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Charleen Coffing
Butler University

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During the years of the journal's publication, the Butler University Botany Department had an active program of research and student training. 201 bachelor's degrees and 75 master's degrees in Botany were conferred during this period. Thirty-five of these graduates went on to earn doctorates at other institutions.

The Botany Department attracted many notable faculty members and students. Distinguished faculty, in addition to Cain and Friesner , included John E. Potzger, a forest ecologist and palynologist, Willard Nelson Clute, co-founder of the American Fern Society, Marion T. Hall, former director of the Morton Arboretum, C. Mervin Palmer, Rex Webster, and John Pelton. Some of the former undergraduate and master's students who made active contributions to the fields of botany and ecology include Dwight. W. Billings, Fay Kenoyer Daily, William A. Daily, Rexford Daudenmire, Francis Hueber, Frank McCormick, Scott McCoy, Robert Petty, Potzger, Helene Starcs, and Theodore Sperry. Cain, Daubenmire, Potzger, and Billings served as Presidents of the Ecological Society of America.

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A QUANTITATIVE STUDY OF THE PHYTOPLANKTON OF THE WHITE RIVER CANAL, INDIANAPOLIS, INDIANA[1]

By CHARLENE COFFING

Numerous quantitative investigations of lake and river plankton are recorded for this country, but there seems to have been little work done on quantitative studies of canal phytoplankton. The present quantitative investigation of one year on the phytoplankton of the White river canal in Indianapolis, Indiana, follows a previous year of study of the taxonomy and periodicity of the plankton flora of that canal (3). There are apparently no published records of quantitative studies of plankton made in the vicinity of Indianapolis.

REVIEW OF LITERATURE

In 1913, Allen (1) reported results of a quantitative study of the plankton of the San Joaquin river and its tributaries in and near Stockton, California. One of the tributaries investigated was Smith canal, located about 400 yards from the San Joaquin river. Smith canal was a straight channel about 60 feet wide and two miles long, with a minimum depth of one meter. This work constitutes the only reference to quantitative studies of canal plankton that the writer has found in American literature. Allen's investigations show that the phytoplankton of the canal was dominated by diatoms. He concluded that temperature is the principal factor determining plankton periodicity. Similar conclusions have been reached by other workers in regard to river and lake plankton.

The metbods of making quantitative studies of canal plankton are very similar to the technique used in the investigation of river and lake plankton.

One of the outstanding studies of river plankton was made by Kofoid (10) in a quantitative investigation of the plankton of the Illinois river. He concluded that tbe plankton of the river channel was subject to great seasonal and annual variations, minimum occurring during January and February, and maximum occurring during April and June. The average montbly production declined gradually during the remainder of the year

[1]This paper is a portion of a thesis in partial fulfillment of the requirements for the degree of Master of Arts in Butler University.

to the winter minimum in January and February. He found that the diatoms were more abundant than any other synthetic group of plankton organisms and exceeded the Chlorophyceæ seven to one.

In the Illinois river only two main types or species groups of plankton were found, the summer and the winter types. The vernal and autumnal species were only transitions between summer and winter when organisms from both were present. The winter plankton of the river was composed of a small number of species peculiar to that season, and several perennial forms, while the summer plankton consisted of a large nnmber of summer organisms with the perennial types.

Allen's (1) analysis of the plankton of the Smith canal confirmed, in part, some of the conclusions obtained by Kofoid for the Illinois river plankton. As in Kofoid's investigation, the phytoplankton was dominated by diatoms, while the Chlorophyceæ were frequent but not abundant. Some of Allen's conclusions are as follows: temperature, within certain limits, determines the seasonal distribution of plankton; water currents above a very moderate rate of flow are inimical to the development of plankton; collections taken at intervals of one week or more do not give sufficient data for accurate detérmination of plankton distribution through the year, but daily collections would probably do so.

In an ecological study of the Hocking river in Ohio, Roach (18) found that phytoplankton varied in abundance in direct ratio with the temperature. Diatoms were the dominant plankton flora, with the Chlorophyceæ second in abundance. Eddy (5), in an ecological study of fresh-water plankton communities, including some rivers, lakes and ponds in Illinois, found that the abundance of fresh-water plankton at different seasons in the same body of water varies directly with the temperature. Kraatz (12), in a quantitative net-plankton survey of East and West reservoirs, near Akron, Ohio, found that diatoms reach a distinct spring maximum in May. The autumn maximum, beginning in late summer, was not nearly so great as the spring maximum. In a limnological study of Lake Erie, Gottschall and Jennings (6) found diatoms to be the most abundant group of planktonts, this group exhibiting the characteristic spring and fall peaks of abundance.

An indication of the difference in periodicity between the plankton of rivers and lakes is seen when Kofoid's results on the Illinois river are compared with the Wests' work on some British lakes. The Wests (20) found that the greatest amount of phytoplankton, both quantitatively and qualitatively, occurred in late summer and autumn, during the autumnal decline in temperature. They are convinced that the most important factor in both the quantitative and qualitative distribution of plankton is the amount of dissolved salts present in the water.

The predominant assumption in literature is that periodic changes in the plankton content of a body of water are due chiefly to temperature variations. It has been assumed that diatoms require lower temperatures for development, since they are usually most abundant during the cooler seasons. Pearsall (14) asserted that it is improbable that temperature alone is of any great importance in determining the periodicity of diatoms. He concluded that the real underlying causes are factors which normally operate during cold weather, namely, the fact that nitrates are washed from the soil most rapidly in cooler seasons when rainfall is in excess of evaporation, the fact that heavy rainfall causes a washing of dissolved silica from the soil, and the fact that rainfall increases the oxygen content of the water.

In a later study, Pearsall (16) emphasized the importance of dissolved substances in the water as a determining factor in the abundance and seasonal distribution of plankton. Diatoms occur in winter and spring when the waters are richest in nitrates, phosphates and silica, while the green algæ occur in summer when nitrates and phosphates are low.

Whipple (21) emphasized the importance of the vertical circulation which occurs in a body of water in spring and autumn. This phenomenon brings to the surface any accumulation of organic matter, which is then oxidized. Some of the products of oxidation are favorable to the growth of diatoms. During the period of vertical circulation, the diatoms, or their spores, which have been lying dormant at the bottom, are carried to the surface by the vertical currents. The extent of the development of diatoms depends upon the amount of food material present and the temperature of the water. The periods of minimum development are during periods of stagnation.

FEATURES OF THE WHITE RIVER CANAL

Canals have certain features which distinguish them from rivers, namely a relatively slower rate of flow, a more uniform depth and a lower amount of aeration or oxidation. A possible difference in temperature may exist, due to the fact that the slower the rate of movement of water, the more likely it is to be affected by the temperature of the air.

White river is the source of the water of the White river canal. The headwaters of White river and its tributaries rise in glacial drift which is high in lime and magnesia. About 40 per cent of the rainfall seeps through several feet of glacial drift. The ground water leaches out the lime and magnesia, making the water high in temporary and permanent hardness. About 25,000,000 gallons per day of ground water flow into White river in the 60 miles or more of its length above Indianapolis (7).

The canal is about 8.8 miles long, averaging 60 feet wide and 6 feet deep. Its rate of flow is rather slow, and is controlled by headgates in sluiceways at Broad Ripple (8). It is characterized by having water of rather low turbidity, a lack of benthon and marginal vegetation, and the presence of fish and mussels. It passes through the outskirts of the city and is relatively unpolluted.

PURPOSE OF THE INVESTIGATION

A qualitative study of the phytoplankton of the White river canal made by the writer in 1933-34 (3) was introductory to the present quantitative investigation made in 1934-35. The present investigation was undertaken for the primary purpose of securing more definite information regarding the plankton flora of the canal as expressed in number of organisms per cubic centimeter, and of classifying the different genera into ecological groups according to their seasonal distribution and time of maximum. As a secondary purpose, an attempt was made to determine the correlation between temperature of water and the abundance and occurrence of the classes of phytoplankton and of the total phytoplankton.

LIMITATIONS OF THE INVESTIGATION

This survey includes only the phytoplankton, no attempt being made to include the unpigmented planktonts. The organisms were listed by genus only, since the species of many small forms could not be determined by using only a 16 mm. objective. Because of the low magnification used, a number of forms could not be identified even to genus, and consequently had to be listed as unknown.

Results are given in terms of number of organisms per cubic centimeter of canal water. In this investigation the term "number of organisms" refers to the number of cells when dealing with isolated unicells, and to the colony or filament when counting colonial and filamentous forms. Genera such as Pediastrum and Tribonema, regardless of the number of cells each possessed, were always counted as a unit. The methods of "standard units" in which the size of organisms is determined, and of "cubic standard units" in which the cubic centimeters of plankton per cubic meter of water is expressed (Whipple, 21) were not used. No attempt was made to determine the weight of plankton or of organic matter of the plankton (Birge and Juday, 2). In connection with this investigation, several major environmental factors were not studied, temperature of water being the only agent with sufficiently accurate data for presentation. Further limitations of this study include the time limit, the investigation being carried on over a period of only fifty weeks; the fact that samples were collected only once a week; the fact that samples were collected at only one depth; and the fact that sampling was done at only one location.

METHODS AND APPARATUS

Collection

The procedure followed in the investigation consisted in, (1) collection of samples; (2) concentration by filtration and preservation of the residuum; (3) the examination of the concentrate and the enumeration of the phytoplankton; (4) the calculation of the number of organisms per cubic centimeter.

A collection was made every Monday during the middle of the day from June 4, 1934, to May 13, 1935, covering a period of fifty weeks. Samples were obtained from near the canal bridge on the Butler University campus. This sampling point is 2.6 miles from the place where the canal begins. The sampling apparatus consisted of two one-half gallon Mason fruit jars equipped with a rope. Collections were made in the center of the canal at a depth not exceeding six inches below the surface of the water, the jars being lowered by a rope from the edge of the bridge. A sufficient amount of water was secured to concentrate duplicate samples of 1000 cc. A thermometer was placed in one of the jars as soon as the water was drawn, and the temperature in degrees Centigrade was read through the jar. The sample was taken immediately to the laboratory and concentrated. The method of concentration used was the Sedgwick-Rafter method in which a measured quantity of the sample is filtered through sand.

Examination and Enumeration

The equipment used in the microscopic examination of the concentrated samples of plankton consisted of a compound binocular microscope equipped with a mechanical stage and 20X oculars, a Whipple ocular micrometer and a Sedgwick-Rafter counting cell. It was almost impossible to recognize with certainty many of the genera when the microscope was calibrated in the usual manner so that the area on the stage covered by the Whipple ocular micrometer was one square millimeter. Consequently, a calibration was worked out whereby a portion of the micrometer would cover an area on the stage exactly .25 square millimeter. Since the counting cell was one millimeter deep, the volume within the outlines of the 49 squares was .25 cubic millimeter.

In the enumeration of the number and variety of organisms present, four fields in each of the duplicate samples were counted, making eight counts for each week's collection. Since the volume per field was .25 cubic millimeter, one cubic millimeter per sample or two cubic millimeters per weekly collection were examined. In the enumeration, cells of organisms touching the upper and left-hand boundaries of the field were not counted, while cells touching or overlying the lower and right-hand limits of the field were counted, as is recommended for blood corpuscle work (Kilduffe, 9). From the counts obtained, the number of organisms per cubic centimeter of canal water was calculated.

The writer realizes that the method of counting only eight fields of .25 cubic millimeter each per collection does not give such representative results as would the customary method in which 10-20 fields of one cubic millimeter each are counted, yet the writer felt justified in using a method whereby greater magnification could be obtained so that recognition of genera would be easier and more accurate.

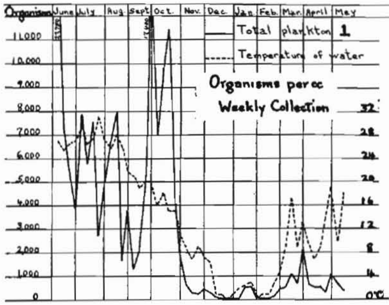
RESULTS

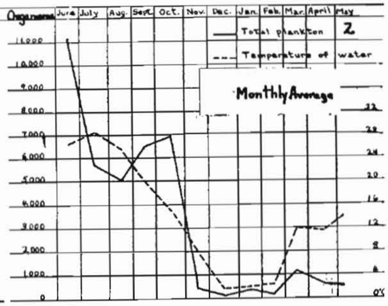
In the 50 collections taken from the White river canal, 39 genera of algæ, representing 7 classes, were recorded. The classes recorded individually were the Myxophyceæ, Chlorophyceæ and Bacillarieæ, since they are usually the classes of algæ found most abundantly. The other four classes were the Chrysophyceæ, Desmidiaceæ, Euglenophyceæ and Heterokontæ. There were some members of the Bacillarieæ and Chlorophyceæ which could not be identified to genus and were listed as "unknown" under their respective groups. In addition, there were a few other algæ whose identity could not be determined and which were placed in the Miscellaneous Group as "unknown." The genera identified are given in an ecological classification following these results.

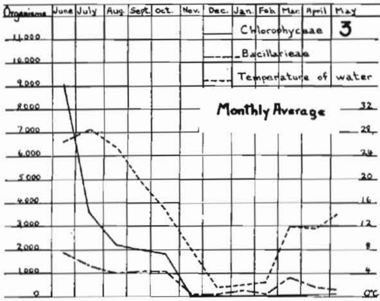
The average number of organisms per cc. per week was 3,338, with a range from a maximum of 27,750 per week on June 4, 1934, to a minimum of 45 per week on February 4, 1935. The average number of genera of algæ per week was eight, with a range from 18 on June 4, 1934, to two on December 31, 1934, January 28, and February 11, 1935.

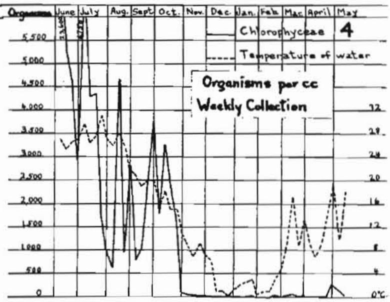
The total amount of plankton occurring in the weekly collections from June 4, 1934, to May 13, 1935, showed definite seasonal variations and also conspicuous weekly variations, especially from June to October. Two periods of maximum occurrence were evident, the higher peak occurring on June 4 and the lower peak on September 24. When considering the monthly averages, June and October were the months of greatest amplitude (Figure 2). The maximum in June was due to an abundance of Chlorophyceæ (Figure 4) and diatoms (Figure 3), but the October maximum was due mainly to the appearance of Tribonema in large numbers. In October the Chlorophyceæ were declining (Figure 4) and diatoms showed only a slight increase (Figure 3). Both maxima showed no definite correlation with temperature. In June, the average temperature was lower than in July (Figure 2), yet the plankton was much more abundant in June, especially during the first part of the month, than in July. In October, the peak in total plankton was preceded and accompanied by a fairly rapid and steady decline in temperature. Except for these two maxima of plankton, the plankton production and temperature were, in general, fairly well correlated (Figure 2). The best correlation came between November and April, when temperature seemed to be the controlliug factor, but from June to October, 1934, and beginning in May, 1935, there were apparently other undetermined factors which played a part in influencing plankton production.

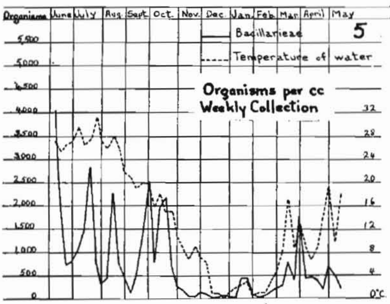
Only the Chlorophyceæ and Bacillarieæ were considered in detail as to time of occurrence and relative abundance, since they comprise most of the plankton of the canal. The very prominent weekly fluctuations in amounts of Chlorophyceæ during summer and early autumn are shown in Figure 4. Those of the Bacillarieæ during summer, early autumn and spring are shown in Figure 5. The results of Kofoid (11), West (20) and Whipple (21) show maxima varying from spring to autumn.

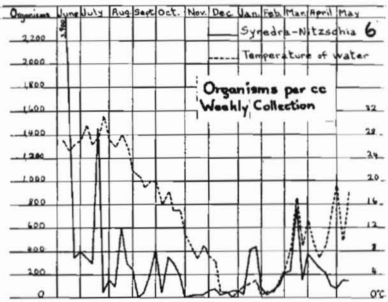

Total plankton 1
Temperature of water
Organisms per cc
Weekly Collection

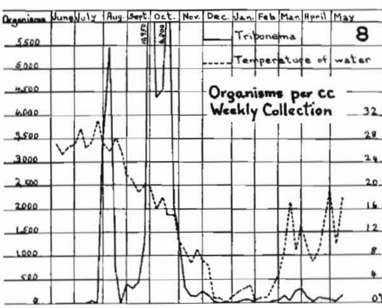

Total plankton 2
Temperature of water
Monthly Average

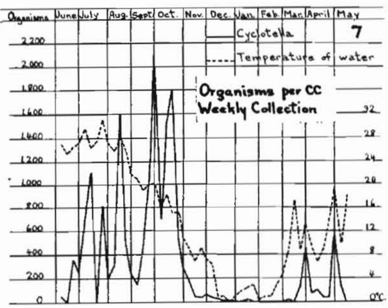

Chlorophyceae 3
Bacillarieae
Temperature of water
Monthly Average


Chlorophyceae 4
Temperature of water
Organisms per cc
Weekly Collection


Bacillarieae 5
Temperature of water
Organisms per cc
Weekly Collection


Synedra-Nitzschia 6
Temperature of water
Organisms per cc
Weekly Collection


Tribonema 8
Temperature of water
Organisms per cc
Weekly Collection


Cyclotella 7
Temperature of water
Organisms per cc
Weekly Collection

In general, the curve for Chlorophyceæ parallels the temperature curve (Figure 3).

Scenedesmus was the most conspicuous genus of the Chlorophyceæ. At times during the early summer months it comprised from one-third to one-fourth the total phytoplankton, and outnumbered the other members of the class several times. Kofoid (11) likewise found that Scenedesmus was the leading green alga numerically.

Diatom frequency is shown in Figure 3. It will be noted that the curve is highest in June and lowest from November to February, with a spring maximum in March. In general, the diatom curve paralleled the temperature curve, which is contrary to the results of other workers (Whipple, pp. 228, 232). In previous work, the writer (3) found a diatom maximum in May, with a fairly uniform and abundant distribution through the rest of the year. Two of the most important genera were Synedra and Nitzschia. Whipple lists Synedra as a truly planktic genus which exhibits spring and autumn maxima. In this investigation, Synedra-Nitzschia were most abundant in the first collection on June 4, 1934, and reached another peak in July. In general, they were most abundant in the summer, declining to a winter minimum in November and December, exhibiting a rather feeble increase in January and an early spring maximum in March, after which they declined (Figure 6). Just how much of the deviation of this curve from the usual spring and fall maxima of Synedra alone was due to the presence of Nitzschia could not be determined.

Another genus probably as abundant as Synedra-Nitzschia was Cyclotella, which was very abundant during the summer months, but increased to a definite autumn maximum in October. It practically disappeared during the winter, but reached a spring maximum of less amplitude in March and April (Figure 7). The curve for Cyclotella is only partially in agreement with Whipple's statement that it is one of the truly planktic diatoms exhibiting spring and fall maxima, for although there is a definite increase in the spring, it is much more abundant during the summer months than in the spring.

A striking ratio between the Chlorophyceæ and Bacillarieæ of the canal was discovered. The total Chlorophyceæ for the year outnumbered the diatoms 2.5 to 1. In direct contrast are Kofoid's results (11), in which the green algæ were outnumbered 6 to 1 by diatoms. Even greater difference was reported by Allen (1): the Chlorophyceæ being outnumbered by the diatoms 14 to 1. In Lake Erie and Presque Isle bay (6), diatoms were also the most abundant group. A few possible explanations for these striking divergences are given. (1) Green phytoplankton (Chlorophyceæ) are more abundant at a higher level than are diatoms (19). Since the samples from the canal were taken within six inches of the surface, they would contain larger quantities of Chlorophyceæ in proportion to the amount of diatoms than the results of workers who have sampled at greater depths show. (2) Welch (19) refers to the work of Cilleuis (1928), in which the plankton of rivers and large streams possessing slow currents is characterized, in part, by having a lower diatom content than the plankton of rivers with a rapid current. The canal has a fairly slow current and therefore would tend to have fewer diatoms in proportion to the number of Chlorophyceæ. (3) Streams with high turbidity, which indicates the presence of silt with silicon, have more diatoms than a less turbid body of water (15, 19). Since the water of the canal exhibits relatively low turbidity, it would tend to have fewer diatoms than a more turbid stream. (4) According to Whipple (21), filtration through sand will retain the nannoplankton better than straining through bolting cloth. In case the smaller plankton were composed of more green algæ than diatoms, the use of sand would obviously increase the amount of Chlorophyceæ.

Myxophyceæ were found in only two samples, June 25, 1934, and January 21, 1935. In studies of lake plankton, the Wests (20), Whipple (21) and Gottschall and Jennings (6) reported maxima of blue-green algæ in autumn, usually after a period of hot weather. Kraatz (12), however, found a maximum in June, soon after the beginning of hot weather. In 1933, the writer (3) found that the blue-greens appeared the last of June, were fairly abundant during August and the first part of September, and disappeared by October. The maximum did not show the relation to temperature that the above workers reported. It is possible that temperature of water is a minor factor influencing the occurrence and abundance of the Myxophyceæ. A factor which some workers emphasize is the amount of organic matter in the water. The Wests (20) reported the blue-greens to be largely absent from lakes with very pure water, while White (22) stated that their abundance was probably dependent upon the amount of nitrogenous matter in the water. If the amount of organic matter in the water is the more important factor, the fact that the writer found so few blue-greens indicates that the canal is relatively free from organic matter, or that the slow current of the canal allows much of the organic matter to sink to the bottom.

Tribonema was found in 41 of the 50 collections, at times in large numbers. Two periods of maximum occurrence were evident. The first peak occurred on July 30 and August 6 (Figure 8). The filaments ranged from fragments of two or three cells to many cells. The number declined to a low level until September 24, when the maximum for the year of almost 11,000 filaments and fragments of filaments per cc. were recorded. The number remained fairly high during October and decreased to a low level during the winter and spring.

From the observations made by the writer and by other workers, Tribonema seems to be primarily an autumn form. White (22) found Tribonema to be the dominant alga in November and December, while Delf (4) reported a definite maximum in February and March, with a lesser maximum in October and November. The writer in 1933 found Tribonema most abundant from August 21 to September 25, with the temperature of the water ranging from 21.5° to 24.5° C. In the present study, Tribonema appeared in greatest numbers when the temperature ranged from 15° to 22° C.

ECOLOGICAL CLASSIFICATION

In making an ecological classification of each genus found in the canal during the two-year investigation, two factors were considered: the distribution of the organism through the year, and the numerical variation of the organisms during the portion of the year that it occurred, with special emphasis on the time of greatest amplitude. The classification of most of the genera was based upon results obtained during 1933-35 and upon data secured from an unpublished study of the plankton of White river in and near Indianapolis from August, 1930, to September, 1931 (13).

The 70 genera found during 1933-35 were grouped into four ecological classes with fairly definite periods of occurrence and times of maximum. A fifth group was made, consisting of forms which were quite variable in time of occurrence and time of maximum in the studies made, and of forms which appeared rarely. Some of the genera were not found in the collections of both years, and some were not reported in the year's investigation of White river plankton (13). Consequently the classification of some of the genera was based on only one year's observation. Such genera were listed as probably belonging in the various groups in which they were placed. The five ecological groups and the genera comprising them are given below:

Group I. June-October group, with maximum in June or July:

Actinastrum	Kirchneriella
Ankistrodesmus	Lagerheimia
Cœlastrum	Micractinium
Crucigenia	Pediastrum
Dictyosphærium	Trachelomonas
Golenkinia	Treubaria

Additional genera probably belonging in this group are:

Eunotia	Schroederia
Hemidinium	Staurastrum
Phacotus	Westella

Closterium, Lepocinclis and Phacus have been placed in Group V, although their distribution approximates that of Group I.

Group II. July-November to all-seasons (continuous) group, with maximum June-October:

Cyclotella	Synedra-Nitzschia
Scenedesmus	Tribonema

Group III. October-May group, with maximum in March or April:

Diatoma	Navicula
Gomphonema	

Group IV. March-May group, with maximum in March or April:

Asterionella	Cymbella
Cymatopleura	Gyrosigma

An additional genus probably belonging in this group is:

Meridion

Group V. Variable in time of occurrence and time of maximum. Includes rare forms. Abbreviation following each genus indicates month of maximum occurrence:

Closterium, July, Aug.	Oscillatoria, Aug.
Dinobryon, Aug.	Pandorina, Sept.
Euglena, March, July	Phacus, July, Aug.
Lepocinclis, July	Selenastrum, July
Lyngbya, Aug.	Stauroneis, April
Oocystis, Aug.	Tetrastrum, Aug., Sept.

Additional genera probably belonging to this group are:

Achnanthes, Dec.	Ceratium, Aug.
Anabæna, Aug.	Chlamydomonas, July, Oct.
Botrydiopsis, Feb.	Chlorella, Aug., Sept.
Carteria, July, Aug.	Chroococcus, Sept.
Cladophora, Feb.	Hantzschia, May, June, Nov.
Cœlosphærium, Oct.	Melosira
Cosmarium, July	Nephrocytium, Sept.
Cryptomonas, Oct.	Œdogonium, May
Elaktothrix, July	Ophiocytium, Sept.
Eudorina, Aug., Sept.	Pinnularia, March
Fragilaria, March	Quadrigula, Sept.
Frustulia, April	Sphærocustis, May
Glœocystis, Aug.	Surirella, Jan., Feb.
Gonium, Sept.	Tetradesmus, Oct.

It seems that the classification of *Cymatopleura solea* into Group IV should be somewhat tentative. Although it may appear to be primarily a spring form as found by Allen (1) at Station II, and by the writer, yet Kofoid's results on the Illinois river and Allen's results on Stations I and III, indicate that it might be considered as a variable form and hence placed in Group V.

The results of Kofoid, Whipple and Palmer differ considerably concerning the occurrence of Diatoma. The writer's results are more similar to Whipple's than to Kofoid's and Palmer's. Since the appearance of Diatoma was very similar during the two years' study, the writer felt justified in placing it in Group III.

The seasonal distribution of Actinastrum in the Illinois river (11) and in the San Joaquin river (1) indicates that the genus unquestionably belongs in Group I, but when the time of maximum occurrence is considered, the writer's classification does not apply to the Actinastrum of other localities. Difference in temperature in different localities during the same month may cause the variation in time of maximum, for the writer found the optimum temperature for Actinastrum to be practically the same as Kofoid (11) reported. Another reason for the variation may lie in the difference in species. Allen and Kofoid reported *A. hantzschii*, while the species in the canal was *A. gracillimum*.

Cœlastrum, another member of Group I, showed a much earlier maximum in the canal than it did in the Illinois river and San Joaquin river, although the period over which it was present is much the same. Again, difference in temperature in different regions during the same month may account for the difference in time of maximum occurrence. In agreement with Kofoid (11), its maximum development was during the period of highest temperature.

The information secured on Pediastrum indicates that its classification into Group I would not hold true in other localities. However, the similarity in seasonal distribution of the organism during 1930-31 (13) and 1933-35, places it in Group I in this region. Kofoid (11) found Pediastrum every month, and the optimum temperature was 15°-20° C., while in the canal it occurred less than half the year and seemed to prefer temperatures of 20°-26° C.

The seasonal distribution of Scenedesmus in the canal coincides fairly well with information secured by other workers, and consequently it was placed in Group II. Although it was a perennial planktont, it was predominant only during the warmer part of the year, at temperatures ranging from 15°-30° C.

Euglena is an exception in Group V in being rather common. However, its range and time of maximum were so different during the two years that it could not be placed in any of the other groups. In 1933 it was present and fairly abundant from July to the latter part of September, but in 1934-35 it appeared only four times during the summer and eight times during early spring. Whipple (21) reported Euglena to be most abundant from June to September. Palmer (13), in samples taken from White river below a sewage disposal plant, found Euglena more or less abundant throughout the year. White (22) emphasized the presence of nitrates as a factor influencing the abundance of Euglena. A similar view was stated by Purdy (17), who named Euglena and its relatives as positive indicators of contamination. From results obtained on Euglena in the investigation of the plankton of the canal, the writer cannot list temperature of water as a determining factor.

SUMMARY

1. A quantative study of the phytoplankton of the White river canal from June 4, 1934, to May 13, 1935, was made by filtering weekly samples through sand and observing measured units of the concentrate at a magnification of 200.

2. The study revealed a marked periodicity of the total plankton and of the classes and genera of algæ.

3. The total plankton showed considerable weekly variation, but when seasonal distribution is considered, it exhibited a summer and early autumn maximum which extended from June through October, and a winter minimum which lasted from November through February. During the winter minimum the plankton curve was uniformly low, but the maximum showed two peaks of abundance, the larger occurring in June and the smaller in October. The October peak was caused by a sudden and large increase in the amount of Tribonema. The total plankton showed a small increase in March, due mostly to diatoms, however.

4. The maximum average monthly production of total plankton, Chlorophyceæ and Bacillarieæ occurred in June.

5. The Chlorophyceæ showed considerable weekly fluctuation. When monthly averages were considered, the green algæ were abundant from June through October and dropped suddenly in November to a winter minimum which lasted until May.

6. The green algæ followed the temperature curve fairly closely except during March, April and May, when they failed to increase with the temperature.

7. Of the Chlorophyceæ, Scenedesmus was by far the most abundant, at times during early summer comprising from one-third to one-fourth the total phytoplankton.

8. The Bacillarieæ showed a summer and early autumn maximum, a winter minimum, and an increase in March when the temperature increased.

9. The diatom curve fluctuated more from week to week than the Chlorophyceæ curve, but the diatoms showed almost as close correlation to the temperature curve as did the green algæ.

10. Of the Bacillarieæ, Synedra-Nitzschia was conspicuously abundant during early summer, and less abundant in early spring, while Cyclotella was dominant in late summer and early autumn.

11. The Chlorophyceæ were the dominant class of algæ in the canal, outnumbering the diatoms 2.5 to 1.

12. The Myxophyceæ of the canal were almost entirely absent, occurring in only two of the 50 collections.

13. Tribonema, although present and at times abundant during late summer, reached a maximum in October during the autumnal decline in temperature. It exhibited tolerance of low temperatures, being present, although in small numbers, during most of the winter.

14. In general, temperature seemed to be a primary factor influencing

plankton production. At times, however, there were apparently other undetermined factors which played an important part in phytoplankton periodicity.

15. From records of three years, the algæ of the canal were placed in five ecological groups, which are as follows:

Group I. June-October group, with maximum in June or July.

Group II. June-November to all-seasons (continuous) group, with maximum June-October.

Group III. October-May group, with maximum in March or April.

Group IV. March-May group, with maximum in March or April.

Group V. Variable in time of occurrence and time of maximum. Includes rare forms.

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