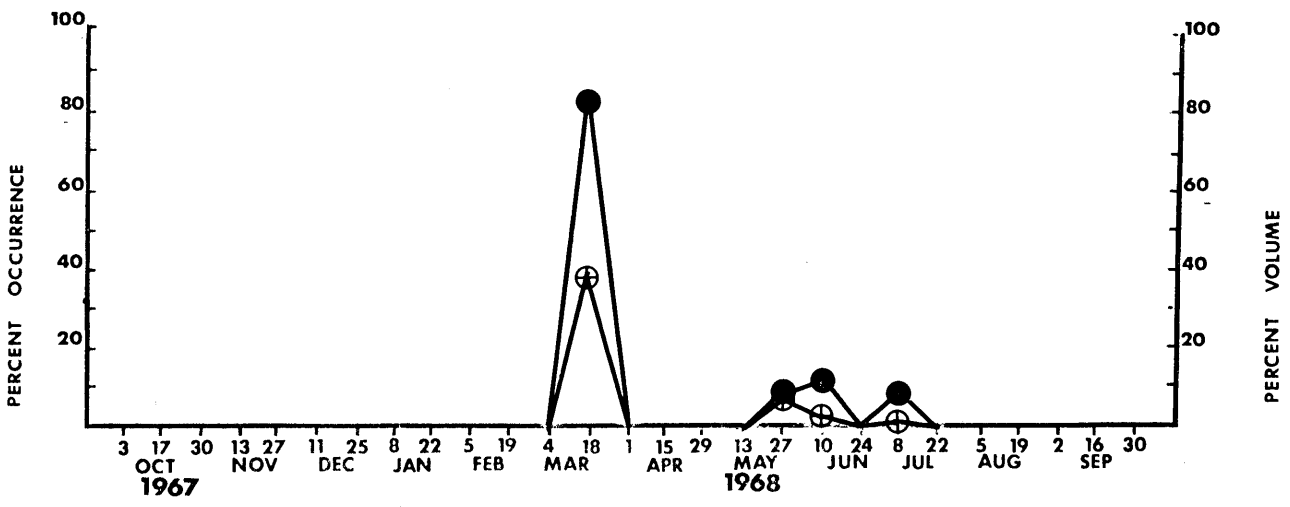
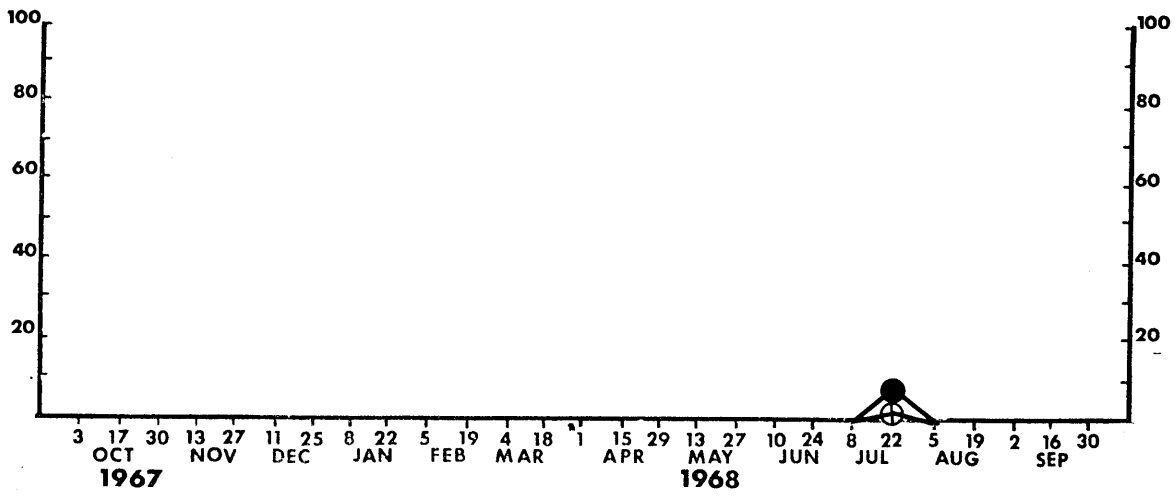


FIGURE 16. Total number and volume for
Fragilaria construens.

Station 1. ●number
⊕volume

Station 2. ●number
⊕volume

Station 3. ●number
⊕volume

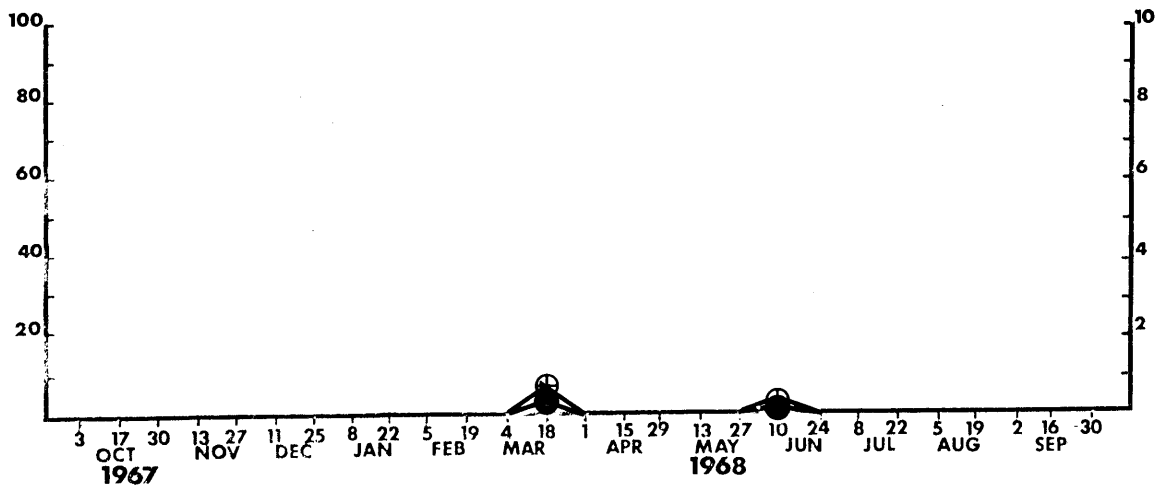
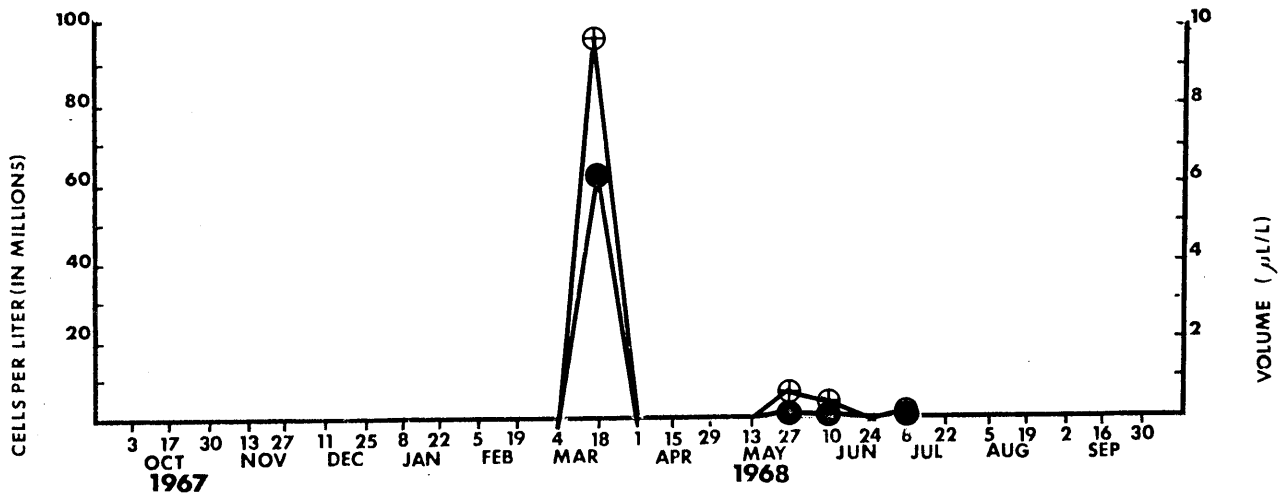
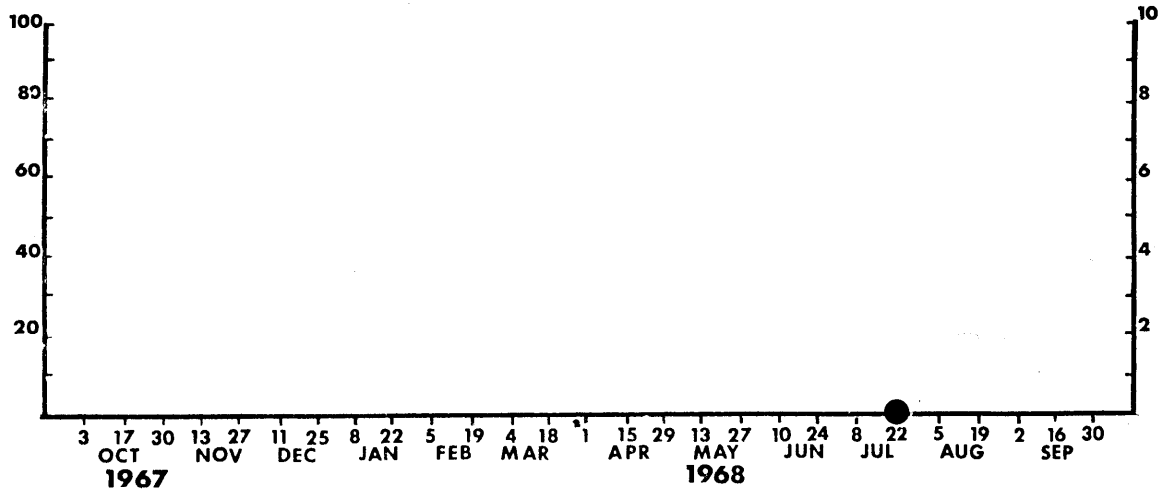
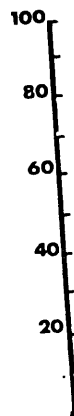


FIGURE 17. Per cent occurrence and volume for Cyclotella glomerata.

Station 1. ● occurrence
⊕ volume

Station 2. ● occurrence
⊕ volume

Station 3. ● occurrence
⊕ volume



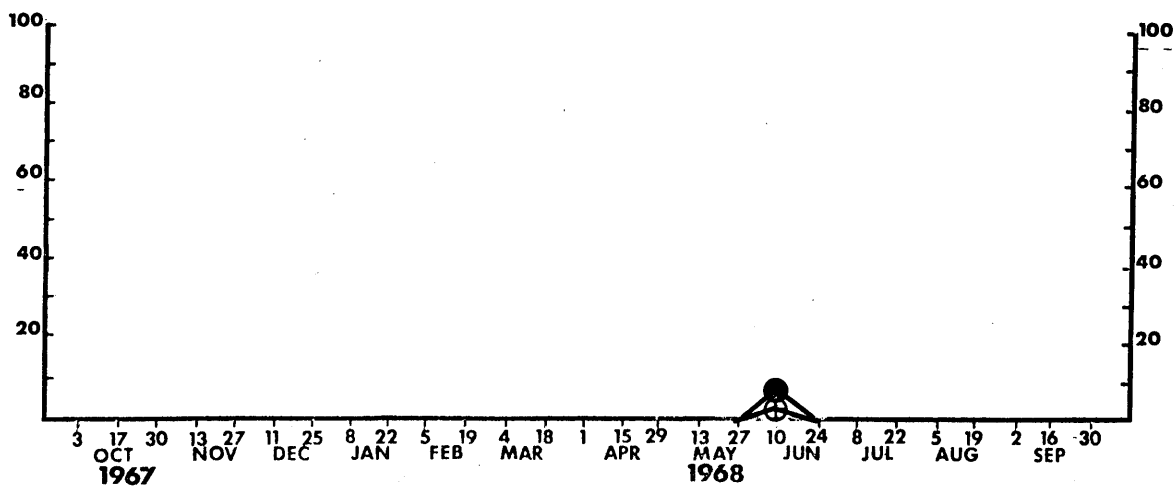
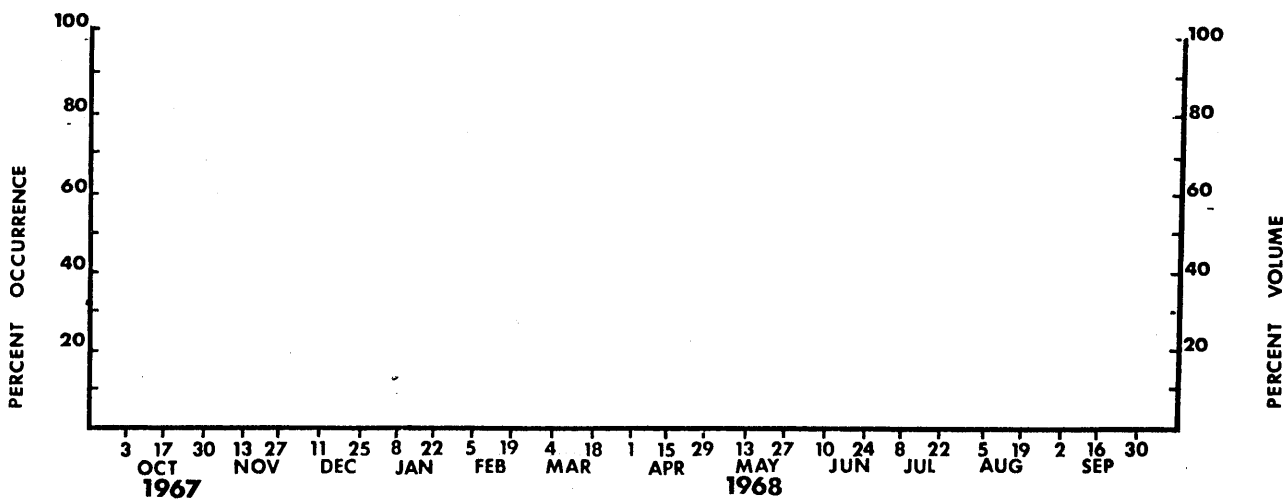
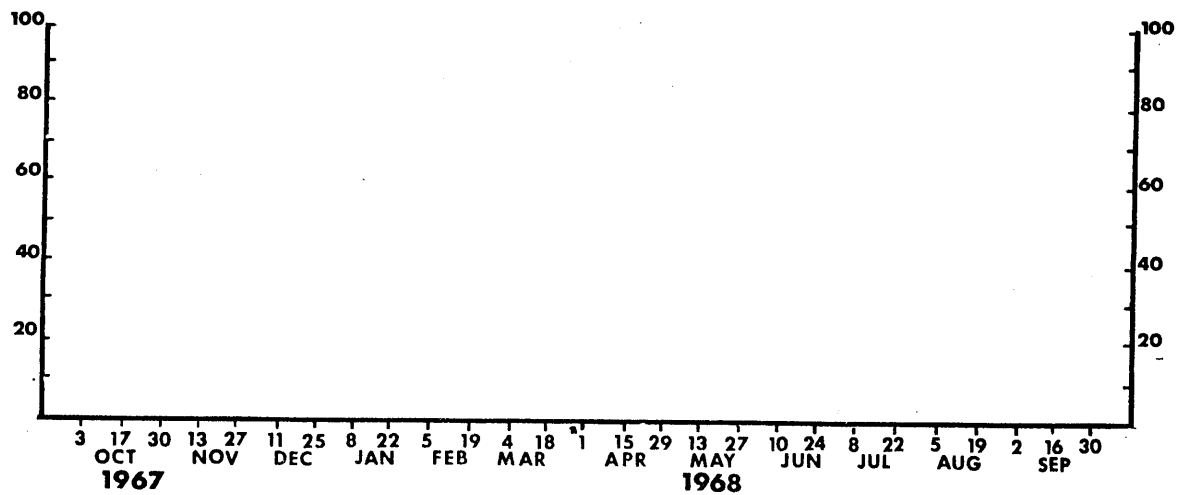


FIGURE 18. Total number and volume for
Cyclotella glomerata.

Station 1. ● number
⊕ volume

Station 2. ● number
⊕ volume

Station 3. ● number
⊕ volume

100

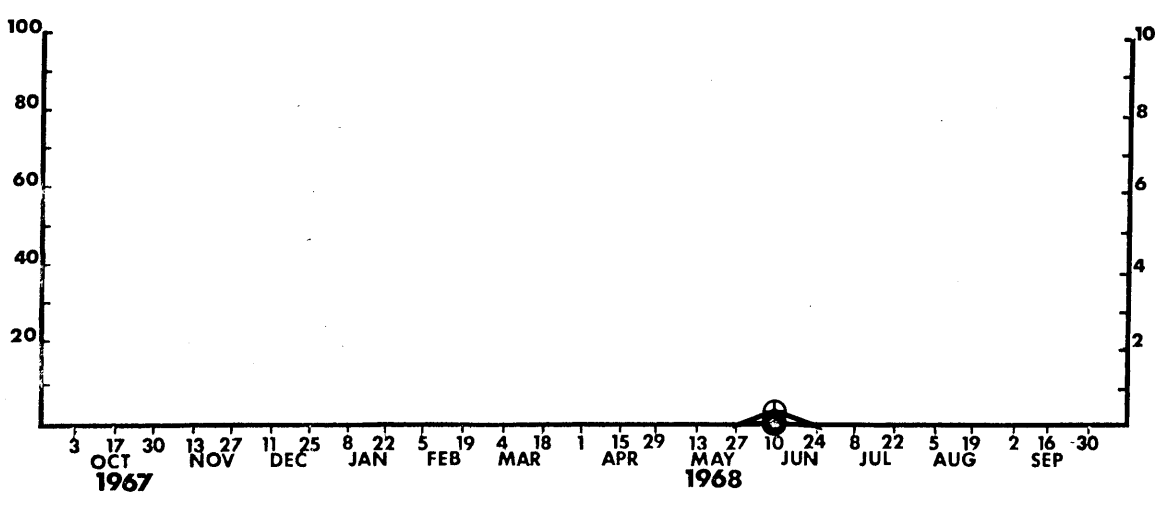
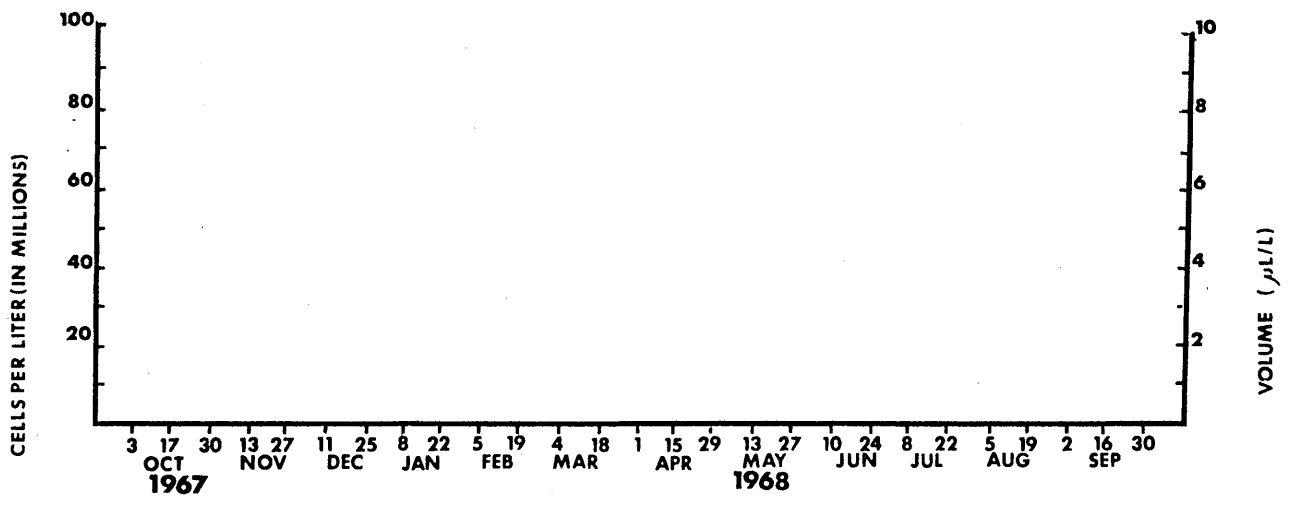
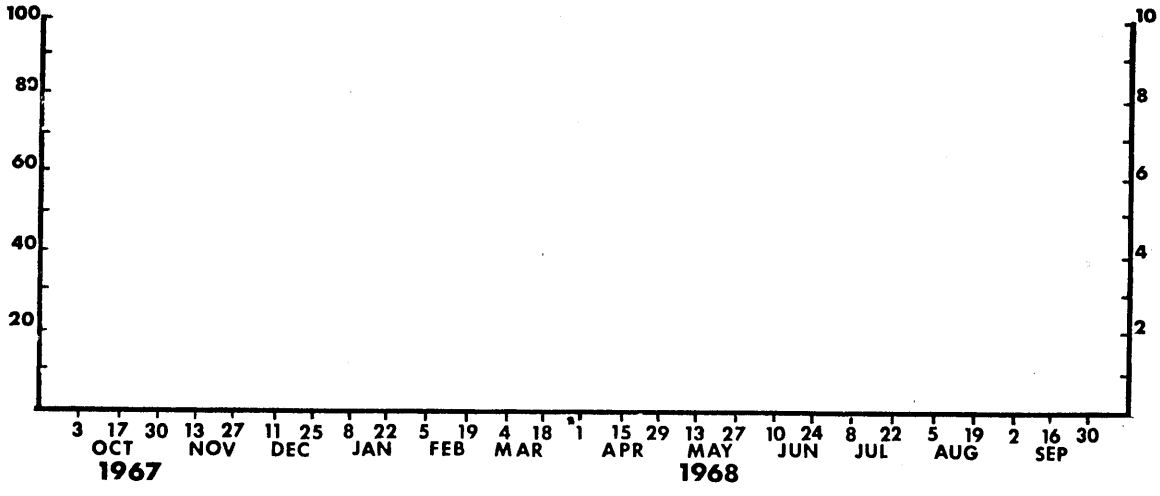


FIGURE 19. Per cent occurrence and volume for
Cyclotella meneghiniana.

Station 1. ● occurrence
⊕ volume

Station 2. ● occurrence
⊕ volume

Station 3. ● occurrence
⊕ volume

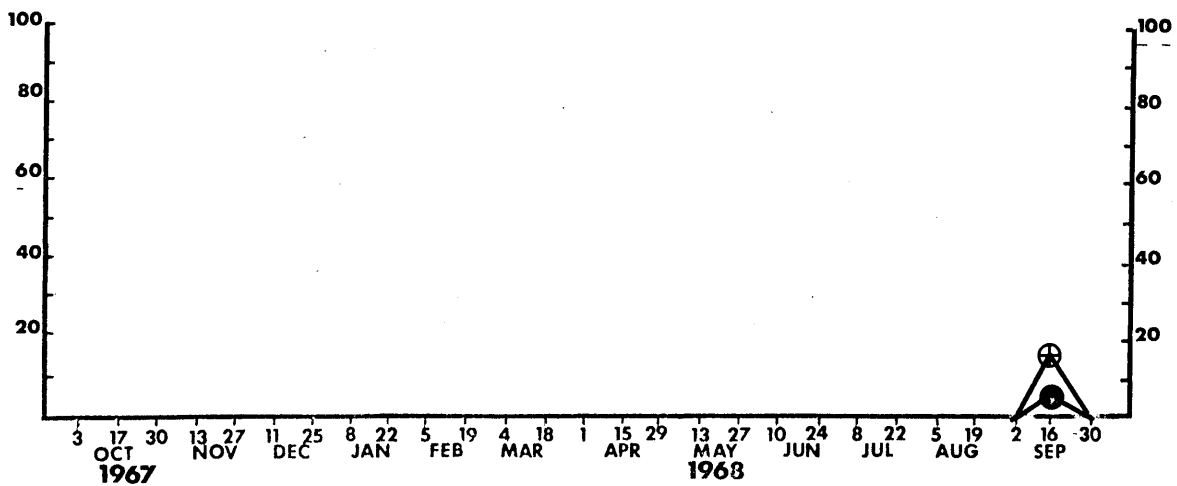
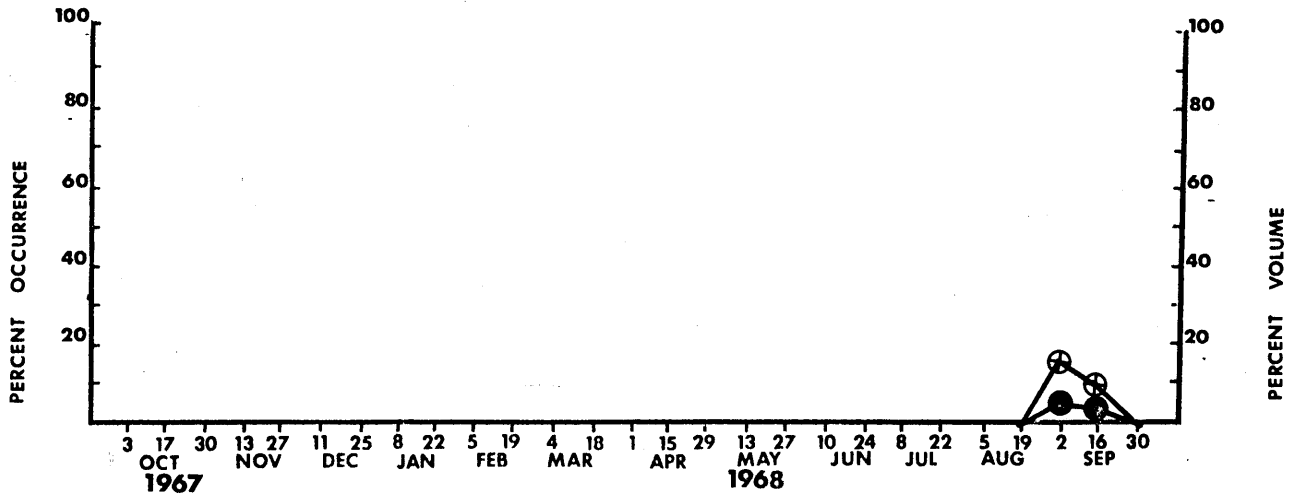
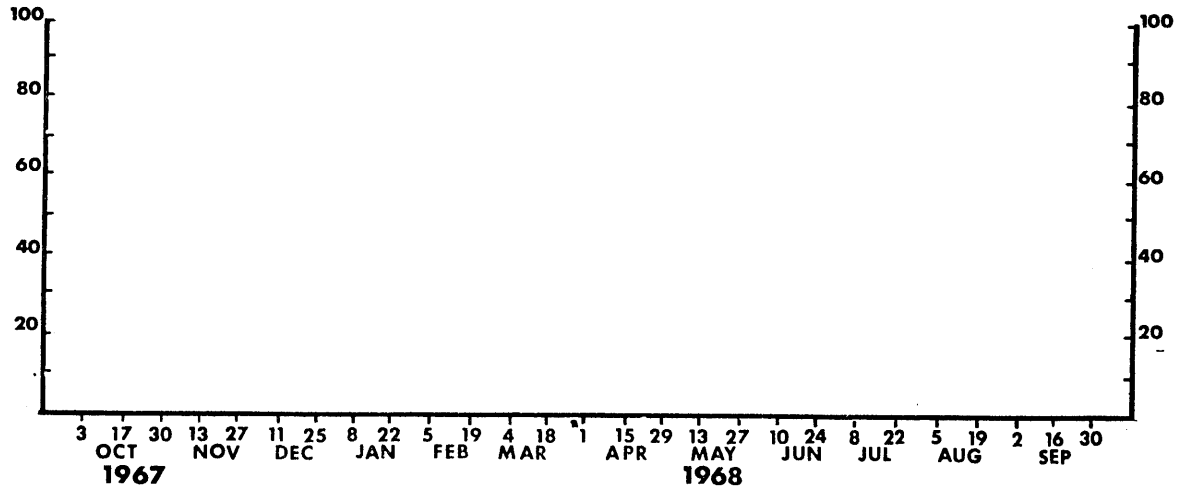


FIGURE 20. Total number and volume for
Cyclotella meneghiniana.

Station 1. ● number
⊕ volume

Station 2. ● number
⊕ volume

Station 3. ● number
⊕ volume

10⁴

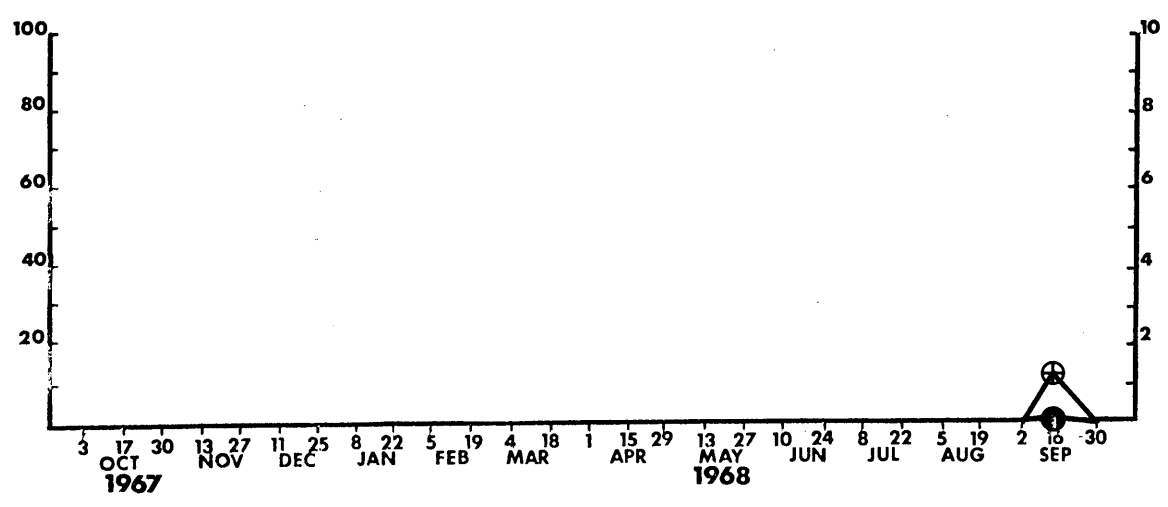
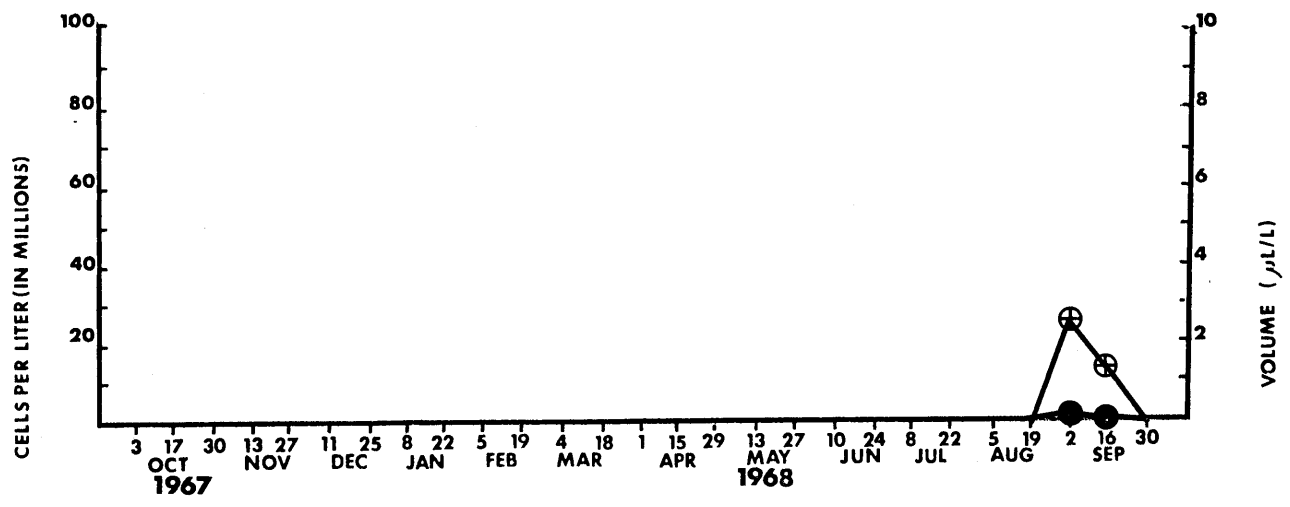
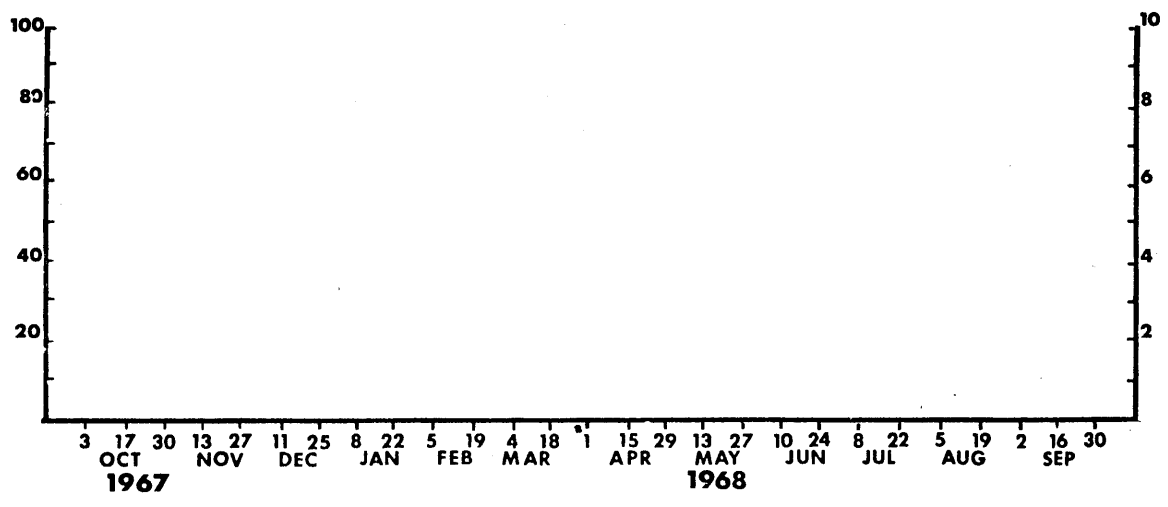


FIGURE 21. Per cent occurrence and volume for
Asterionella formosa.

Station 1. ● occurrence
⊕ volume

Station 2. ● occurrence
⊕ volume

Station 3. ● occurrence
⊕ volume

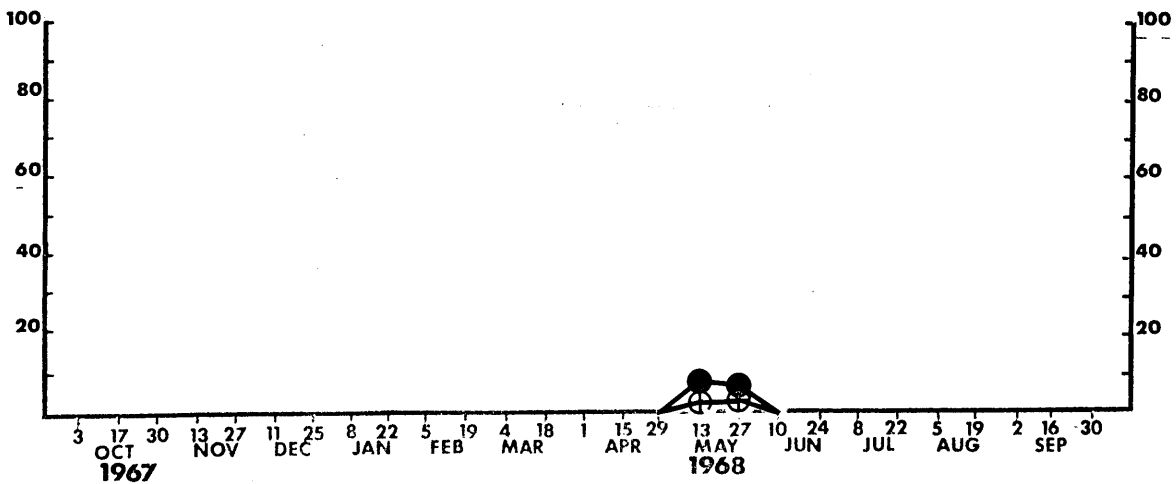
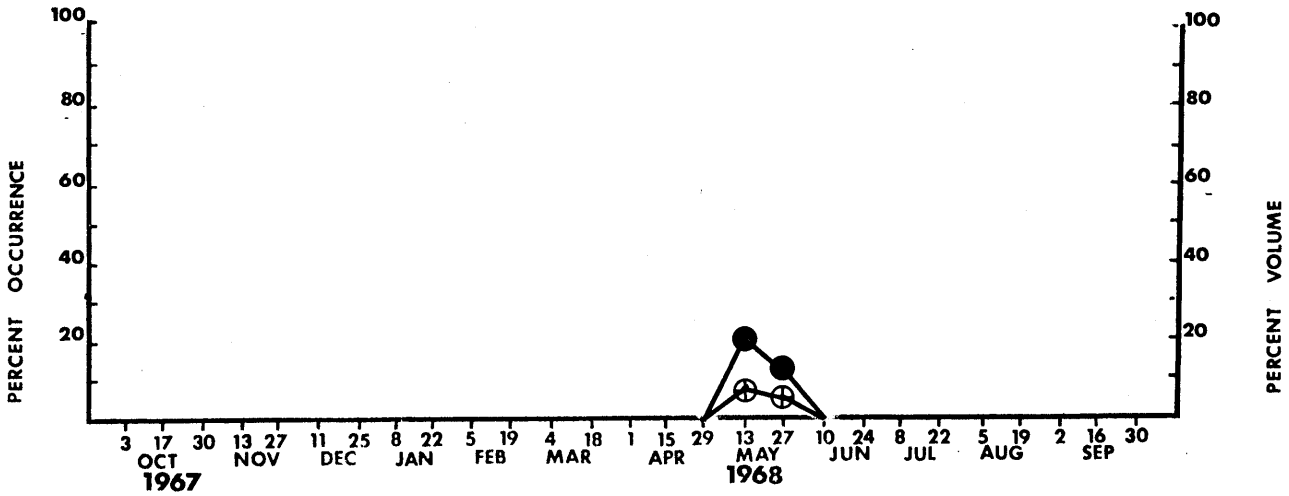
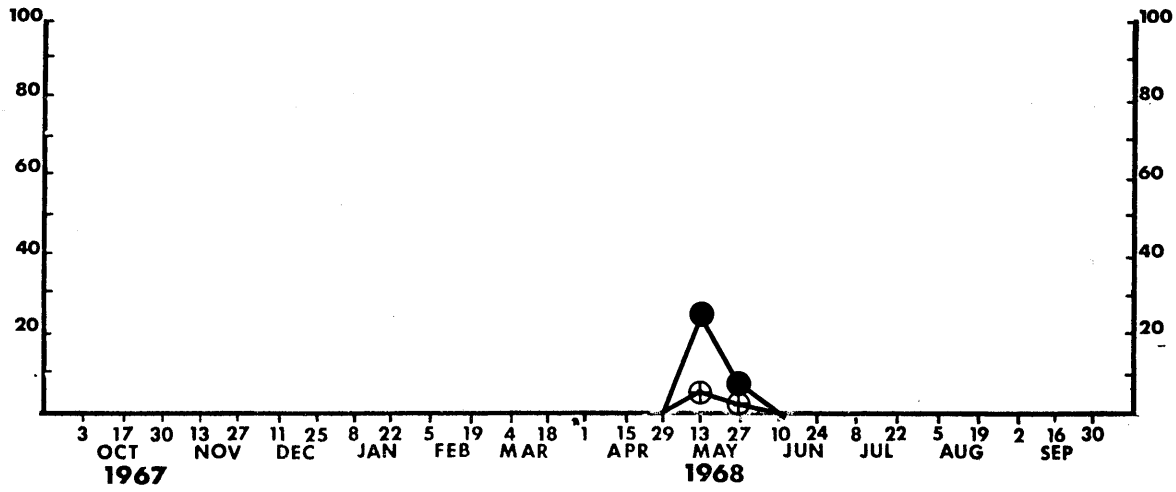


FIGURE 22. Total number and volume for
Asterionella formosa.

Station 1. ●number
⊕volume

Station 2. ●number
⊕volume

Station 3. ●number
⊕volume

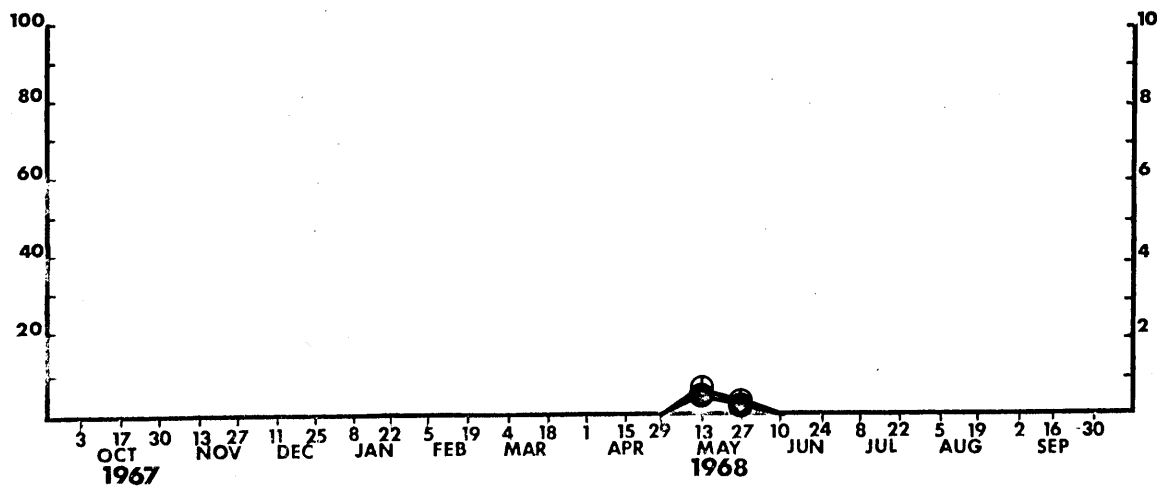
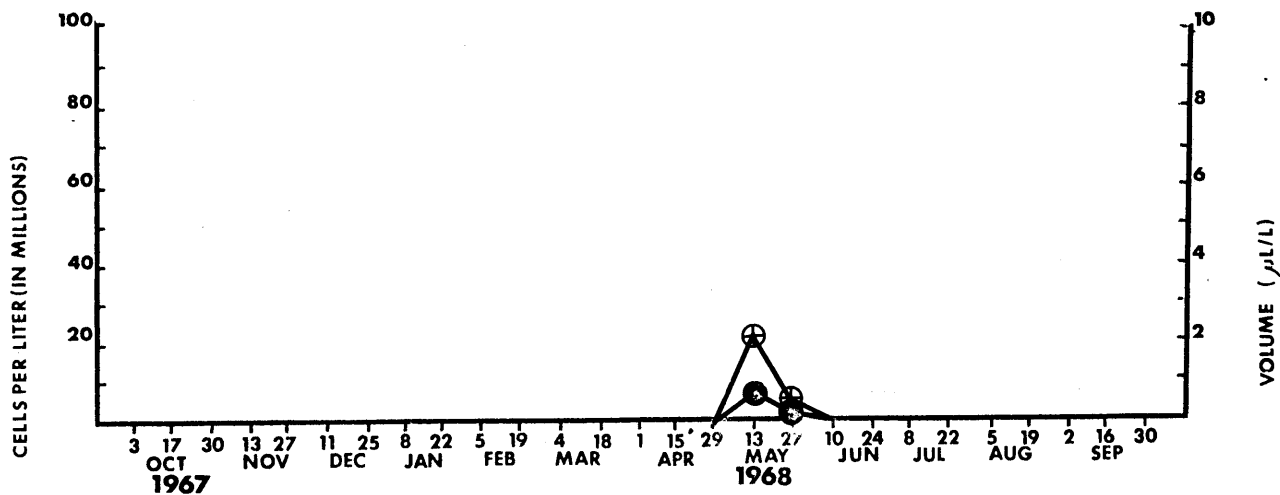
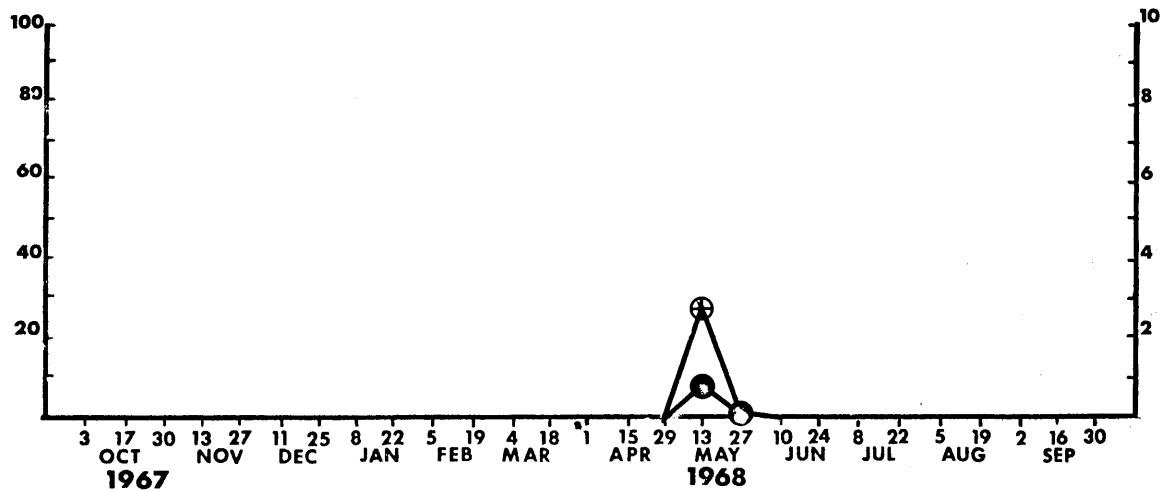


FIGURE 23. Per cent occurrence and volume for Diatoma elongata.

Station 1. ● occurrence
⊕ volume

Station 2. ● occurrence
⊕ volume

Station 3. ● occurrence
⊕ volume

100
80
60
40
20
10
PERCENT OCCURRENCE

FIGURE 24. Total number and volume for Diatoma elongata.

Station 1. ● number
⊕ volume

Station 2. ● number
⊕ volume

Station 3. ● number
⊕ volume

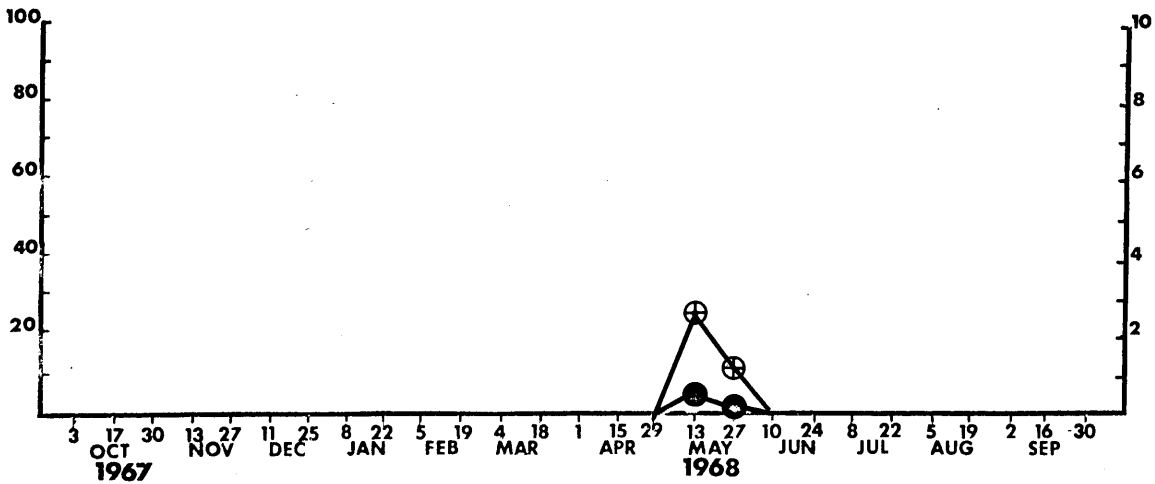
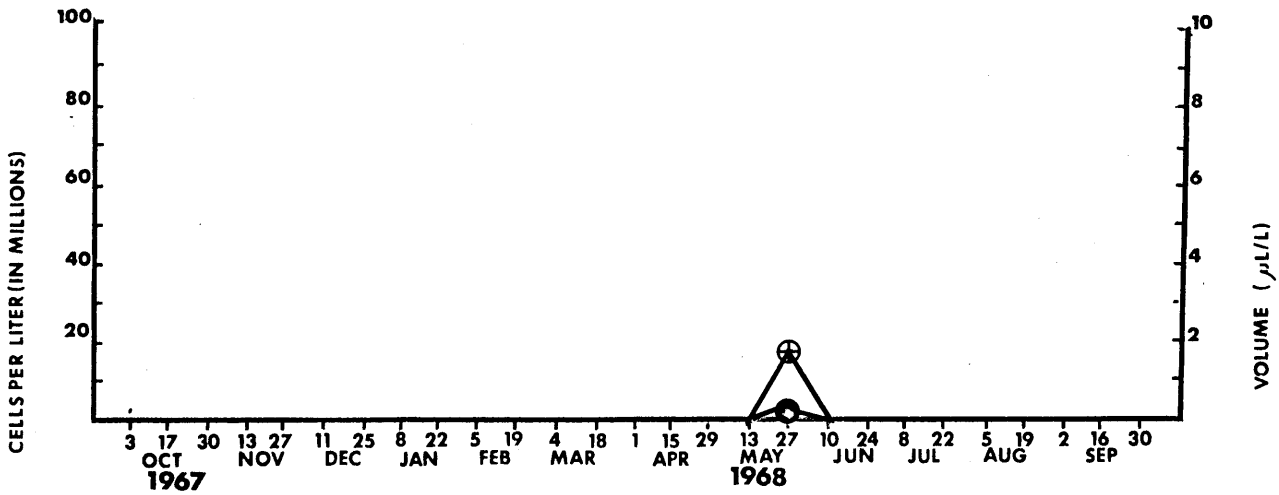
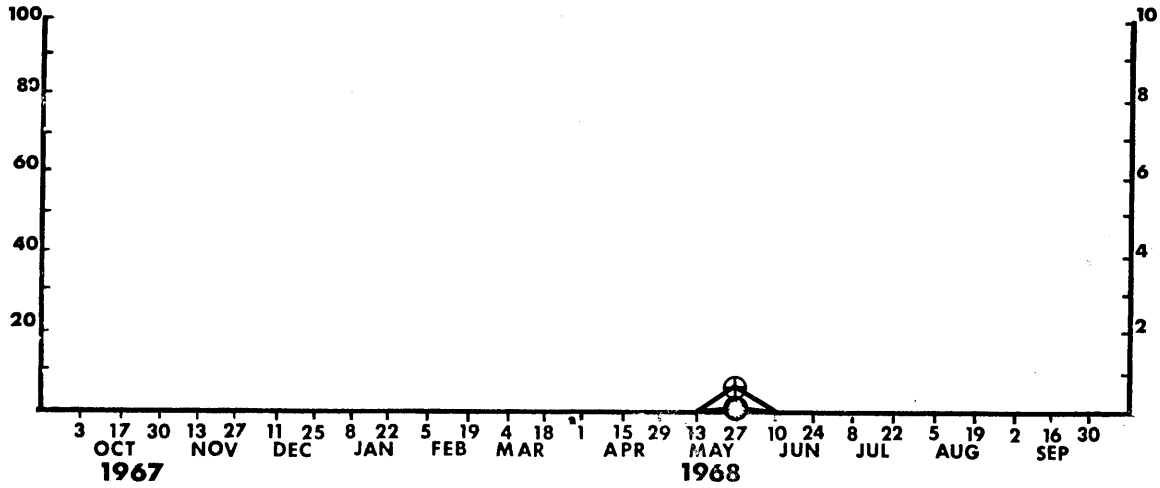


FIGURE 25. Number of cells per liter correlated with alkalinity in parts per million, Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

Station 1. ●numbers
⊕alkalinity

Station 2. ●numbers
⊕alkalinity

Station 3. ●numbers
⊕alkalinity

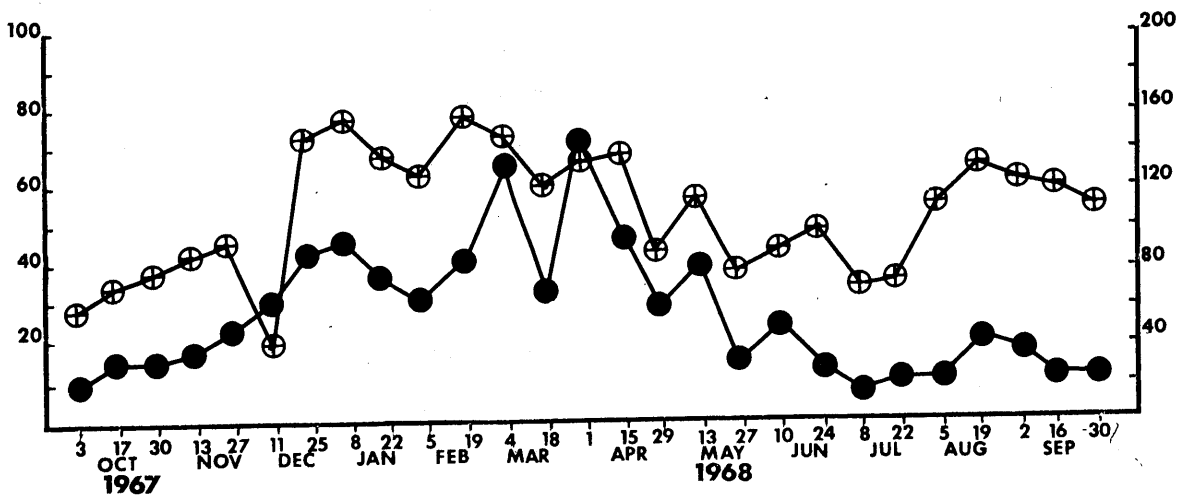
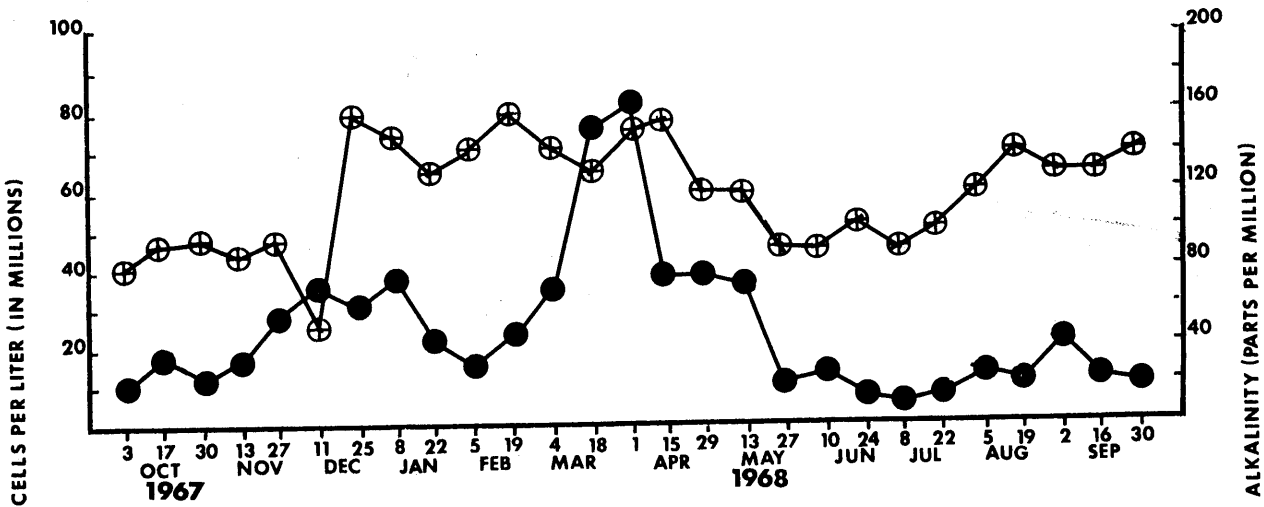
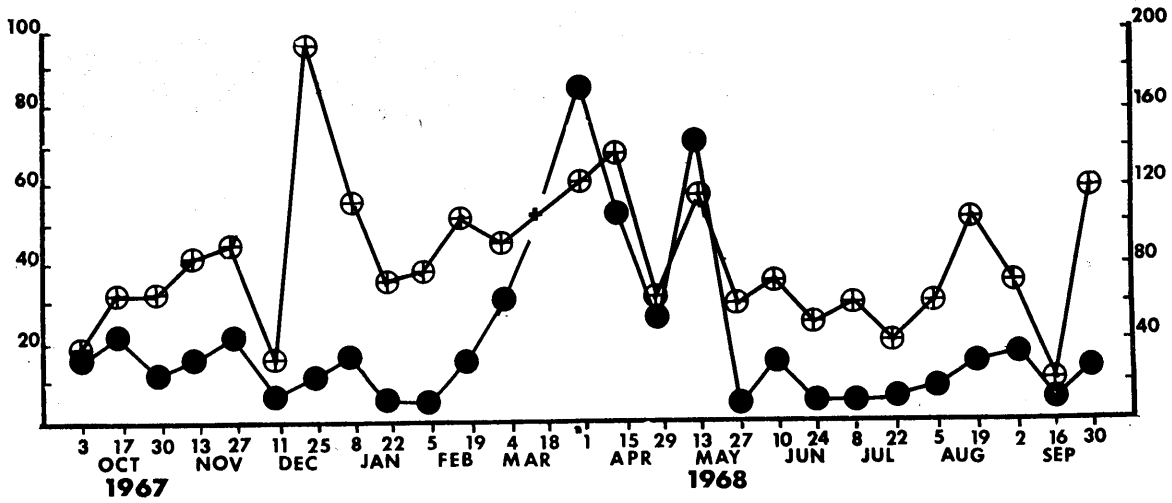


FIGURE 26. Calcium in parts per million correlated with water temperature (centigrade), Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

Station 1. ●calcium
⊕temperature

Station 2. ●calcium
⊕temperature

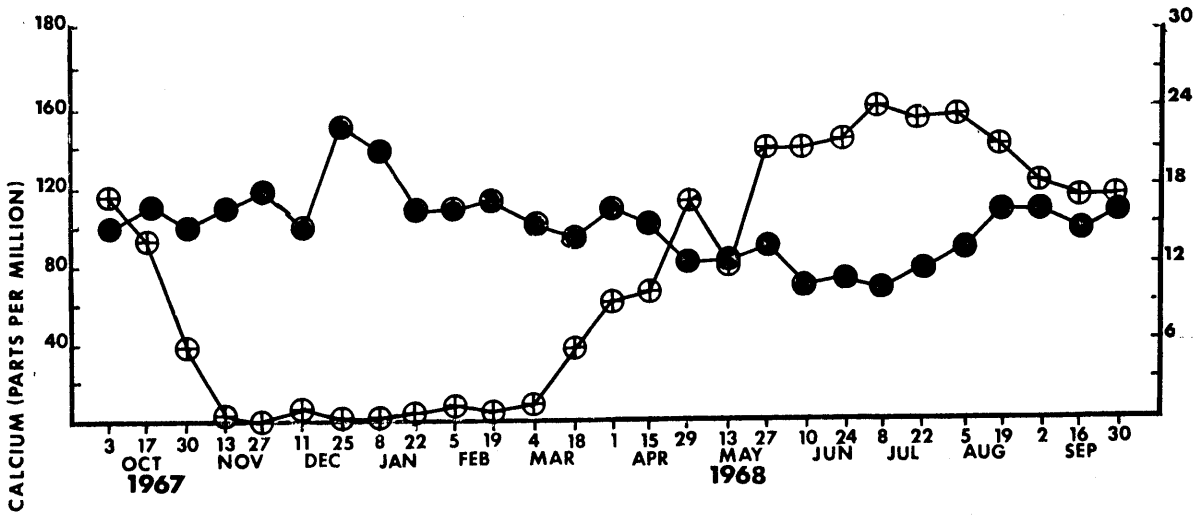
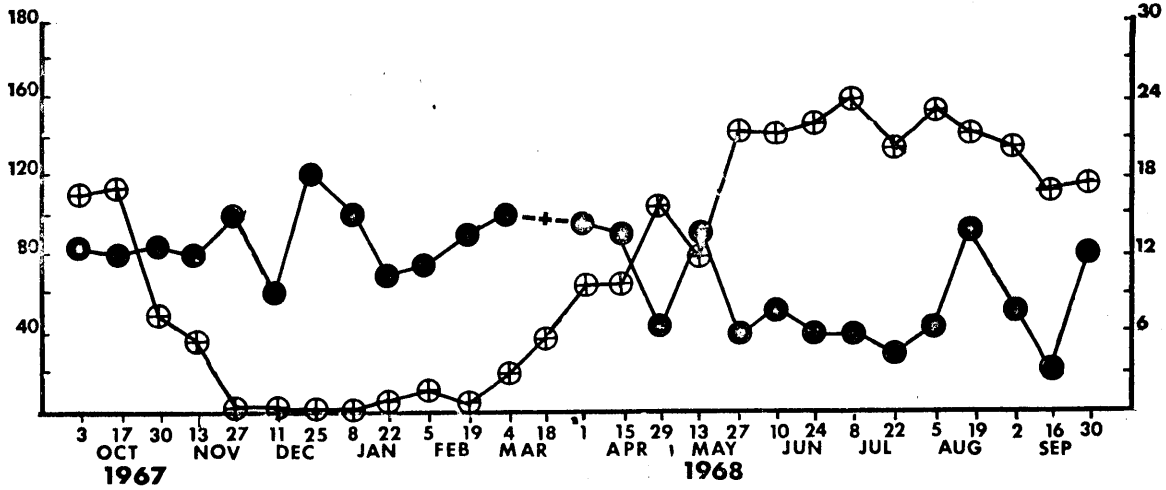
Station 3. ●calcium
⊕temperature

180

160

120

(PARTS PER MILLION)



WATER TEMPERATURE (CENTIGRADE)

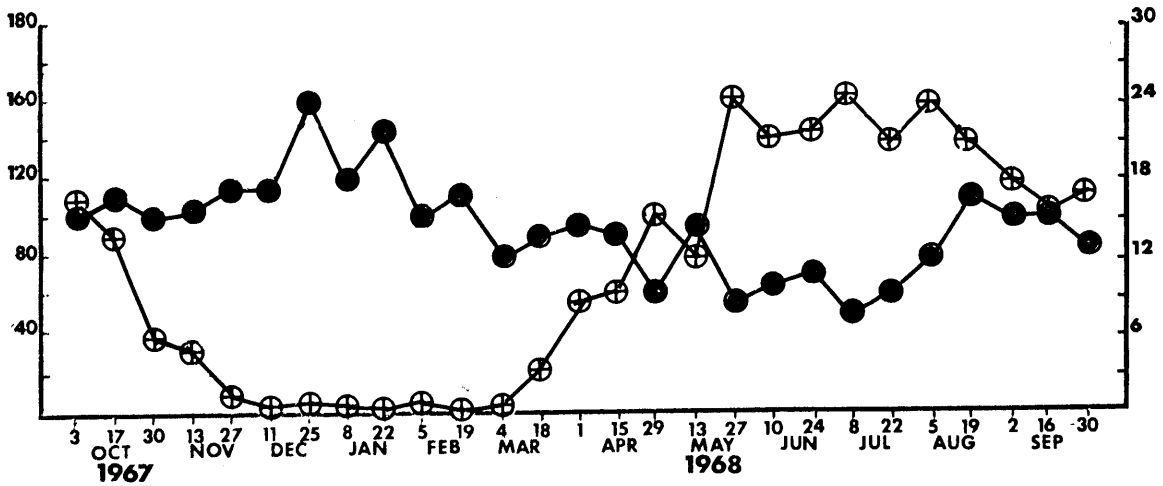


FIGURE 27. Silica in parts per million correlated with
nitrate nitrogen in parts per million, Mississippi River,
La Crosse, Wisconsin, October 1967 through September 1968.

Station 1. ●silica
⊕nitrate

Station 2. ●silica
⊕nitrate

Station 3. ●silica
⊕nitrate

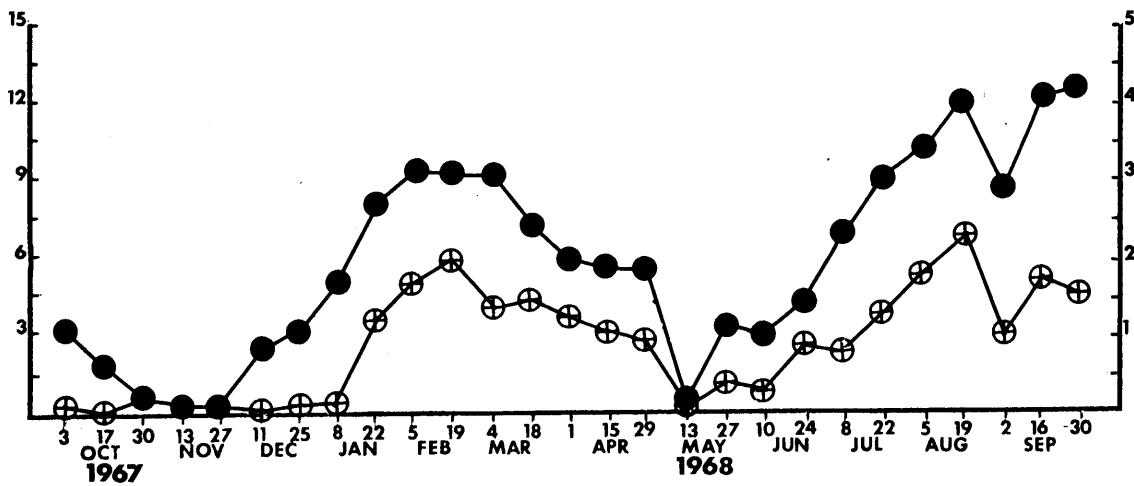
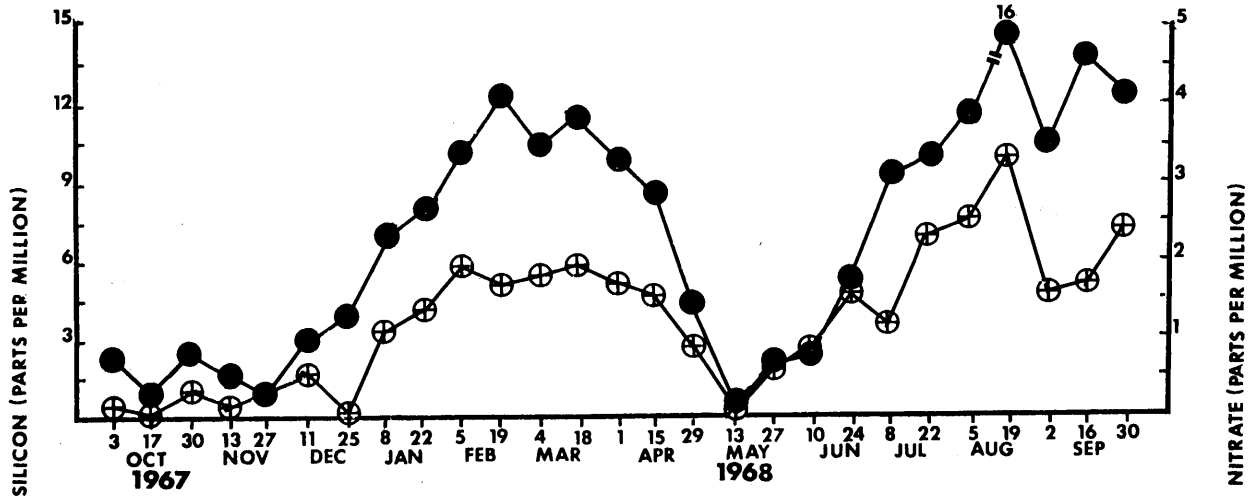
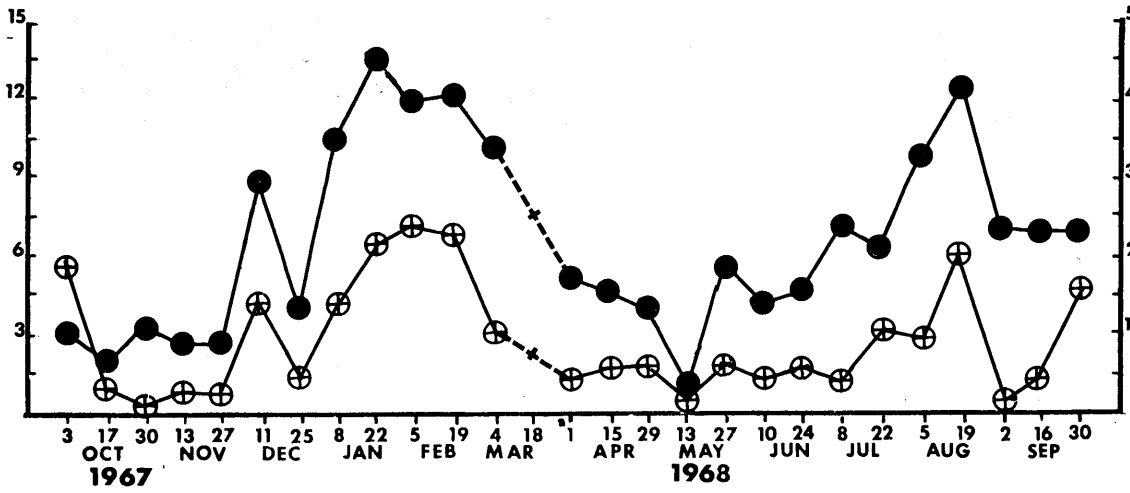


FIGURE 28. pH readings in the Mississippi River, La Crosse, Wisconsin, October 1967 through September 1968.

Station 1.

Station 2.

Station 3.

