PHYTOPLANKTON STUDY OF LAKE MICHIGAN AT EVANSTON, ILLINOIS[1]

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As a continuation of a quantitative survey of the phytoplankton of Lake Michigan started during May, 1937, under the direction of Dr. L. H. Tiffany, regular weekly collecting was taken over by the writer during November, 1938. It appears (Fig. 1) that due to the fluctuations of various chemical and physical factors, the data for any one year scarcely represent, in themselves, a complete picture of either the phytoplankton crop or its periodicity.

Although several papers have been published on the plankton of Lake Michigan, none have dealt with quantitative collections over any extended period of time. Briggs (1872) listed 45 species of diatoms found in Lake Michigan. Thomas and Chase (1887) brought together a long list of 215 species of diatoms found over a period of 16 years in the water supply of the city of Chicago. Ward (1896) worked in the Traverse Bay region on the relation of plankton and bottom organisms to the whitefish. Jennings, Thompson and Kofoid later added appendices, on rotifers, phytoplankton, and protozoa respectively, to Ward's publication.

Eddy (1927) published quantitative data obtained from two series of collections which were made in 1887-88 and 1926-27. A total of 119 species were found, sixty of which were phytoplankters and fifty-nine were zooplankters. A comparison of the more recent collections with those made forty years previous, showed that very little change had occurred in the general composition of the plankton. Diatoms were found to predominate at all times and constituted the majority of the organisms of the plankton.

Bayliss and Gerstein (1929) in a two year study of phytoplankton and zooplankton in the lake water of the Chicago Water Supply found that peaks of plankton periodicity were reached in May and October of 1927 but only in September of 1928. Ahlstrom (1936) published a very complete account of the deep water and inshore plankton of Lake Michigan at Evanston, Illinois. He recognized the need for quantitative studies to establish the existence of seasonal periodicity which he detected in his qualitative collections.

Daily (1937) initiated what is expected to be an extended quantitative survey of the phytoplankton of Lake Michigan at Evanston, Illinois. He considered temperature as being important in optimum growth but not significant enough to be the controlling factor of periodicity. Further correlations were made with hours of sunlight, turbidity, hydrogen ion concentration, and bacteria.

In the present study, regular weekly quantitative collections of phytoplankton were made from a breakwater adjoining the Northwestern University campus over a period of one year, November, 1938 to November, 1939. The Sedgwick-Rafter method was used exclusively. This method consists of filtering water samples through sand supported upon 200 mesh bolting cloth disks and then calculating the number of organisms from the concentrate. The formula for such calculation is found in the Standard Method of Water Analysis, 1936 and is represented as follows:

$$\frac{\text{No. of fields in a one ml. counting cell one mm. deep}}{\text{No. of fields counted}} \times \frac{\text{ml. of concentrate}}{\text{ml. of water filtered}} = \text{the multiplier}$$

Thus: $\frac{1000}{10} \times \frac{10}{1000} = 1$

TABLE 1.—MONTHLY AVERAGES OF ALGAL CLASSES EXPRESSED IN NUMBERS PER CC AND PERCENTAGE OF THE TOTAL YIELD

		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Averages
Bacillariophyceae	%	95.9	95.8	93.8	97.1	97.8	98.8	97.5	89.2	90.2	90.3	91.0	94.0	94%
	Per cc.	403	364	272	134	94	266	631	612	388	328	266	366	343.
Chyrsophyceae	%	1.5	1.8	3.1	0	0.1	0.4	0.5	4.5	7.0	6.6	5.4	1.4	3%
	Per cc.	6	7	9	0	1	1	3	31	30	24	16	5	11
Myxophyceae	%	1.9	1.8	1.7	2.2	0.1	0.4	0.8	4.2	1.0	1.1	2.0	2.3	2%
	Per cc.	8	7	5	3	1	1	5	29	4	4	6	9	6.8
Chlorophyceae	%	0.7	0.6	1.4	0.7	0	0.4	1.2	2.1	1.6	1.7	1.3	2.3	1%
	Per cc.	3	2	4	1	0	1	8	15	7	6	4	9	5
Dinophyceae	%	0	0	0	0	0	0	0	0	0.2	0.3	0.3	0	.06%
	Per cc.	0	0	0	0	0	0	0	0	1	1	1	0	.2
Totals per cc.		420	380	290	138	96	269	647	687	430	363	293	389	366

DISCUSSION AND CONCLUSIONS

1. The Bacillariophyceae dominated every collection averaging 94% of the total phytoplankton. Chyrsophyceae, Myxophyceae, and Chlorophyceae were responsible for 3%, 2%, and 1% respectively, while Dinophyceae yielded only a small fraction of 1% (Table 1).

2. The maximum weekly yield of 1,052 organisms per cubic centimeter was recorded May 9, 1939 while the minimum of 81 occurred twice, March 14 and 21, 1939. The maximum and minimum monthly totals (Fig. 1) were established during June and March respectively.

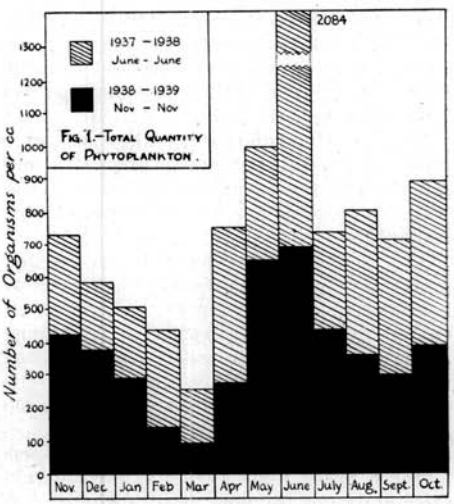
3. Two peaks of abundance were evident in the average monthly totals of phytoplankton. The major peak occurred in June; the minor in November.

4. Each genus displayed its own pulse independently at some time throughout the year. *Asterionella* and *Cyclotella* each reached a peak in November, *Synedra* in May, *Fragilaria* in June and *Tabellaria* in July.

5. The total Bacillariophyceae closely parallels the total phytoplankton except in June, when the Chyrsophyceae, Myxophyceae, and Chlorophyceae reached their peaks.

6. Some of the constituent genera of diatoms and their relative abundance for the year are the following:

1. *Synedra* 39%
2. *Fragilaria* 17%
3. *Tabellaria* 11%
4. *Cyclotella* 11%



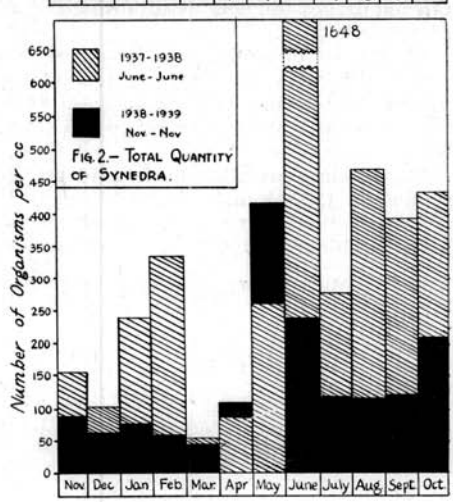


Fig. 1 (above): Total quantity of phytoplankton.
Fig. 2 (below): Total quantity of synedra

5. *Asterionella* 7%
6. *Navicula* 6%
7. *Melosira* 5%
8. *Nitzschia* 2%
9. *Rhizosolenia* 1%
10. *Stephanodiscus* 0.3%

Cymatopleura, *Amphiprora*, *Cymbella*, *Pinnularia*, and *Pleurosigma* ranked in the order mentioned but with an almost insignificant yield.

7. The Chyrsophyceae represented mainly by *Dinobryon* and *Synura* were present in all monthly averages with the exception of February. The average for the year was 3% of the total phytoplankton.

8. The Myxophyceae were never abundant but were present every month of the year; ranging from 0.1% in March to 4.2% in June. The average for the entire year was 2% of the total phytoplankton. Tiffany (1938) reported an absolute autumnal dominance of the Myxophyceae in Lake Erie but no such occurrence has yet been detected in Lake Michigan.

9. The Chlorophyceae, likewise, were never abundant but were present every month with the exception of March. They were responsible for 1% of the total phytoplankton.

10. The Dinophyceae, few in number and species, were present during three consecutive months only. *Ceratium* occurred in July and *Peridinium* in August and September. However, the plankton tow collections seem to indicate that the above mentioned forms were more abundant throughout the year.

11. Temperature apparently has a pronounced effect upon the total phytoplankton but is not the sole determining factor of periodicity.

12. Hours of sunshine show a positive correlation with the total phytoplankton during the spring and summer months but have little or no relation to the October increase.

13. A close parallelism is evident between the 1937-38 and the 1938-39 quantitative studies of the phytoplankton of Lake Michigan. However, a comparison of the total phytoplankton (Fig. 1) and the total *Synedra* (Fig. 2) reveals a partial explanation of two conspicuous inconsistencies; the 1937-38 June and August totals of phytoplankton. The exceptionally high increase of *Synedra* from May to June of 1937-38 and a marked decline during June, 1938-39 accounts for the first. A second but lower peak of *Synedra* in August, 1937-38 and no such occurrence in 1938-39 explains the other. The February, 1937-38 yield of *Synedra* failed to alter the consistent character of the total phytoplankton curve (Fig. 1). The abundance of *Fragilaria* during November, December, and January preceding February offset such a possibility. From the evidence, now at hand, it appears that each genus has high and low productive years which in turn have a pronounced effect upon the total yield of phytoplankton for any one year. It is probable then, that such evidence would support the consistently higher total yield of phytoplankton for 1937-38 as due mainly to *Synedra*. Bayliss and Gerstein reported similar results during 1927 and 1928 when Tabellaria was especially abundant during 1927 and then 1928 followed as a low productive year. The real explanation of the problem now lies in determining what factors might be responsible for the high and low productive years of the various genera and not alone determining what genera are responsible for the variations in yield from year to year.

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[1] A portion of the work done in partial fulfillment of the requirements for the Master of Science Degree in Northwestern University, Evanston, Ill.