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Plankton Study of the Eastern Illinois State College Campus Lake

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INTRODUCTION

This study was made to try to measure the variations in the plankton count in a small lake as compared to the changes and factors controlling these changes in a large lake, Lake Michigan, as reported by the work of K. E. Damann in 1943.

Qualitative and quantitative plankton data compiled from collections made during two separate periods from the Campus Lake at Eastern Illinois State College, Charleston, Illinois have been studied to see if there is any relationship between the pH, light penetration and surface water temperature and plankton populations in such a lake. If physical or chemical factors have a continuous major influence upon the plankton population it should be detectable during any season of the year. Authors of such studies differ as to the importance of any one environmental factor upon plankton growth and reproduction.

I have made nine collections and counted and named the principal plankton plants and animals and I have made and recorded the water temperatures, pH measurements and the depths of light penetration.

DESCRIPTION OF THE LAKE

Seventy-two acres were purchased by the college in 1931 as an addition to the campus. An earthen dam was constructed across the draw and the lake basin was excavated in 1935. As a part of the Twenty-Five Year Plan (Coleman 1950) for the development of Eastern's campus the original lake was changed completely when it was reshaped and dug deeper during 1948. In this plan the men's athletic area was moved to the 72 acres from the main campus and is now known as Lincoln Field. A new concrete spillway and dam consisting of driven sheet metal and earth were constructed on the south end. Two large and one small tile drain a portion of the golf course and the athletic field to the north. In addition to the water supply from the drainage mentioned the lake is fed by other surface drainage and possibly by underground sources because some water appeared in the newly constructed lake after construction was completed and before rainfall occurred. A rather constant water level has been maintained since the lake was constructed.

This most recent lake commonly called Campus Lake was measured and sounded on April 9, 1955 (Fig. 1). The lake has a constriction at the middle where a small footbridge was constructed. A north-south line was sighted through three reference points and the southwest corner of Douglas Hall. Reference point No. 1 is a driven $2\frac{1}{2}$ inch pipe located approximately 40 feet from the southeast shoreline. The bridge post on the northwest corner was used as reference point No. 2. Another $2\frac{1}{2}$ inch pipe was driven approximately 60 feet from the shoreline on the north end of the lake to permanently mark reference point No. 3. The depth and contour as compared with the blueprint showed no appreciable amount of silting. The greatest depth of 7 feet was measured in the south

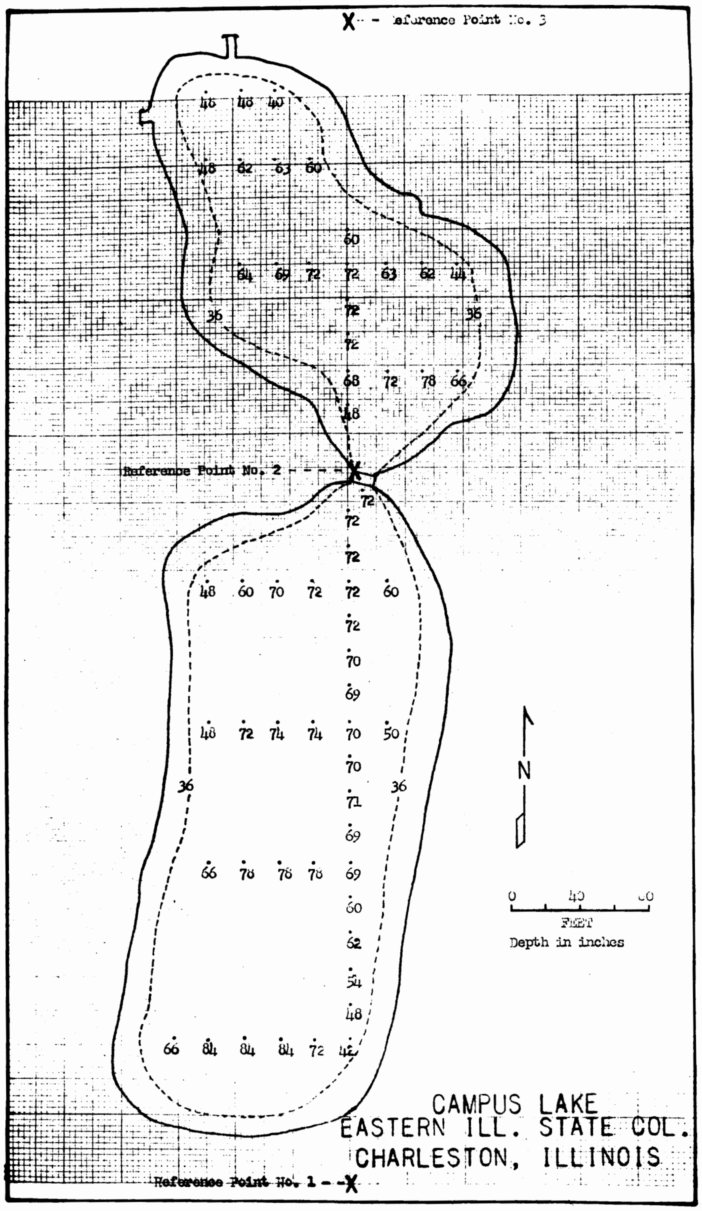

Fig. 1. Eastern Illinois State College Lake

basin. The total length is approximately 600 feet and the widest part is approximately 160 feet across. Water level was established at 20 inches below the beveled edge of the bridge abutment on the southwest corner.

The Campus Lake had been kept clear of the emergent vegetation. This elimination resulted in only open water, submerged and floating leaf species. Potamogeton, Marsilea, Elodea and Chara were well established during the last study.

The following students have contributed to these studies: Paul Trotta, from September 17, 1953 through November 16, 1953, Charles E. Compton, from Janurary 5, 1955 through March 1, 1955 and Anita Hopkins Brown, from March 1, 1955 through April 1955. The first two studies were both qualitative and quantitative in nature while the latter was qualitative only.

Plankton tow net collections were made weekly from the footbridge for qualitative study. In addition a sample of unconcentrated lake water was taken into the laboratory and examined immediately by the Direct Count Method for microscopic organisms (Damann 1950). The Secchi disk was used each time to measure light penetration. Surface temperature of the water was recorded and upon returning to the laboratory the pH was determined by colormetric methods.

RESULTS INCLUDING COUNTS

A. Fall, 1953, Plankton

The phytoplankton was more abundant during the major part of the period until the last two collections on the 10th and 16th of November when the zooplankton had slightly greater numbers (Table 1). Scenedesmus which was most plentiful increased in numbers until a peak of 25,950 organisms per cc. was reached on the 29th of September and then steadily declined to 400 organisms per cc. on the 16th of November. The total phytoplankton showed a trend similar to that of Scenedesmus. Scenedesmus and Closterium were the only species counted in every collection. Several species of the Bacillariophyceae were present with Navicula being in all collections except the one of the 22nd of September. Aphanizomenon and Trachelomonas were present in all but the first collection. Phytoplankton species other than those mentioned appeared sporadically.

Zooplankton was absent on the 17th, 29th of September and on the 6th of October. Thereafter the population increased with one exception until the maximum was reached on the 10th of November. Listed according to abundance the zooplankton consisted of Protozoans, Rotifers and Crustaceans. The phytoplankton was most abundant when the water temperature reached the maximum of 72° F. and the zooplankton was most numerous when the water temperature was at the minimum of 45° F. More phytoplankton species were present on the 25th of October and the 3rd of November when the water temperatures were 54 and 55° F. respectively.

CHEMICAL AND PHYSICAL DATA

During the fall period the pH varied only 0.2 from 8.8 to 9.0 (Table 2). Light penetration was fairly shallow varying from a minimum of 9 inches to a maximum of 14 inches. The change in the water temperature throughout the period reflects the cooler weather as fall

Table 1. Plankton counts made by Paul Trotta between September 17, 1953 and November 16, 1953. Given in numbers per cubic centimeter.

Algal classes and genera encountered	September 17	22	29	October 6	13	20	28	November 3	10	16
CHLOROPHYCEAE:										
Ankistrodesmus	—	—	—	—	600	40	50	100	140	—
Chlamydomonas	—	—	—	—	—	—	—	—	—	160
Closterium	1.001	700	450	350	375	840	750	1,600	540	320
Cosmarium	—	—	—	—	—	—	—	20	—	—
Scenedesmus	14,245	23,160	25,950	20,450	6,300	2,940	2,250	1,580	520	400
Schroedéria	—	100	—	—	—	40	—	20	—	—
Sphaerocystis	—	—	—	—	75	120	—	40	—	—
BACILLARIOPHYCEAE:										
Cyclotella	231	680	50	900	500	80	50	40	—	—
Cymbella	—	—	—	50	—	—	—	—	—	—
Gyrosigma	—	160	300	—	—	—	50	—	—	—
Navicula	539	—	50	100	25	20	50	40	20	60
Synedra	—	160	50	100	200	40	50	20	—	—
CHRYSOPHYCEAE:										
Mallomonas	—	—	—	—	—	—	50	—	20	—
EUGLENOPHYCEAE:										
Euglena	—	—	—	—	—	—	650	520	1,080	—
Phacus	—	—	—	350	—	—	50	—	—	—
Trachelomonas	—	1,160	250	100	75	40	150	20	120	100
MYXOPHYCEAE:										
Aphanizomenon	—	2,060	3,700	4,950	1,550	580	400	520	60	—
Coelosphaerium	—	—	—	—	—	—	—	—	60	—
Microcystis	—	—	—	—	—	—	—	60	—	—
Spirulina	—	—	—	100	—	—	50	—	20	20
TOTAL PHYTOPLANKTON:	16,016	28,180	30,800	27,450	9,700	4,740	4,600	4,580	2,580	1,060
TOTAL ZOOPLANKTON:	0	220	0	0	75	120	100	440	2,860	1,540

Table 2. Physical and chemical data recorded by Paul Trotta from September 17, 1953 through November 16, 1953

Factor	September 17	22	29	October 6	13	20	28	November 3	10	16
Water temperature (Degrees F.)	70	70	72	60	64	70	54	55	45	52
Light penetration (Inches)	14	14	11	9	12	14	9	11	16	14
pH	8.8	8.8	8.8	8.8	8.8	8.8	8.8	9.0	9.0	9.0

advanced. The difference between the maximum and minimum is 27° F.

B. Winter, 1955, Plankton

During the winter the plankton population was predominately zooplankton (Table 3). There was no steady trend in numbers, however, the minimum of 30 organisms per cc. was recorded on the 5th of Janurary and a significant increase in population occurred during the last two collections with a maximum of 775 organisms per cc. on the 1st of March. Protozoans and Rotifers made up the total zooplankton population counted with the Protozoans being most abundant.

The phytoplankton was particularly scarce during the winter collections. Only five species were recorded with Navicula occurring most frequently. Of the Myxophyceae, Oscillatoria was found on the 15th of February and the 1st of March. It had the largest population of any of the phytoplankton. According to Whipple (1933) the Myxophyceae usually seem to grow best in warm water especially during the summer. All other phytoplankton species appeared only once or twice during the collecting period. Phytoplankton was absent on the 25th of Janurary when the water was at the lowest temperature (36° F.) and again on the 22nd of February when the temperature was 42° F. The maximum phytoplankton and zooplankton populations occurred when the water temperature reached its maximum of 48° F. during the winter collecting period. Phytoplankton species were most numerous on the 1st of March when the temperature was 48° F.

Table 3. Plankton counts made by Charles Compton from January 5, 1955 through March 1, 1955. Given in numbers per cubic centimeter.

Algal classes and genera encountered	January 5	11	18	25	February 1	8	15	22	March 1
CHLOROPHYCEAE:									
Chlamydomonas	--	--	--	--	--	--	10	--	30
BACILLARIOPHYCEAE:									
Navicula	10	--	20	--	10	55	10	--	240
CHRYSOPHYCEAE:									
	--	--	--	--	--	--	--	--	--
EUGLENOPHYCEAE:									
Euglena	--	5	--	--	--	10	--	--	15
Trachelomonas	5	--	--	--	--	--	--	--	--
MYXOPHYCEAE:									
Oscillatoria	--	--	--	--	--	--	15	--	1,325
TOTAL PHYTOPLANKTON:	15	5	20	0	10	65	35	0	1,610
TOTAL ZOOPLANKTON:	30	35	205	105	135	510	60	705	775

Table 4. Physical and chemical data recorded by Charles Compton from January 5, 1955 through March 1, 1955.

Factor	January 5	11	18	25	February 1	8	15	22	March 1
Water temperature (Degrees F.)	43	38	37	36	38	39	38	42	48
Light penetration (Inches)	18	21	26	26	36	32	36	36	18
pH	7.0	7.4	7.5	7.6	7.6	7.6	7.6	7.6	7.7

CHEMICAL AND PHYSICAL DATA

The pH steadily rose from a neutral 7.0 to an alkaline 7.7 during the winter period (Table 4). Depth of penetration for light varied from 18 to 36 inches. Temperature fluctuated over a range of 12° from a maximum of 36° F. to 48° F.

DISCUSSION OF RESULTS

Algological literature has established the fact that temperate lakes usually have two periods during the year when the plankton population exceeds the population during any other period of the year. These abundant growth periods usually occur in the fall and again in the spring. In addition they have occasional large fluctuations in numbers due to "blooms" of certain species. Although it is thought that the population in the Campus Lake also follows this trend it should not be concluded that the population relationship will be exactly similar during every fall and winter period.

It becomes exceedingly difficult to attribute the qualitative or quantitative changes to any single chemical or physical factor. The fluctuation of the hydrogen-ion concentration over a range from pH 7 to 9 does not seem unusual since most ordinary lakes range from pH 6.5 to 8.5 (Welch 1935). Certain algae thrive better under alkaline conditions, while others appear to be adapted to acid conditions (McCombie 1952). A decrease in carbon dioxide will cause the pH value to become greater. The increased growth of phytoplankton could have caused the pH value to increase during both seasons, however, the increase is not great enough nor is the increase correlated well enough with the population to make it appear that pH was a controlling factor. Rawson (1939) states that the pH may be of less importance as a limiting factor for aquatic life than has been supposed.

Depth of light penetration is modified by the dissolved substances, suspended materials, concentration of organisms and the position of the sun (McCombie 1952). Too much light may be lethal to plants while insufficient quantities will definitely limit the photosynthetic rate (Damann 1943). Because of the higher absorption rate of suspended particles turbid water is usually warmer than clear water (Blum 1956). Just how variation in light affects the total plankton population is not known. It has been shown that variation in light penetration will affect specific organisms. Plankton growth may be controlled by other factors even when sufficient light is available, although insufficient light may not allow the organisms to reach their maximum numbers when other factors are at the optimum for their growth (McCombie 1952).

The relationship between water-temperature and the abundance of plankton is sometimes obscured by other factors, however, the relationship with this environmental factor is closer than with any other measured. As shown in figures 2 and 4 with few exceptions the phytoplankton population increased or decreased with the temperature. Phytoplankton population was greatest during both seasons when the temperature was at the maximum.

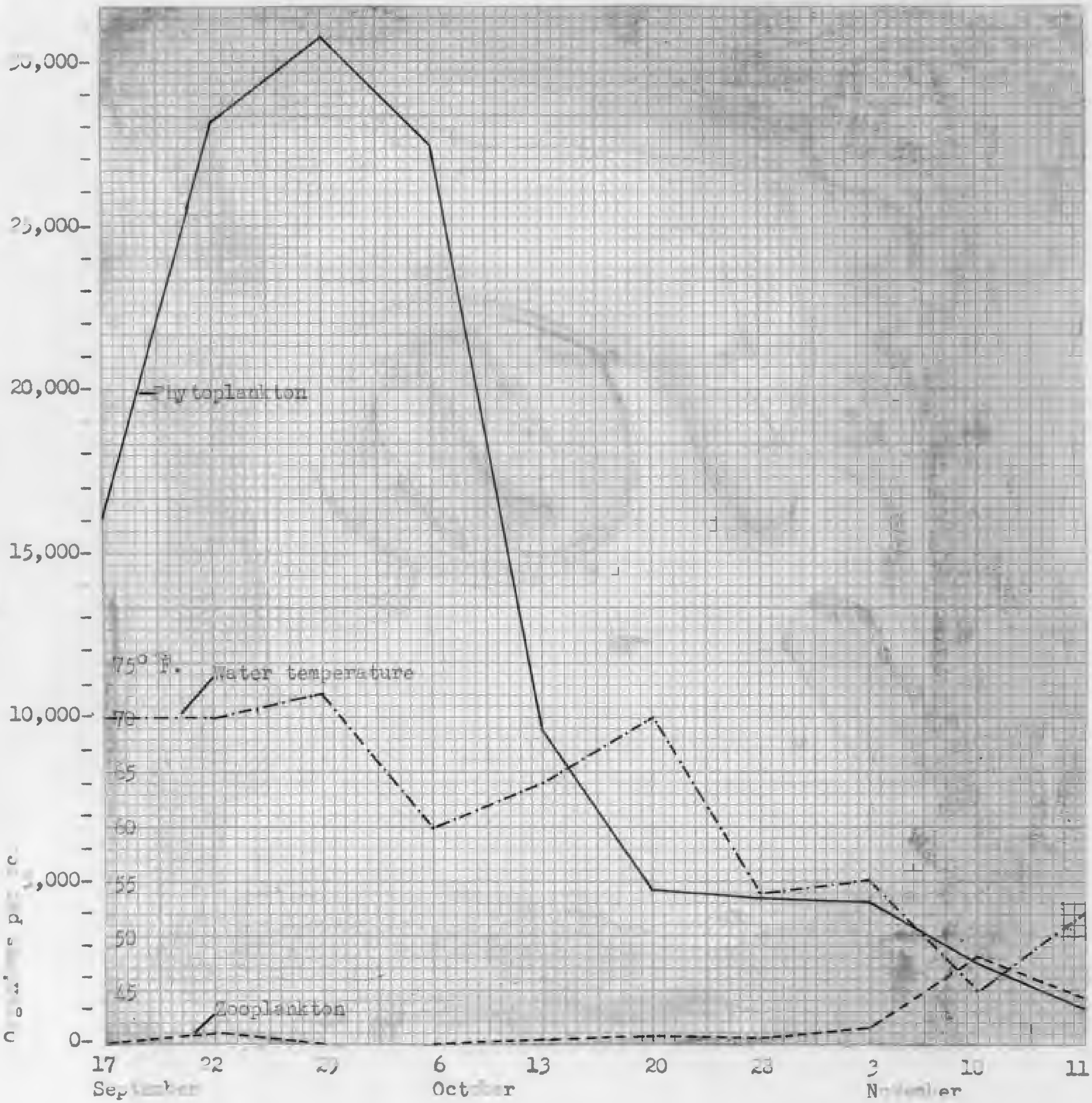

Fig. 2. Total number of phytoplankton and zooplankton organisms as compared to water temperature.

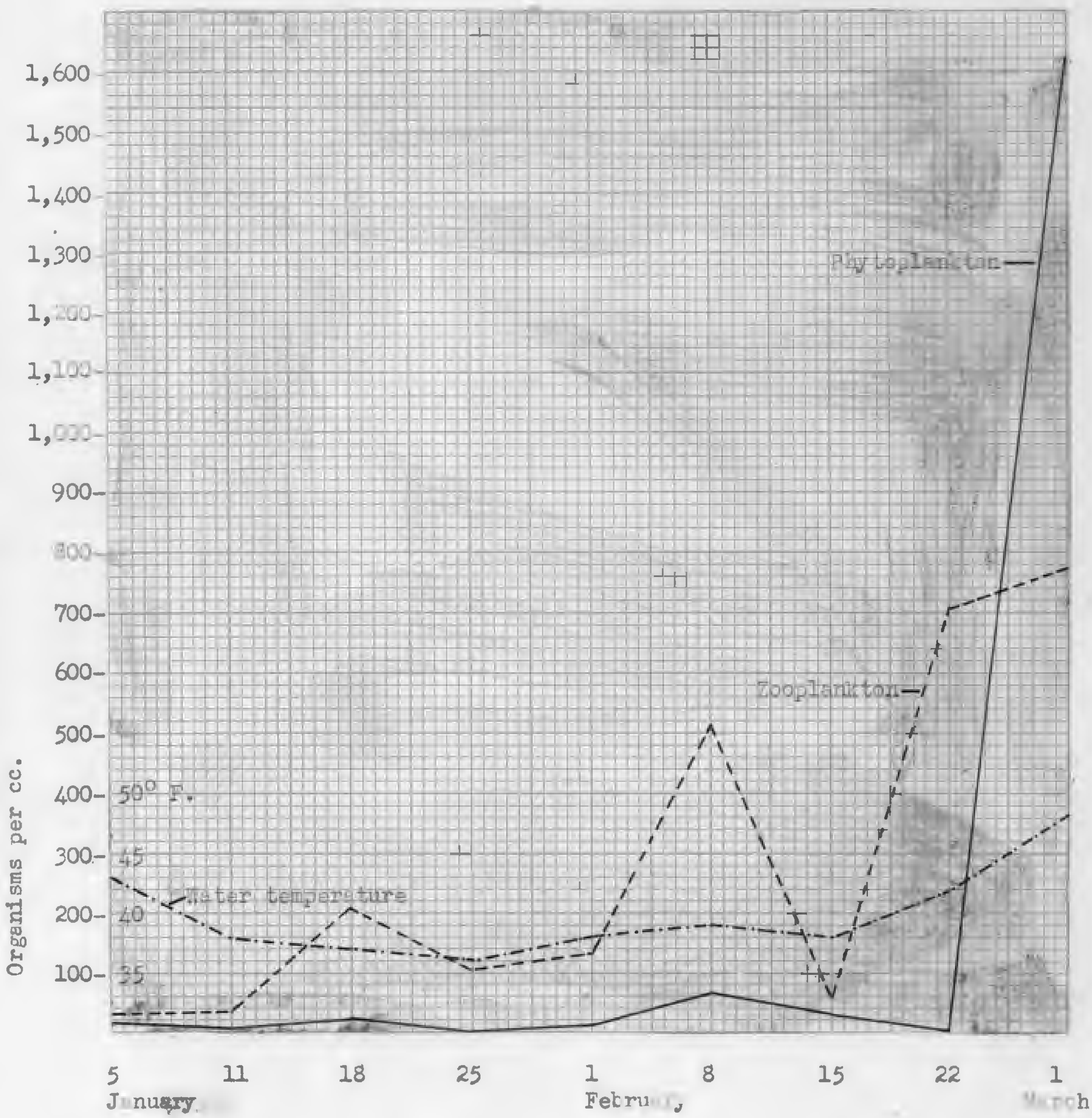

Fig. 3. Total number of phytoplankton and zooplankton organisms as compared to water temperature.

Also, populations were at a low when temperatures were at the minimum. In 1943 Damann concluded that water temperature was the most important single factor determining and controlling growth of plankton in Lake Michigan. That temperature may have a controlling influence on the metabolism of lake organisms is evidenced by the fact that subarctic and tropical lakes with essentially the same nutrient contents will be inhabited by cold or warm tolerant organisms (Ohle 1956). The graphs should not be interpreted to mean that all species of phytoplankton are affected in a similar manner. Whipple (1933) gives the following information regarding the groups of phytoplankton:

> Bacillariophyceae are thought to grow at lower temperatures than the Chlorophyceae especially during the spring and fall.
>
> Chlorophyceae populations most nearly parallels the curve of the water temperature.
>
> Myxophyceae have a growth pattern similar to the Chlorophyceae with the exception that maximum growth occurs a little later.

In this report it should be noted that the Bacillariophyceae were most numerous during the fall and in very small numbers during the winter. The Chlorophyceae followed closely the pattern as given by Whipple. The one major exception encountered in the growth of the Myxophyceae was its presence in the two counts during late February and early March. Why it appeared so early is not known, but it is believed that whether or not it would have developed into a "bloom" would depend upon the water temperature. Although temperature has a controlling effect upon plankton, fluctuations thought to be caused by temperature may at times be due to light fluctuations which sometimes accompany temperature changes (Prescott 1939).

Lapse of time between the occurrence of a physical or chemical condition and the resultant effect upon organisms makes the tying together of cause and effect difficult. During the fall more species were encountered in two collections than throughout the rest of the period. On the 28th of October and the 3rd of November thirteen species were present. Total population had been decreasing previously. The greater number of species may be attributed to the fact that warm water species were decreasing while the cooler water species were beginning to increase.

Seasonal variation of zooplankton population is not necessarily related to temperature. Tressler (1939) states that it is impossible to make general statements regarding the quality or quantity of zooplankton. The Protozoa, Rotifera and Crustacea populations are related to the species present, available food supply, hatching season and competition (Whipple 1933).

CONCLUSION

Even though the organisms in a lake are influenced by many factors and exist in an intimate relationship, temperature is probably the most important controlling factor. It has a direct effect upon the rate of metabolism thereby determining its distribution and rate of reproduction. Rather than a whole group responding similarly to the same temperature evidence indicates each species may be influenced in an individual way.

SUMMARY

Data from two quantitative collection periods has been examined and compared. The periods were not continuous chronologically. Hydrogen-ion concentration and population or light penetration and population showed no definite relationship. A significant paralleling of temperature and population curves was evident. It is believed that the optimum temperature for one species may be undesirable for another. The maximum phytoplankton population occurred on September 29, 1953 when the temperature was the highest and no organisms were counted on Janurary 25, 1955 when the temperature was at a minimum. Zooplankton populations are not necessarily controlled in the same way by the physical and chemical factors as are the phytoplankton populations.

We did not attempt to compile an exhaustive taxonomic list, but each tow net collection was carefully examined and a list of organisms was made as they were identified. Seventy-six kinds of organisms were identified of which 50 were phytoplankton and 26 zooplankton. A list of these organisms follows this summary.

PHYTOPLANKTON:

CHLOROPHYCEAE

Ankistrodesmus
Chlamydomonas globosa
Cladophora
Closterium acerosum
Coelastrum microporum
Cosmarium
Docidium
*Franceia droescheri
*Lagerheima longiseta
Mougeotia
Oedogonium
Pediastrum duplexPleurotaenium
Schroderia setigra
Scenedesmus bijuga
Sphaerocystis schroeteri
Spirogyra sp.
**Tetraedon constrictum

BACILLARIOPHYCEAE

Achnanthes
Cyclotella
Cymbella
Diatoma anceps
Fragilaria virescens
Gomphonema
Gyrosigma
Navicula
Nitzschia sigmoidea
Pinnularia
Surirella
Synedra

EUGLENOPHYCEAE

Euglena acus
Euglena oxyuris
Lepocinclis
Phacus longicauda
Trachelomonas urceolata
Trachelomonas hispida

* New records for the genera in Illinois.
Collected by Anita Hopkins Brown, March 28, 1955.

** New record for the species in Illinois.
Collected by Paul Trotta on October 13, 1953.

MYXOPHYCEAE

Amphitrix janthina
Anabaena
Aphanizomenon flosaguae
Coelosphaerium
Gloeocapsa
Microcystis aeruginosa
Merismopedia convulata
Nostoc
Oscillatoria
Spirulina nordstedtii

CHRYSOPHYCEAE

Dinobryon sociale
Mallomonas

DINOPHYCEAE

Ceratium hirundinella

SCHIZOMYCETES

Beggiatoa

ZOOPLANKTON:

PROTOZOA

Amphimonas globosa
Chilomonas
Codonella cratera
Difflugia urceolata
Dileptus
Epistylis
Monas
Nassula
Opistonecta henneguyi
Rhodomonas
Stentor igneus
Scyphidia
Vorticella

ROTIFERA

Anuraea
Asplancha
Brachionus
Conochilus
Philodina
Polyarthra
Pterodina
Rotaria neptunis
Synchaeta
Triarthra

CRUSTACEA

Bosmina
Cyclops
Daphnia

LITERATURE CITED

1. Blum, J. L. 1956. The Ecology of River Algae. The Botanical Review Vol. XXII (5).

2. Britton, M. E. 1944. A Catalog of Illinois Algae. Northwestern Univ. Study. Evanston, Illinois.

3. Coleman, C. H. 1950. Fifty Years of Public Service. Eastern Illinois State College Bulletin, No. 189.

4. Damann, K. E. 1943. An Analysis of Plankton Yields of Lake Michigan. Summaries of Doctoral Dissertations, No. 11. Northwestern Univ., Chicago.

5. Damann, K. E. 1950. A Simplified Plankton Counting Method. Ill. Acad. of Science. 43: 53-60

6. McCombie, A. M. 1953. Factors Influencing the Growth of Phytoplankton. Journal Fish. Res. Bd. Can., 10(5).

7. Ohle, W. 1956. Bioactivity, Production and Energy Utilization of Lakes. Limnology and Oceanography. 1 (2).

8. Prescott, G. W. 1939. Some Relationships of Phytoplankton to Limnology and Aquatic Biology. The Science Press Print. Co., Lancaster, Penna. Pub. of A. A. A. S. No. 10.

9. Rawson, D. S. 1939. Some Physical and Chemical Factors in the Metabolism of Lakes. The Science Press Print. Co., Lancaster, Penna. Pub. of A. A. A. S. No. 10.

10. Tiffany, L. H. and Britton, M. E. 1951. The Algae of Illinois. Univ. of Chicago Press.

11. Tressler, W. L. 1939. The Zooplankton in Relation to the Metabolism of Lakes. The Science Press Print. Co., Lancaster, Penna. Pub. of A. A. A. S. No. 10.

12. Welch, P. S. 1935. Limnology. McGraw-Hill Book Co. Inc., N. Y. and London, 1st Ed. 2nd Imp.

13. Whipple, G. C. 1933. The Microscopy of Drinking Water. John Wiley & Sons, Inc., N. Y. 4th Ed. revised by G. M. Farr and M. C. Whipple.