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APPROVED BY

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CHAPTER I

INTRODUCTION

Early investigations of fresh-water plankton populations in this country centered around the Great Lakes and numerous smaller lakes in the glaciated regions. Studies were usually limited primarily to the warmer months of the year. In the last two decades, interest in such work has extended to the semi-arid southwestern United States. Since water is a limiting factor for agriculture, industry, and urban expansion in the Southwest, impoundments have come into great prominence and along with it, interest in scientific study of such habitats.

By 1950, one hundred eighty-eight artificial lakes and 71,000 impounded stock ponds (less than 10 acre-feet) were present in Oklahoma with construction of small ponds still prevalent (Kelting and Penfound, 1950). More current estimates of the total number of ponds in Oklahoma range between

150,000 and 200,000 averaging one acre in surface area, and approximately 10,000 new ones are being constructed annually (Jenkins, 1958). In Texas, over 340,000 farm ponds of various sizes are in use and construction continues at the rate of 7,500 per year (United States Department of Agriculture, 1958; Bennett, 1961). Ninety-six impoundments of over 5,000 acre-feet are in existence and 13 more are under construction (Texas Water Commission, 1961).

The impoundment concerned in this study is in the same general region as those investigated by Jones (1939), Harris and Silvey (1940), Patterson (1942), Cheatum _et_ _al_. (1942), and Gunn (1953). Harris and Silvey (1940) did probably the most complete work on reservoirs in Texas to date. Their study was of four reservoirs, ranging in age at the time of investigation, between one year and 22 years, with Lake Worth as the oldest. Lake Dallas was nine years old at the time, Eagle Mountain Lake was two years old, and Lake Bridgeport, one. Harris and Silvey found the most productive lake in net plankton on a statistical basis to be Lake Worth and following in order were Lake Dallas, Eagle Mountain Lake, and Lake Bridgeport. Not only was Lake Worth most productive in net plankton but also consistently showed the greatest variety of species. However, in a gravimetrical determination of total plankton which is considered by Pennak (1946) to be a more satisfactory basis for determining standing crop, Lake Worth ranked third while Lake Dallas, next to the oldest, was first. In general, the predominants of net plankton and their distribution patterns were basically the same for each of the lakes. Cheatum et al. (1942), in their three-year study of Upper Ellis Lake, 19 years old at the time of the investigation, found no repeated seasonal blooms of dominants in successive years. Although no general statements could be made, late winter and spring appeared to be more favorable for desmids and the early part of these seasons were least favorable. Cladocera and Copepoda population patterns paralleled surprisingly closely. They collected only two copepods and nauplii. This concurs with Pennak (1953) who stated that copepod plankton may be composed of one, two or three species. They detected no definite correlation between net phytoplankton and zooplankton. Their work was not of the nature to provide definite clues about aging or stabilization of a population.

The works of Jones (1939), Patterson (1941), and Gunn (1953) ranged from a six-month period in the case of Patterson to one year in each of the others. Jones worked with net plankton of Lake Como, 49 years old at the time of study and probably the oldest impoundment in Texas. His results paralleled closely those of Harris and Silvey (1940) and Cheatum et al. (1942). Patterson's work on White Rock Lake, 38 years old, was not of sufficient duration to indicate population trends. Gunn's interest was directed toward bottom fauna and identification of plankton found in contents of fish stomachs.

A survey of the literature reveals, as has been noted by Pennak (1949) and Andrews (1953), that only a limited number of continuous qualitative and quantitative plankton studies have been made for a period of more than one year. Most reports contain information which is seasonal and data are lacking for comparisons during different seasons of a single year. Investigations on a year-round basis, including some quantitative study of plankton along with other aspects of limnology, are those by Birge and Juday (1922), Chandler (1940, 1942, 1944), Chandler and Weeks (1945), and Pennak (1949).

Birge and Juday (1922) sought information on annual plankton production with specific emphasis on quantity and chemical composition of organic substance in the water. They pointed out the difficulty in attaining total plankton productivity and their data did not enable them to evaluate the plankton crop in the biologic economy of the lake. They indicated that cladocerans are more important than copepods because the former are used more extensively as food by fish. Their results indicated that 25 to 75 percent of the organic matter in net plankton was composed of crustaceans and rotifers. The maximum was found in late winter and early spring when algae and protozoans were at their lowest points of net material. The studies of Chandler (1940, 1942, 1944) and Chandler and Weeks (1945) concerned the phytoplankton of Lake Erie as it was affected by various physical, chemical, meteorological, and climatic conditions. Phytoplankton varied in quality and quantity from year to year. These variations were associated with such factors as differences in temperature, turbidity, ice coverage, seiches, and storms.

Pennak (1949) investigated the chemical and physical conditions of seven small reservoirs in Colorado over a two year period in relation to plankton populations. Six of these impoundments were over 40 years of age at the time of the study and the other one was over 30. Each impoundment exhibited individuality in annual population quality and quantity with no consistent typical pattern. One, two, or three pulses appeared annually and at almost any time during the year. Correlations of seasonal occurrence and magnitude of plankton populations were not established between annual cycles of temperature and dissolved oxygen. Some investigators maintain that artificial reservoirs reach their maximum biological production within three to five years after being impounded and that high production persists for an equivalent period after which biological balance is lost (Harris and Silvey, 1940; Pennak, 1949). Accordingly, production should begin to decrease after a 10 to 15 year period. To the contrary, Pennak found that in five of the impoundments, though more than forty years of age, plankton production was relatively high.

My investigation was initiated and continued throughout a five-year period in an attempt to determine the development of the plankton community in the newly filled Renshaw impoundment located in Wise County, Texas. Construction was started in December, 1949 and was completed in January, 1950. My research began on March 17, 1950 and continued through October 24, 1954. Plankton samples were collected on a biweekly basis. Records of other investigations for a comparable period of time are not evident.

Plankton was studied both qualitatively and quantitatively. Individual species were identified and counted to establish the quantitative species pattern of organisms collected, possible annual and or seasonal succession if any, and trends toward probable stabilized community components. Each individual species was treated quantitatively to establish individual species population patterns. A composite of the organisms of each species was used to determine the total population pattern and periods of high productivity.

CHAPTER II

MORPHOMETRY AND CLIMATOLOGY

The impoundment is located on the Renshaw Ranch in Wise County, Texas eight miles east of Decatur. It has a surface area of two and one-fourth acre-feet when the water level at the collecting station (Fig. I) is 20 feet deep.

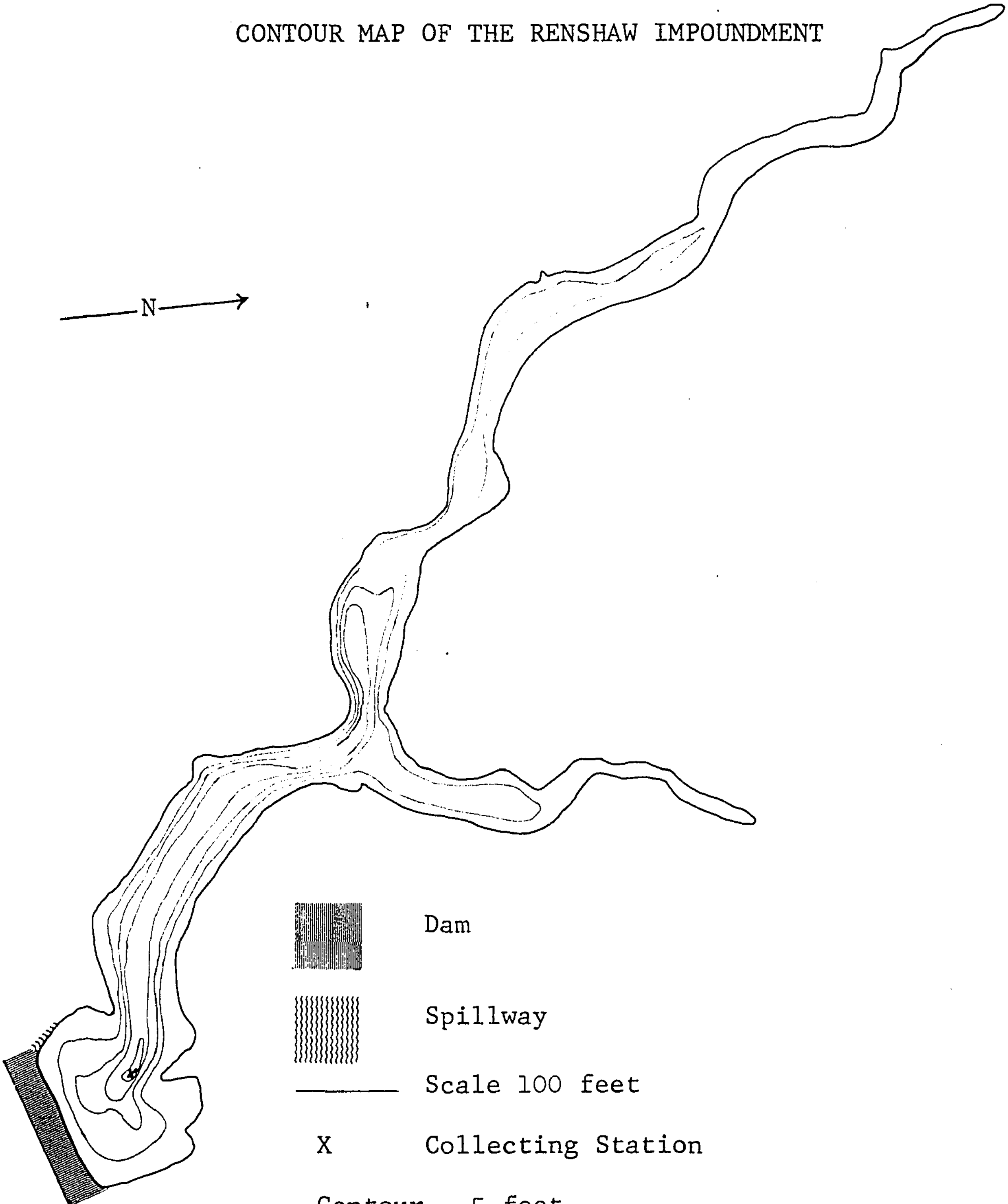
The impoundment was constructed by building a dam across a ravine through which a small spring-fed stream flowed. The main channel is formed by two branches converging to lend a "Y" shape to the body (Fig. I). This channel empties into an enlarged basin enclosed by the dam and a sloping shore on either side. The remainder of the impoundment is enclosed by an irregular shore line formed by a steep bank.

The surrounding drainage area approximates 100 acres. The soil is of black silty clay near the water which changes to a gray sandy type back from the shore.

The period of study from March, 1950 through October, 1954, coincides with a five-year period each year of which

FIGURE 1

CONTOUR MAP OF THE RENSHAW IMPOUNDMENT



had, for the State of Texas as a whole, less than normal rainfall. Total precipitation for the Denton, Texas area, the nearest Government Weather Station, in 1951, 1952, and 1954 was lower than the state average despite the fact that it is normally higher. Only in 1950 was there an average amount for this area (United States Department of Commerce, 1951, 1952, 1953, 1954, 1955).

The average temperature for the state as a whole was above normal except in 1950 when it was 0.2 of one degree Fahrenheit below normal (United States Department of Commerce, 1951, 1952, 1953, 1954, 1955). Air temperature at the impoundment ranged from 30.2° F. to 104° F. Surface temperatures of the water ranged between 41.9° F. and 93.2°F. It ranged between 41.9° F. and 87.8° F. in the middle stratum and between 41.9° F. and 87.8° F. at the bottom. Concurrently with the high temperature and low precipitation, the water level receded from a maximum depth of 20 feet to 5 feet.

CHAPTER III

MATERIALS AND METHODS

Air and water temperatures were determined by a standard thermometer. Other climatological data were obtained from bulletins of the United States Department of Commerce (1950, 1951, 1952, 1953, and 1954).

Chemical analyses of water, alkalinity, dissolved oxygen, free carbon dioxide, and hydrogen-ion concentration were determined by using the methods as outlined by the American Public Health Association (1946). The Rideal-Stewart modification of the Winkler procedure was used for dissolved oxygen. Hydrogen-ion concentrations were determined from March, 1950 through September, 1951 by use of the LaMotte colorimeter and a Hellige Pocket Colorimeter was used after September, 1951.

Plankton samples were taken at surface, middle, and bottom levels using a modified Kemmerer water sampler (Welch, 1948) of three liters capacity. Fifteen liters were poured through a plankton net of No. 25 bolting cloth and the concentrate was preserved in five percent formalin.

Qualitative and quantitative analyses were made by examining one milliliter of the preserved concentrate. Each organism was identified, counted and the number per liter was calculated. A Sedgwick-Rafter counting chamber and microscope were used for identification and counting.

Averages per liter are illustrated by the spherical curve (Lohmann after Birge and Juday, 1922) in Figures 2 to 5.

CHAPTER IV

POPULATION COMPOSITION AND VARIATION

Sixty-nine species were collected during the study period. Only 45 to 55 species occurred in any one year and 8 to 31 in any one month (Table I; Appendix I). During the first two years, spring and fall peaks in number of species occurred. As the impoundment matured, there was a tendency toward a consistent distribution of species from month to month.

Only four species (Appendix I) appeared in collections representing 90 percent or more of the collecting time. Six species appeared in collections representing 70 to 90 percent of the collecting time and 25 species were present in collections representing less than 10 percent of the collecting time. Eight species were collected between 50 and 69 percent of the collecting time, 9 between 30 and 49 percent, and 17 between 10 and 29 percent of the collecting time. This distribution reflects seasonal and annual variations in some forms of plankters, but little or none in others.

TABLE I

NUMBER OF SPECIES COLLECTED EACH MONTH
THROUGHOUT THE COLLECTING PERIOD

	1950	1951	1952	1953	1954
Jan.	*	12	20	8	20
Feb.	*	12	23	12	32
March	12	14	24	18	27
April	19	19	27	19	31
May	*	20	28	25	28
June	18	14	24	24	25
July	*	18	25	25	28
Aug.	8	14	26	24	21
Sept.	17	27	*	16	24
Oct.	20	24	27	24	30
Nov.	19	23	25	20	*
Dec.	18	21	15	15	*

* No collections made.

Only 45 percent of the 69 species were collected during each of the five years. Many representatives of this group are of wide distribution (Brown, 1929; Edmondson, 1959; Jones, 1955). Approximately 21 percent of the species were collected in one year only and thus, none exhibited annual variations. Thirty-four percent of the species either appeared consistently or were not collected a sufficient number of times and in sufficient quantities for a regular pattern to be discernable. Of the organisms first collected after 1950, Tropocyclops prasinus (Fischer) was the most consistent in appearance. It was present in all except three months after its initial appearance in September, 1951.

New species appeared during each successive year (Appendix I). However, 65 percent of the total species was collected in 1950, each of which appeared in two or more successive years. Sixty-six percent of the species collected in 1954 were taken in each of the five years of collecting. It may therefore be assumed that those species are relatively permanent and could be expected to establish themselves early in the history of any impoundment in the local area.

The following organisms, Ceratium hirundinella (O.F.M.), Mesocyclops edax (Forbes), Keratella cochlearis (Gosse),

TABLE II

PHYTOPLANKTON AND ZOOPLANKTON PREDOMINANTS, EXCLUDING DINOBRYON SERTULARIA, MARCH, 1950 THROUGH NOVEMBER, 1954

No. of Months Collected	Organisms	Position of Rank 1st.	2nd.	3rd.
15	*Asplanchna* sp.	1	0	0
50	*Bosmina longirostris* (O.F.M.)	7	5	1
38	*Brachionus angularis* (Gosse)	3	5	1
5	*Brachionus havanaensis* (Rousselet)	0	0	1
53	*Ceratium hirundinella* (O.F.M.)	13	15	2*
17	*Chydorus sphaericus* (O.F.M.)	0	0	1
11	*Cymatopleura* sp.	0	0	1*
48	*Daphnia longispina* (O.F.M.)	1	1	1
9	*Daphnia pulex* (deGeer)	0	1	0
38	*Difflugia cratera* (Leidy)	3	1	5
7	*Euglena acus* (Ehrenberg)	0	0	1*
10	*Filinia longiseta* (Ehrenberg)	0	1	0
52	*Keratella cochlearis* (Gosse)	6	5	14
53	*Mesocyclops edax* (Forbes)	0	0	1
52	Nauplius	1	4	16
47	*Peridinium willei* (Huitfeld-Kaas)	16	11	4*
24	*Phacus pleuronectes* (Mueller)	1	0	0*
12	*Synchaeta* sp.	0	1	1
39	*Trichocerca longiseta* (Schrank)	0	0	1
37	*Tropocyclops prasinus* (Fischer)	2	5	3
28	*Euglena tripteris* (Ehrenberg)	0	1	0*

* indicates phytoplankters.

Bosmina longirostris (O.F.M.), Peridinium willei (Huitfeld-Kaas), Difflugia cratera (Leidy), Trichocerca longiseta (Schrank), Brachionus angularis (Gosse), Daphnia longispina (O.F.M.) and Daphnia pulex (deGeer), all of wide distribution, were collected between 70 and 100 percent of the collecting time and because of their consistent appearance, exhibited no seasonal variation. Some may be autotrophic and others feed on bacteria, small plankton forms, detritus and periphyton. They are common in bodies of water similar to this impoundment (Harris and Silvey, 1940; W. Jones, 1955; D. Jones, 1939; Ratzlaff, 1952).

Some organisms could be expected to appear in certain seasons and not in others since only 45 percent of the total were collected in all four seasons of the year. Twenty-six percent were collected in three seasons, 13 percent in two, and 16 percent in one season. Of the latter, the majority was collected during just one month and was not found in great abundance.

When considering total plankton, only 16 percent of the total species collected were present in sufficient quantities to occupy the predominant position (highest average number per liter per month). Nineteen percent occupied the second

TABLE III

ZOOPLANKTON PREDOMINANTS, MARCH, 1950
THROUGH NOVEMBER, 1954

No. of Months Collected	Organisms	1st.	2nd.	3rd.
15	*Asplanchna* sp.	1	0	1
50	*Bosmina longirostris* (O.F.M.)	7	9	6
38	*Brachionus angularis* (Gosse)	6	3	4
5	*Brach. havanaensis* (Rousselet)	1	0	1
26	*Cerodaphnia lacustris* (Birge)	0	0	2
17	*Chydorus sphaericus* (O.F.M.)	0	0	1
48	*Daphnia longispina* (O.F.M.)	2	4	4
9	*Daphnia pulex* (deGeer)	0	1	0
38	*Difflugia cratera* (Leidy)	4	1	2
10	*Filinia longiseta* (Ehrenberg)	0	1	0
52	*Keratella cochlearis* (Gosse)	16	10	10
53	*Mesocyclops edax* (Forbes)	0	5	7
52	Nauplius	12	15	8
23	*Polyarthra trigla* (Ehrenberg)	0	0	3
12	*Synchaeta* sp.	1	1	1
39	*Trichocerca longiseta* (Schrank)	0	0	1
37	*Tropocyclops prasinus* (Fischer)	5	5	5

position and 23 percent the third. In the predominant group, P. willei and C. hirundinella, considered zooplankters by some authorities and phytoplankters by others but treated here as the latter, were the leading phytoplankters (Table II). Although zooplankters were more numerous as a group in the above categories, no one zooplankter compared with C. hirundinella and P. willei in predominance (Table III). Only one phytoplankter, P. willei, occupied the predominant position during all four seasons of the year (Appendix IIa). Only K. cochlearis and D. cratera of zooplankters occupied a similar position (Appendix IIb). Other species indicated seasonal quantitative variations by occupying predominant positions in three or fewer seasons of the year. The organisms occupying the predominant as well as second and third positions exhibited seasonal qualitative fluctuations by the number of species present during the respective seasons.

The average number of plankters per month (Table IV) reflected seasonal and annual variations. The highest average number of organisms per liter on a seasonal basis over the entire period was that of the fall, followed in order by summer, spring, and winter. The highest average over the entire period for a given winter month was in December; in

TABLE IV

AVERAGE NUMBER OF ORGANISMS PER LITER, TOTAL PLANKTON EXCLUDING *DINOBRYON SERTULARIA*

	1950	1951	1952	1953	1954	Monthly Average	Seasonal Average
Jan.	*	435	2428	560	1050	1118	4838
Feb.	*	445	1250	2807	3232	1934	
Mar.	495	329	1430	3406	1621	1456	
Apr.	16396	1752	2950	10364	8785	8049	
May	*	8433	9512	5049	2276	6317	15822
June	3590	4605	14303	49529	21718	18749	
July	*	1115	8075	3187	1509	3472	
Aug.	161	353	4925	1090	9538	3213	25434
Sept.	91696	1370	*	8417	54566	39013	
Oct.	12433	3514	5381	23376	30904	15122	
Nov.	3335	4036	10133	4076	*	5395	59530
Dec.	682	2299	2908	1256	*	1786	
Total	128788	28686	63295	113117	135199		
Average	16098	2391	5754	9426	13520		

* No collections made.

spring--April; in summer--June, and September in the fall (Table IV). The highest mean of the averages per liter over the entire period occurred in September, followed by June; the lowest was in January.

On an annual basis, the highest mean of the monthly averages occurred in 1950. The means were progressively lower in 1954, 1953, 1952, and 1951 (Table IV). This annual population distribution exhibited an initial surge in 1950, which declined markedly in 1951. During the next three years, there was a progressive increase in the population up to 1955, when the population mean approached that of 1950.

After the initial population of 1950, the greatest number of new species was collected during the third year of the investigation. Some continued to appear during the next two years while others disappeared. It is interpreted that climatic effects contributed to the environmental conditions to the extent that those organisms collected only in 1952 were favored by the high temperature and low water level.

CHAPTER V

POPULATION TRENDS OF MAJOR GROUPS BY SPECIES

CLADOCERA

Eight different species of the Order Cladocera were collected. *Bosmina longirostris* was most frequently found while *Daphnia longispina* and *Daphnia pulex* respectively were next in order. These three composed the most frequently occurring association of Cladocera.

Seven of the eight species were collected in 1950 and the eighth, *Alona* sp., did not appear until May, 1953. All species did not occur in a given month nor in a given year. Seven species was the highest number collected in a given year and six occurred during each of the last three years. The highest number of species collected in a single month was five while the least was one. When only one species occurred, it was *B. longirostris*.

Alona sp. was collected in just three months and the highest average number per liter per month was sixteen. *Pleuroxus denticulatus* (Birge) and *Diaphanosoma brachyurum*

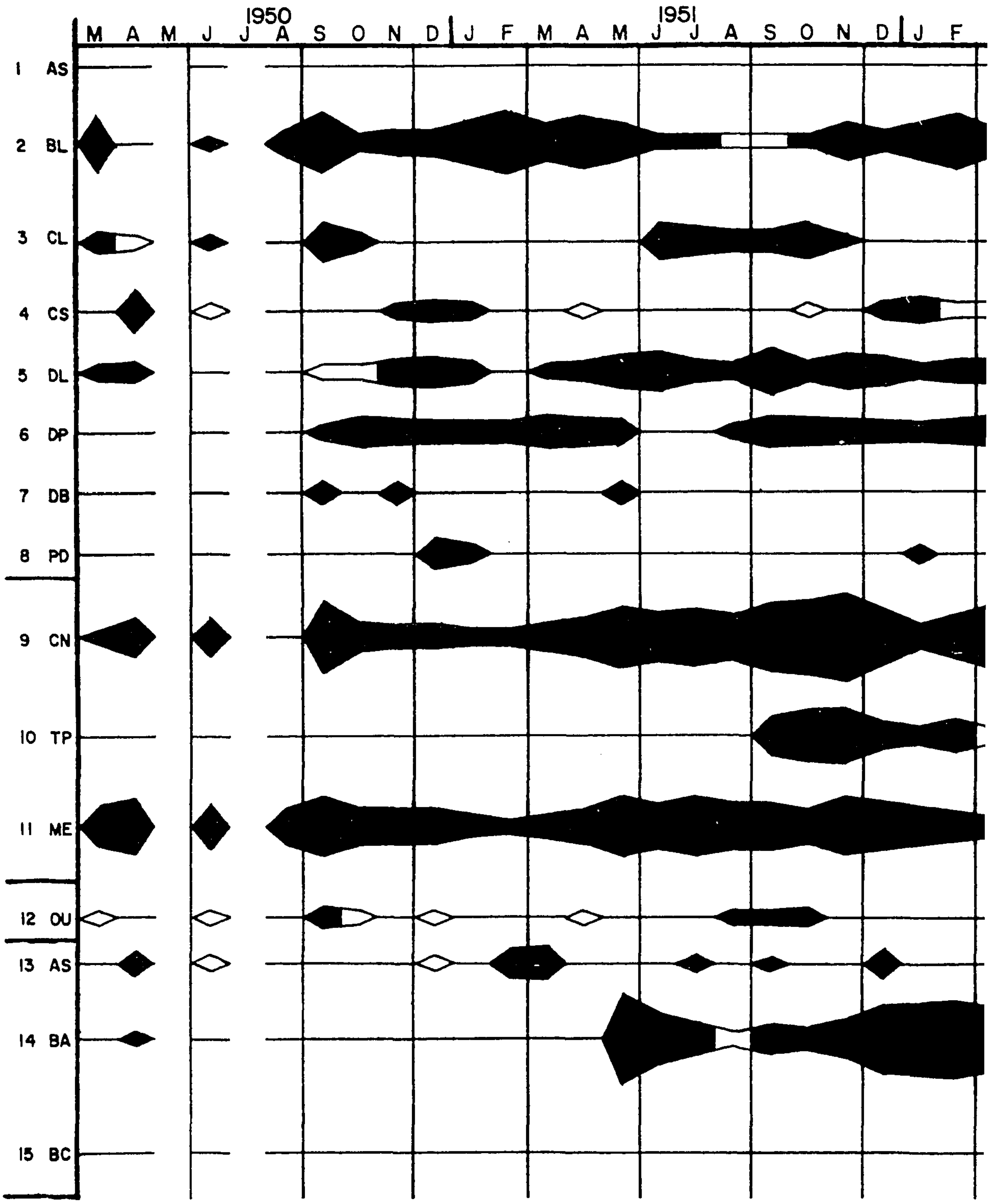
(Leiven) were collected in four months and each was found in very small quantities (Fig. 2).

Chydorus sphaericus (O.F.M.) was collected in 18 months. It appeared most prominently in April, especially in 1950 and 1954. The highest average per liter occurred in the second month of the investigation and did not approach that figure thereafter. It was not collected in July, August, and September and its population declined continuously after the first year (Fig. 2; Appendix III).

Ceriodaphnia lacustris (Birge) appeared in 26 months (Appendix IV). Its highest population was in June of 1953 and the low was in the same month of 1950. It was not collected in December, January, or February and was not prominent in June, October, and September respectively (Fig. 1).

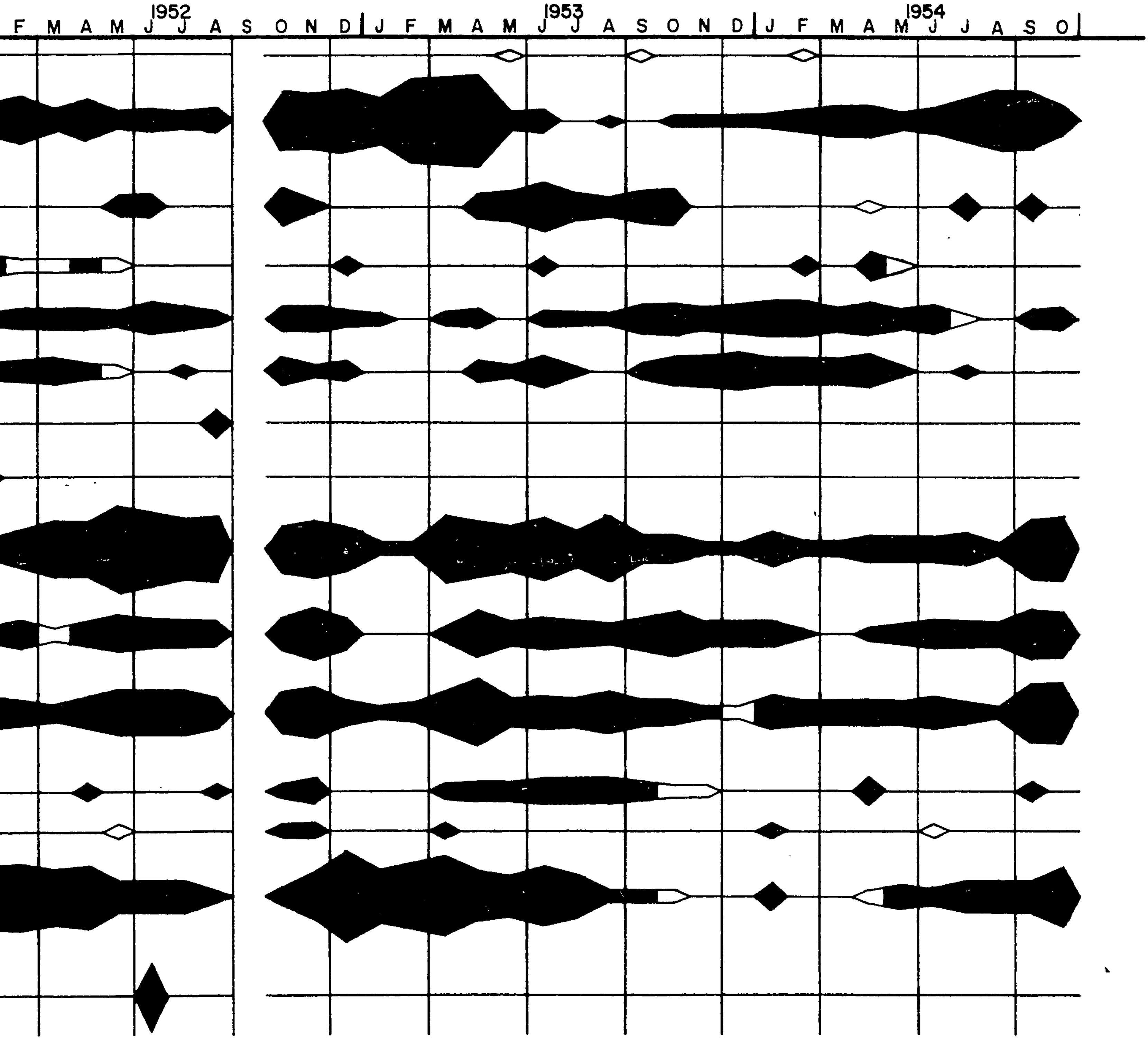
Bosmina longirostris was not only the most frequently occurring but also the most numerous of the cladocerans (Fig. 2; Appendix V). Its peak population occurred in April, 1953 and the highest average per liter for a given month over the entire investigation was in April while the lowest was in June. Two population peaks per year occurred. The higher was in February through April; the lower in September through December. There was a pronounced drop in May through July. Annual averages per liter revealed that

FIG. 2--DIAGRAM SHOWING THE NUMERICAL RESUL



1. AS-<u>Alona</u> sp.
2. BL-<u>Bosmina longirostris</u>
3. CL-<u>Ceriodaphnia lacustris</u>
4. CS-<u>Chydorus sphaericus</u>
5. DL-<u>Daphnia longispina</u>
6. DP-<u>Daphnia pulex</u>
7. DB-<u>Diaphanosoma brachyu</u>
8. PD-<u>Pleuroxus denticulat</u>
9. CN-Copepoda nauplii
10. TP-<u>Tropocyclops prasinu</u>

SULTS FOR NET PLANKTON OF THE RENSHAW IMPOUNDMENT......1950-1954.



chyurum
ulatus
sinus

11. ME-Mesocyclops edax
12. OU-Ostracoda
13. AS-Asplanchna sp.
14. BA-Brachionus angularis
15. BC-Brachionus calyciflorus

1-8 Cladocera
9-11 Copepoda
12 Ostracoda
13-15 Rotifera

Radius > 1

Radius < 1

the *B. longirostris* population remained essentially the same through the first two years but doubled in the third and almost tripled in the fourth. There was a marked decline during the fifth year which was more pronounced than for any other cladoceran at any time.

Daphnia longispina was collected in 47 months and reached its population peak in September, 1951 (Fig. 2; Appendix VI). The highest average per liter for a given month over the entire period was September and the low was in August. The highest annual average was in 1954, and the low was in 1950. Throughout the investigation, *D. longispina* did not exhibit a pattern of population peaks as explicitly as did *B. longirostris*. The high tended to occur between September and January inclusive with a single peak per year or two very close together.

Daphnia pulex appeared in the collections of 37 months and reached its highest population peak in December, 1953 (Fig. 2; Appendix VII). During each year, the highest peak occurred between October and February inclusive. Two peaks per year occurred in 1951 and 1952 but only one in each of the other three years. Annual averages revealed a pattern of high population peaks in alternate years followed by a positive decline.

Cladocera appeared in the first collections and were present throughout the investigation. Ceriodaphnia lacustris, Daphnia longispina, and Pleuroxus denticulatus are restricted cosmopolitan species while the others are cosmopolitan. This classification is in accordance with Brown (1929b), Welch (1935) and Jones (1958). A population of these Cladocera would normally be expected because of wide tolerance ranges for temperature and chemical limiting factors (Brown, 1929, 1929a, 1929b; Pennak, 1953).

In this study, three species, B. longirostris, D. pulex, and D. longispina, were found consistently and in quantities indicating they were compatible species. Daphnia pulex was collected in greater quantities in the spring and fall which is in agreement with Brown (1929). Daphnia longispina exhibited a pattern of greater consistency throughout the year than D. pulex and of greater consistency than reported by Brown (1929). An inverse proportion to number of species of Cladocera and quantity of individuals was not clearly exhibited throughout the investigation which is contrary to the work of Brown (1929b).

Ceriodaphnia lacustris appeared to complement the low population of D. pulex by coming into prominence during the summer and early fall while it was collected in very low numbers or not at all during the other seasons. Jones (1955) however, reported *C. lacustris* as one of the most frequently collected cladocerans in Oklahoma where it was found abundantly in all seasons.

The distribution pattern of *Chydorus sphaericus* differed from that found in Oklahoma by Jones (1955, 1958) and in Kansas by Prophet *et al*. (1959). My observations indicate that in a new impoundment of this type, *C. sphaericus* may be an early inhabitant which declines in frequency and prominence with the invasion and stabilization of Cladocera of the species found in this investigation.

Daphnia longispina was collected more frequently and in greater abundance than *D. pulex*. This observation indicates that, although these species are compatible, environmental conditions in this habitat were more nearly optimal for *D. longispina* than *D. pulex*. The pattern of *D. longispina* and *D. pulex* is not consistent with the work of Brown (1929), Jones (1958), or Prophet (1957). Yeatman (1956) considered *D. pulex* more robust than certain varieties of *D. longispina*. Ratzlaff (1952), however did not report the presence of *D. pulex* but found *D. longispina* in each locality.

COPEPODA

Two species of Copepoda were collected. *Mesocyclops edax* (Fischer) appeared in March, 1950 and was present in each of the 53 months of collecting (Appendix VIII). *Tropocyclops prasinus* (Fischer) did not appear until September, 1951. It was present in all but three months throughout the remainder of the investigation (Appendix IX).

Mesocyclops edax appeared in greater quantities from April through November. Except in 1951 and 1953, the highest averages per liter were in September, October, or November. The highest in 1951 was in May, while in 1953, it was in April. Spring and fall population peaks occurred each year except in 1954 when only the latter occurred. Usually, the fall peaks exceeded that of the spring (Fig. 2; Appendix VIII). The highest average for a single month occurred in April of 1953. Over the entire period, September had the highest average per liter; the lowest average was in February. On an annual basis, the mean of the monthly averages remained at a near constant except in 1953 when there was a slight decline.

Tropocyclops prasinus, like *M. edax*, was collected in greater quantities from April through November. Except in

1953 when the highest monthly average per liter was in April, the highest count occurred in September, October or November. The highest average for a single month was in November, 1952 and the low was in April of the same year. Over the entire period, the highest average for a given month was in November. Like _M_. _edax_, _T_. _prasinus_ exhibited a dicyclic population pattern with the fall peak exceeding the spring except in 1954 when only the fall peak was apparent. On an annual basis, the average remained at a near constant (Fig. 2; Appendix IX).

Copepoda nauplii, except for one month, were present throughout the entire period (Fig. 2; Appendix X). The population pattern in general paralleled that of the two adults. The highest average per liter for a single month was in October, 1954 and the low occurred in January of 1953 and 1954. For a given month over the entire period, October had the highest average and January the lowest. Usually, two population peaks per year occurred. In 1950, 1951, and 1954, the highest peak was in the fall and in each case there was a marked difference between the two. However, in 1952, the spring peak was considerably higher than that of the fall but both were approximately equal in 1953 (Appendix X).

The number of copepod species collected is not considered to be unusual as it is supported by the work of Willey (1923), Ratzlaff (1952), and Pennak (1953). The latter stated that copepod plankton is rather monotonous, usually being composed of one, two, or three species. Both species were recovered during each month of the year. *Mesocyclops edax* and *T. prasinus* were collected in lesser quantities from December through March. Pennak (1953) listed *Eucyclops prasinus* (Fischer), here regarded as *Tropocyclops prasinus*, as breeding between July and October. He, along with Prophet *et al.* (1959), listed *M. edax* as an occasional inhabitant in ponds during the fall and spring and *T. prasinus* as a common inhabitant in all types of habitats, appearing especially from early spring through fall.

After the first few months, copepod nauplii exceeded the adults in number. Two or three larval peaks appeared each year. The spring peak was frequently followed by a more pronounced increase in *M. edax* than *T. prasinus*. Larval peaks later in the year were usually followed by similar increases in both adults. However, *T. prasinus* adult population usually reached its peak earlier than *M. edax*.

Larval population peaks were not always followed by equally pronounced increases in adult populations (Fig. 2). Several pronounced larval peaks occurred and were followed by only slight increases in adults. This may possibly be accounted for in part by the fact that numerous larval forms were eaten and these data may have been affected by the sampling frequency.

OSTRACODA

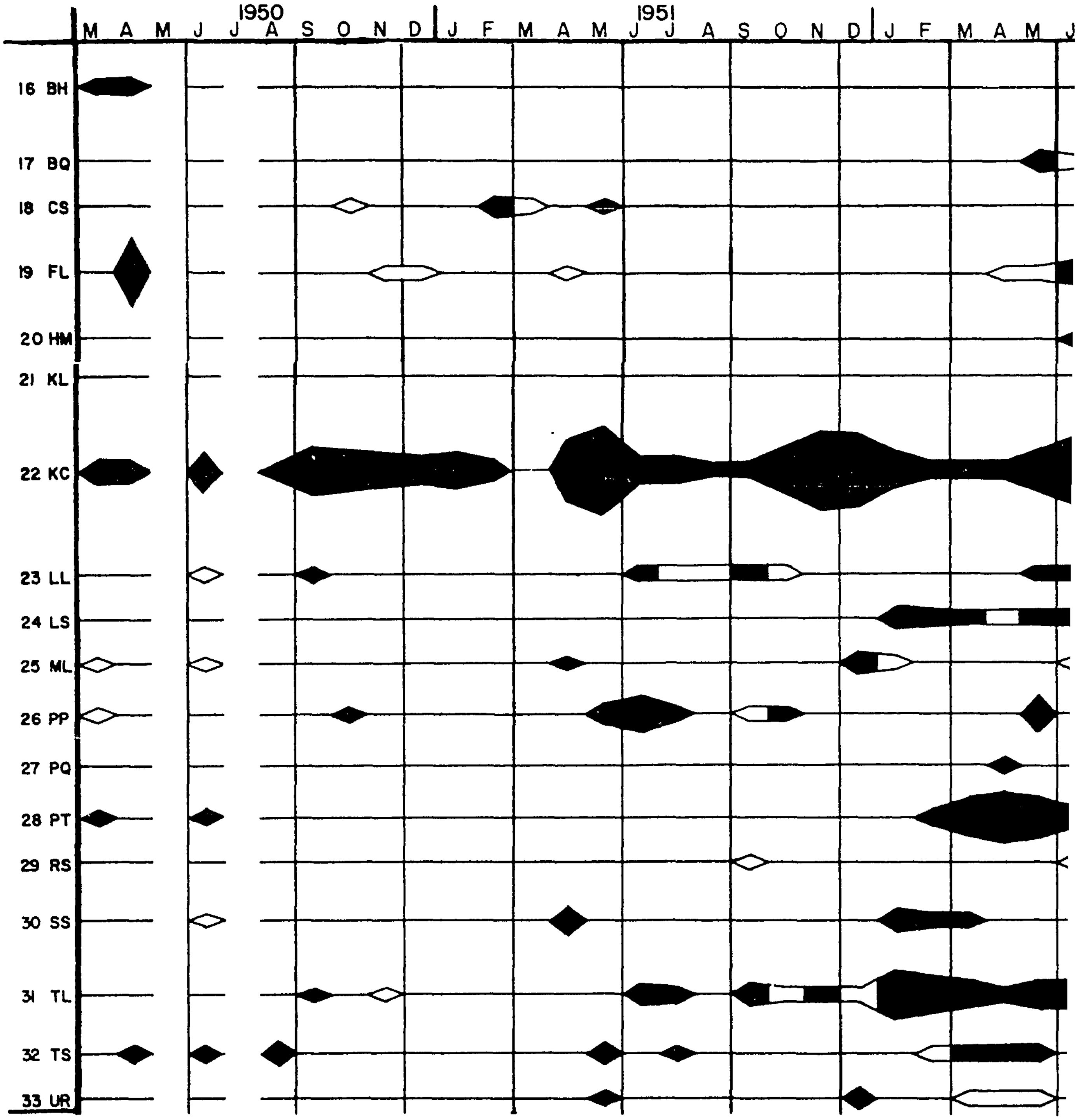
Ostracoda were collected in 24 months. They were first recovered in March, 1950 but were very sporadic in appearance until 1953. They occurred in 9 months of that year but were collected only twice in 1954. The highest averages per liter occurred from June through September, inclusive. They did not appear in January or February and only once in December (Fig. 2; Appendix I).

Tolerance to heat and cold differs for those ostracods reproducing early in spring and those reproducing in summer (Kesling, 1951). In accordance with their abundance in the warmer months, it is indicative that the species recovered reproduce primarily in the summer. The population of ostracods in this investigation would have been more determinative had samples of mud and periphyton been analyzed.

ROTIFERA

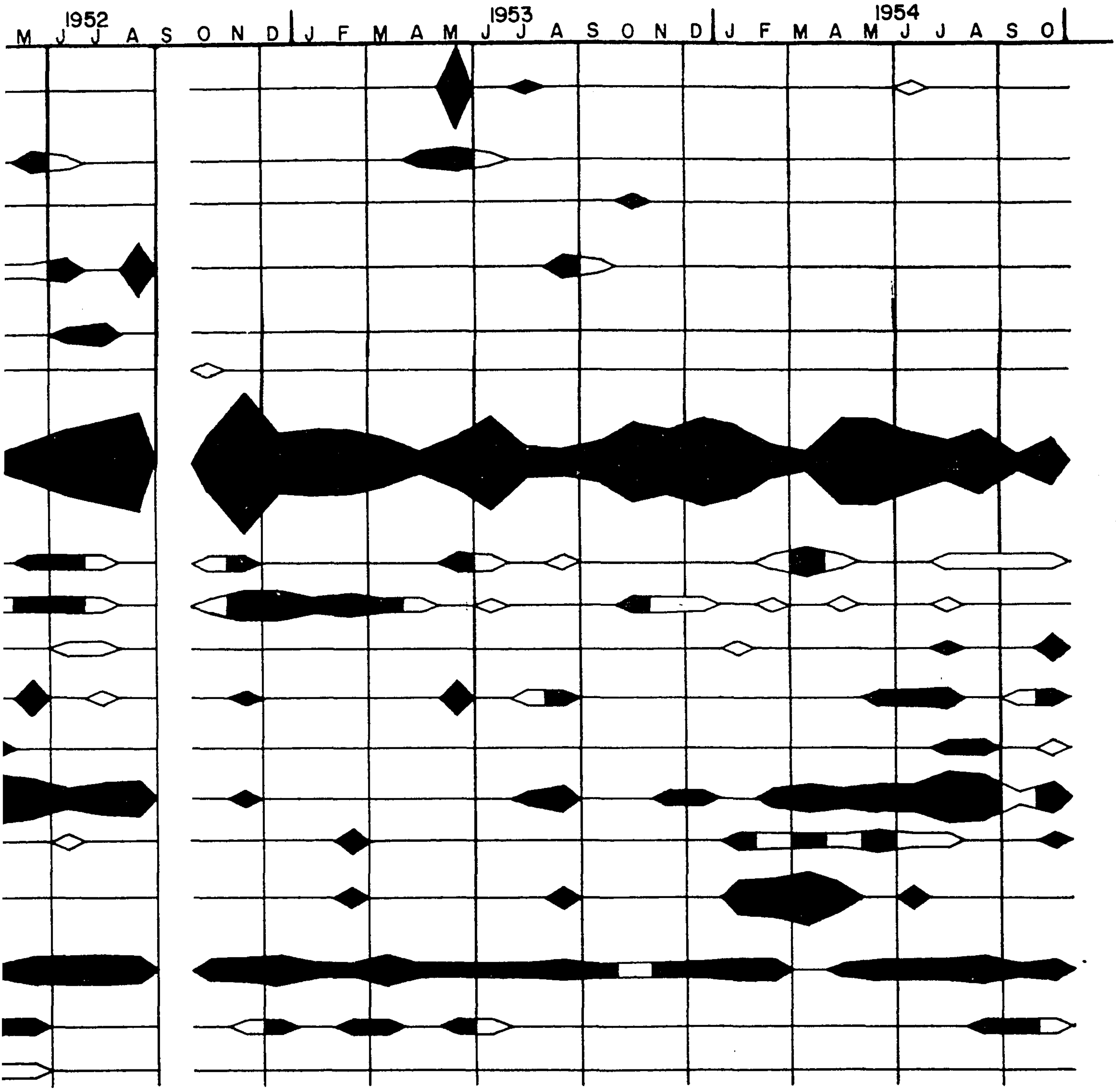
Twenty-one species of Rotifera were collected. Not all were collected in any one month or in any one calendar year (Fig. 2, 3; Appendix I). Thirteen species were collected in 1950. Two new forms appeared in 1951 and six more in 1952. No new species were collected after 1952. Of the eight species first collected in 1951 and/or 1952, only two, *Lepadella* sp. and *Rotaria* sp. appeared in more than 10 months. Of the 13 species collected in 1950, only two appeared in less than 10 months (Table V). The highest number of species in a given month occurred in May and June of 1952, while the lowest was in August and October of 1951. The greatest variety over the entire period was present from April through July, inclusive. Only three species, *Keratella cochlearis* (Gosse), *Trichocerca longiseta* (Schrank), and *Brachionus angularis* (Gosse) appeared in more than 50 percent of the collecting period. *Keratella cochlearis* was collected in all but one month. Of the 18 species collected in less than 25 months, 10 were present in 10 months or less (Table V). Those forms which were a part of the more fixed community appeared in the early stages of the impoundment. Those which were collected during the second and third years were very

FIG. 3--DIAGRAM SHOWING THE NUMERICAL RESULTS FOR N



16. BH-Brachionus havanaensis
17. BQ-Brachionus quadridentata
18. CS-Cephalodella sp.
19. FL-Filinia longiseta
20. HM-Hexarthra mira
21. KL-Kellicottia longispina
22. KC-Keratella cochlearis
23. LL-Lecane luna
24. LS-Lepadella sp.
25. ML-Monostyla lunaris
26. PP-Platyias patulus
27. PQ-Platyias quadricornis
28.
29.
30.
31.
32.
33.

'OR NET PLANKTON OF THE RENSHAW IMPOUNDMENT......1950-1954.



28. PT-Polyarthra trigla
29. RS-Rotaria sp.
30. SS-Synchaeta sp.
31. TL-Trichocerca longiseta
32. TS-Trochosphaera solstitialis
33. UR-Unidentified rotifer

16-33 Rotifera

Radius > 1

Radius < 1

TABLE V

FREQUENCY OF COLLECTION AND INITIAL APPEARANCE OF ROTIFERA

Organism	Number of Months Collected	First appeared Month	Year
Keratella cochlearis (Gosse)	52	March	1950
Trichocerca longiseta (Schrank)	40	Sept.	1950
Brachionus angularis (Gosse)	37	April	1950
Polyarthra trigla (Ehrenberg)	23	March	1950
Lecane luna (Müller)	22	June	1950
Lepadella sp.	21	Jan.	1952
Trochosphaera solstitialis (Thorpe)	19	March	1950
Platyias patulus (Müller)	18	March	1950
Asplanchna sp.	14	April	1950
Synchaeta sp.	12	June	1950
Rotaria sp.	11	Sept.	1951
Monostyla lunaris (Ehrenberg)	10	March	1950
Filinia longiseta (Ehrenberg)	10	April	1950
Cephalodella sp.	5	Nov.	1950
Brachionus quadridentata (Hermann)	5	May	1952
Brachionus havanaensis (Rousselet)	5	March	1950
Platyias quadricornis (Ehrenberg)	4	April	1952
Brachionus calyciflorus (Pallas)	1	June	1952
Hexarthra mira (Hudson)	2	July	1952
Kellicottia longispina (Kellicott)	1	Oct.	1952
Unidentified	5	May	1951

sporadic in appearance. Five species of the rotifers after being collected for the first time, were absent from the collections for a year or more and then reappeared. This agrees with the work of Pennak (1953) and there was no accountable reason for this pattern.

Keratella cochlearis, a cosmopolitan species (Ahlstrom, 1943), was present in the first collections and reached its peak population the following month, while the lowest occurred in August, 1951 (Fig. 3; Appendix XI). Over the entire period, the highest average per liter was in April and the lowest was in March. Annually, the highest average was in 1950 with a continuous decline through the next four years with the most pronounced in 1952. _Keratella cochlearis_ occurred in greater numbers than any other species of rotifer and exhibited a dicyclic population pattern except in 1952. The first peak occurred either in April, May, or June and the second in September through December. The spring peaks were higher in each case.

Keratella cochlearis was expected in this impoundment although Edmondson (1959) related that it was generally absent from tropics but probably the most common plankton species in the temperate regions. This impoundment, based on temperature (Welch, 1935), is considered to be an intergrade between tropical and temperate lakes.

Trichocerca longiseta was collected approximately 74 percent of the time (Fig. 3; Appendix XII). It was collected only twice in 1950 and was not found consistently until September, 1951. The highest average per liter for a given month over the entire period was in January while the lowest was in April. The highest annual average was in 1952. In general, it was found in greater numbers while the water level was low and during the cooler part of the year. This is consistent with Edmondson (1959), Pennak (1953), and Pratt (1948) who indicated this species inhabits shallow water.

Brachionus angularis was collected approximately 72 percent of the time. In 1950, it occurred only in April and did not reappear until May, 1951. It appeared consistently thereafter through October, 1953 (Fig. 2; Appendix XIII). Like T. longiseta, B. angularis appeared more prominently in the cooler months, reaching its peak population in December, 1952. Excluding 1950, when B. angularis appeared in a single month, its highest annual peak was in 1952. Brachionus angularis and T. longiseta are found in comparable habitats

(Edmondson, 1959). However, in this study, B. angularis was found in greater quantities than T. longiseta and tended more toward a dicyclic population pattern.

Lecane luna (Müller), Lepadella sp., Platyias patulus (Müller), Polyarthra trigla (Ehrenberg), and Trochosphaera solstitialis (Thorpe) were recovered in a total of 18 to 23 months (Table V; Fig. 3). Polyarthra trigla appeared most frequently and in the greatest quantities (Appendix XIV). Other organisms of this group were rather sporadic in appearance. All, except Lepadella sp., were more prominent during the warmer months (Appendixes XIV through XVIII).

Asplanchna sp., Filinia longiseta (Ehrenberg), Monostyla lunaris (Ehrenberg), Rotaria sp., and Synchaeta sp. were collected in a total of 10 to 14 months (Table V; Fig. 2, 3; Appendixes XIX through XXIII). Filinia longiseta and Synchaeta sp. appeared in high numbers in just one or two months. No definite population patterns were exhibited by any of this group.

Brachionus calyciflorus (Pallas), Brachionus havanaensis (Rousselet), Brachionus quadridentata (Hermann), Cephalodella sp., Hexarthra mira (Hudson), Kellicottia longispina (Kellicott), Platyias quadricornis (Ehrenberg), and an unidentified species were collected in five or less months (Table V; Fig. 2, 3). Each appeared in small numbers except _B. havanaensis_. This species exhibited a single pulse in May, 1953, when it averaged 767 per liter. There was no accountable reason for this pronounced surge.

Rotifer species were more numerous than any other group of organisms collected in this investigation. Although regarded potentially as cosmopolitan forms, they may be limited geographically by certain chemical conditions of the environment (Myers, 1931, 1942; Edmondson, 1959). _Keratella cochlearis_ and _Brachionus angularis_ respectively were the two species collected in greatest abundance (Fig. 2, 3). _Brachionus_ was listed by Myers (1931) along with _Asplanchna_, _Filinia_, and _Notholca_ (the latter recognized as _Kellicottia_), as genera especially associated with alkaline water and _Keratella_ with both acid and alkaline water. Alkaline waters usually contain an immense number of individual rotifers represented by relatively few species while acid water contains relatively few individuals representing many species (Harring and Myers, 1928). Since pH of 7.0 is not a sharp dividing line between acid and alkaline water species (Pennak, 1953), even though this impoundment is of alkaline nature and two species were definitely predominant in abundance, it is difficult to make a close comparison between this investigation and that of Harring and Myers.

TESTACEA

Three species of Testacea were represented in this impoundment. Difflugia cratera (Leidy) was collected in 80 percent of the collecting time while Arcella vulgaris Ehrenberg and Centropyxis aculeata (Ehrenberg) were present in less than 15 percent of collecting time (Fig. 4).

Difflugia cratera first appeared in April, 1950 and reached its peak population in April, 1952. The highest average per liter for a given month over the entire period was November and April was next. On an annual basis, the peak population occurred in 1952 and a definite decline followed in each of the next two years. The lowest average per liter was in 1954 (Fig. 4; Appendix XXIV).

Difflugia cratera exhibited a dicyclic population pattern each year except 1950. The first peak occurred in April or May while the second was in October. The spring peak exceeded that of the fall except in 1953.

Difflugia cratera closely resembles a ciliate belonging to the Family Tintinnidae (Leidy). Since only the shell of the organism was observed and the description of Leidy (1879), including plates, resembles this organism more closely than that of Kudo (1947), the classification is after Leidy.

Arcella vulgaris and Centropyxis aculeata were not collected frequently enough nor in sufficient quantities to ascertain a particular population pattern. Although A. vulgaris is one of the most common shell-bearing fresh-water rhizopods and is found in almost every pond, ditch, or long-standing pool (Leidy, 1879), its habit of creeping in soft ooze of the bottom or in flocculent matter adherent to sub-merged plants must have reduced the probability of its being collected in great frequency. Centropyxis aculeata is closely associated in habit and behavior with A. vulgaris which accounts for its being collected very infrequently. A variation in sampling methods may have resulted in dif-ferent records for each.

EUGLENOIDINA

Two genera of Euglenoidina, Euglena and Phacus, were collected and each genus was represented by two species. Euglena acus Ehrenberg, a rather uncommon species (Prescott, 1951), was collected only in seven months of 1954 (Fig. 4). Phacus longicauda (Ehrenberg), Euglena tripteras (DuJardin), and Phacus pleuronectes (Mueller) appeared in 33, 29, and 25 months respectively.

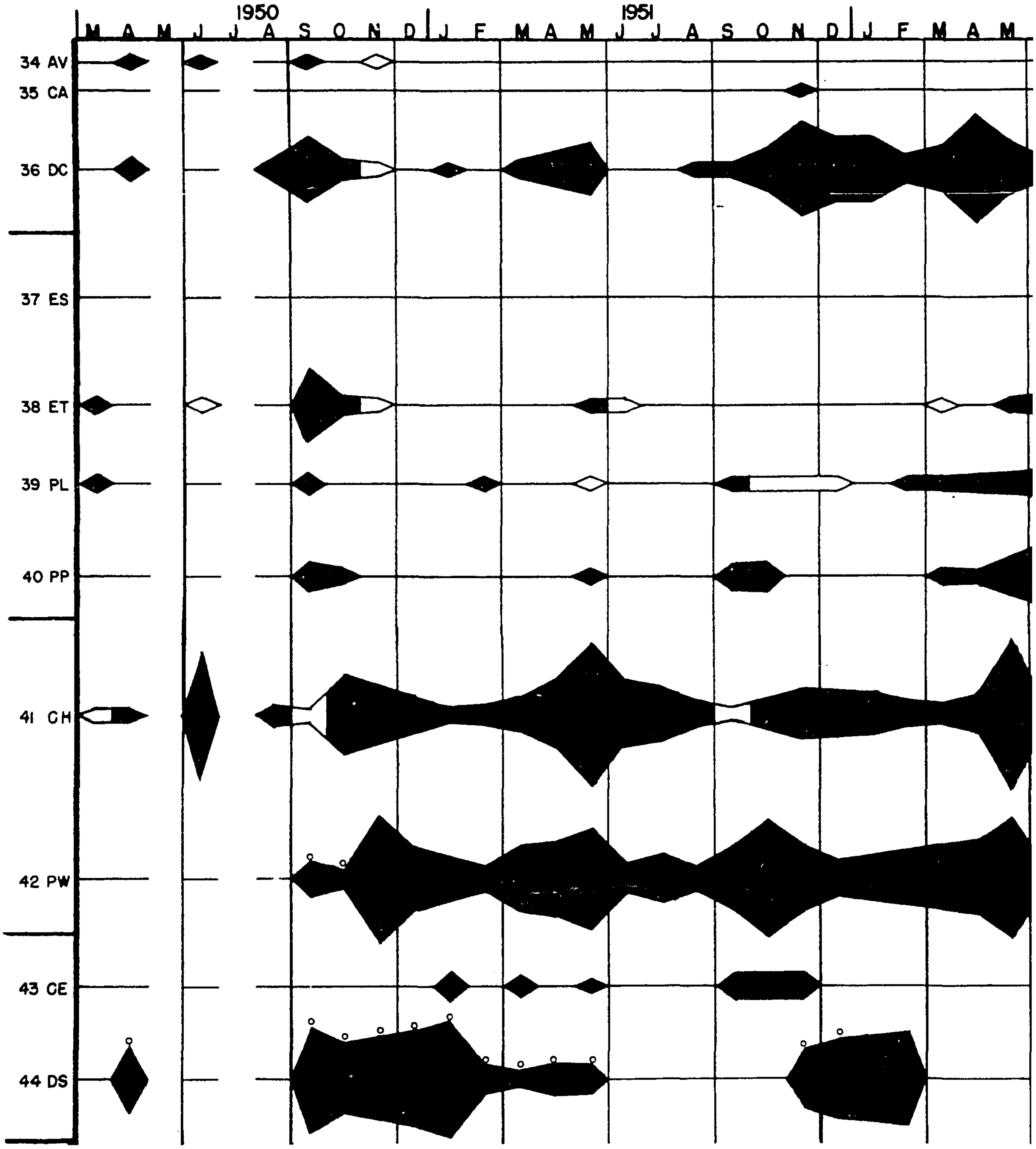
Euglena tripteris first appeared in March, 1950 and reached its peak population in September of the same year. Only in June of 1953 did it again approach this number. Its higher population occurred in the warm months and it did not appear in January or February and appeared only once in December (Fig. 4; Appendix XXV).

Phacus longicauda first appeared in March, 1950 but was not collected consistently until 1952 when it was present in greatest quantities. Over the entire period it appeared most frequently during the warmer months (Fig. 4; Appendix XXVI).

Phacus pleuronectes was first collected in September, 1950 and, after that, occurred only sporadically. Its highest population peak was in July, 1953. This was a very high pulse and probably due to collections being made during a "bloom" (Fig. 4; Appendix XXVII).

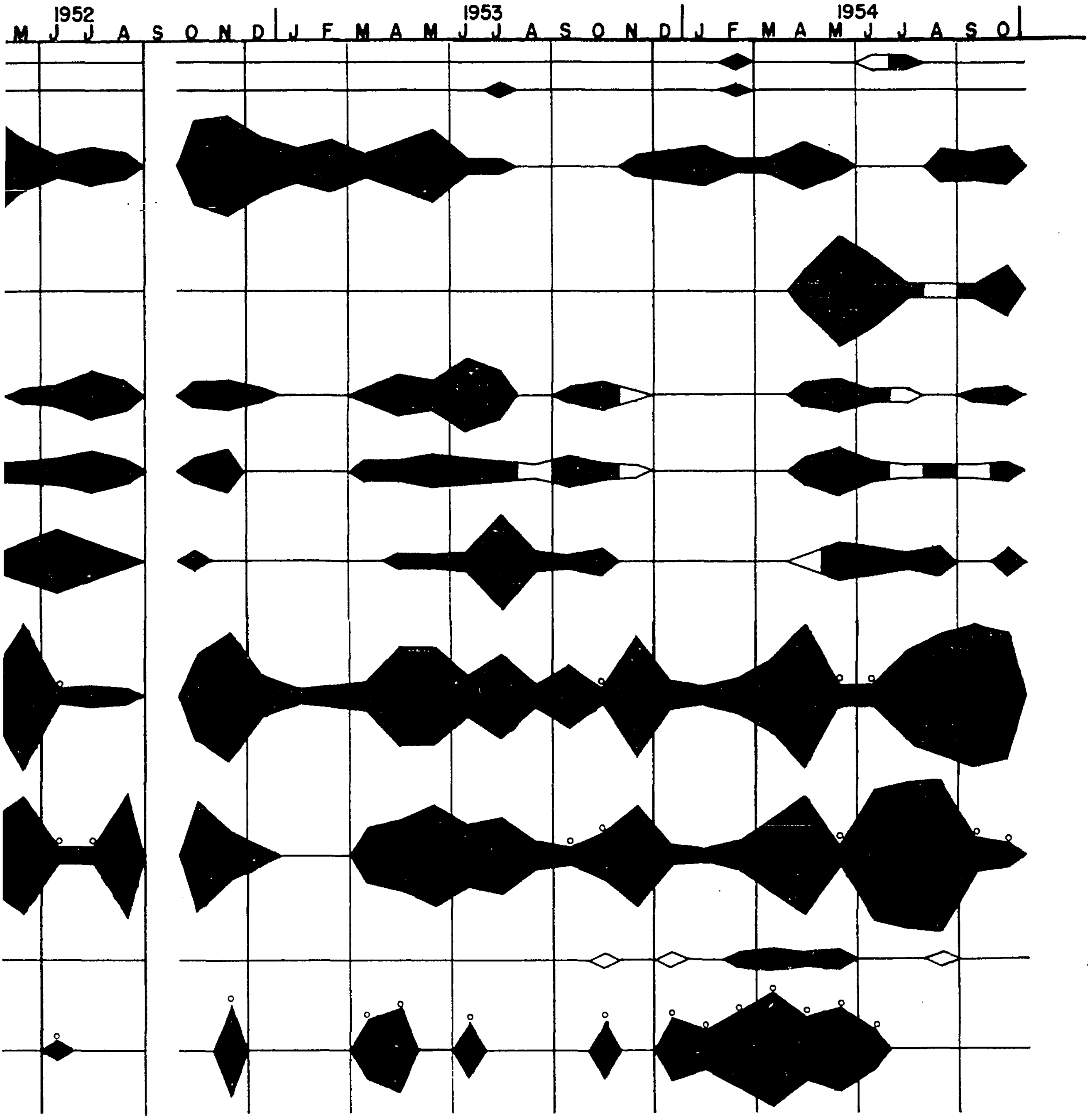
Only E. tripteris competed in frequency of appearance with either species of Phacus. Since Euglena is more commonly found in tycoplankton than euplankton (Smith, 1950; Prescott, 1951) and all collections were from the open water, the results obtained may not represent the true population.

FIG. 4--DIAGRAM SHOWING THE NUMERICAL RESULTS FOR



34. AV-Arcella vulgaris
35. CA-Centropyxis aculeata
36. DC-Difflugia cratera
37. ES-Euglena acus
38. ET-Euglena tripteris
39. PL-Phacus longicauda
40. PP-Phacus pleuronectes
41. CH-Ceratium hirundinella
42. PW-Peridinium willei
43. CE-Cymatopleura sp.
44. DS
34-36 T
37-40 E
41-42 D
43-44 C

)R NET PLANKTON OF THE RENSHAW IMPOUNDMENT......1950-1954.



DS-Dinobryon sertularia 41. CH°, 42 PW°, 44 DS°--
5 Testacea reduced scale 1:0.1
0 Euglenophyta
2 Dinoflagellata
4 Chrysophyta

Radius > 1

Radius < 1

Phacus longicauda and *P. pleuronectes* exhibited somewhat similar population patterns. *Phacus pleuronectes* appeared in greater abundance and was more limited to the warmer months than *P. longicauda*. Since samples were from the deeper water and free of barriers to wave action or turbulence, *P. pleuronectes* may not have been collected even though it were present in the more protected areas. *P. pleuronectes* is associated with marginal waters (Prescott, 1951). The high average in July, 1954 was probably during a "bloom" which resulted in a wider distribution of this organism throughout the impoundment.

Euglena and *Phacus* are both associated with hard water and higher temperatures (Johnson, 1944; Prescott, 1951). Throughout the investigation the highest averages per liter per month for each organism did not occur earlier than May or later than September except for *P. pleuronectes* in 1951 and *P. longicauda* in 1952 (Fig. 4; Appendix XXVI, XXVII).

DINOFLAGELLATA

Two representatives of Dinoflagellata were collected. *Ceratium hirundinella* (O.F.M.) was present in each of the 53 months while *Peridinium willei* Huitfeld-Kaas was present in 46 months.

Ceratium hirundinella reached its population peak in June, 1954. The lowest average per liter for a given month was in September of 1951, while the highest for a given month over the entire period was in May (Fig. 4; Appendix XXVIII). It exhibited a dicyclic population pattern. The spring peaks occurred in either April, May, or June and the fall peak occurred in either September, October, or November. Except in 1953, the spring peak exceeded that of the fall. In general, lower averages over the entire period were in the cooler months. On an annual basis, the average per liter declined slightly in alternate years. A pronounced rise followed each decline until it reached the highest peak in 1954 (Fig. 4). The development and disappearance of Ceratium "blooms" in this investigation coincide with those described by Prescott (1951).

Peridinium willei first appeared in September, 1950. Only once, October, 1953, was this organism recovered in greater abundance in a given month than in the first month of its appearance (Fig. 4; Appendix XXIX). It exhibited a dicyclic population pattern. The spring peak occurred in May or June and the fall peak was in September or October. Except in 1952, the fall peak exceeded the spring. The spring peak was not as pronounced as that of the fall. Higher populations occurred during warmer months with the highest averages per liter recorded in August and September. The highest annual average occurred in 1953.

The population patterns of _C_. _hirundinella_ and _P_. _willei_ complemented each other not only with respect to time but also in abundance. The fall peaks were usually higher for one while the spring was higher for the other. Although _C_. _hirundinella_ is a cosmopolitan species (Eddy, 1930) and _P_. _willei_ is distributed widely in American waters, the work of Prescott (1951) and the current investigation indicate that the two species vary as to abundance from region to region.

CHRYSOPHYTA

Nine species of Chrysophyta, including _Botryococcus braunii_ Kuetzig which is considered by some authorities as belonging to Chlorophyta, were represented in this impoundment (Fig. 4, 5; Table VI). _Dinobryon sertularia_ (Ehrenberg) was collected in 52 percent of the collecting time. It was not collected in July or August and only once in September (Appendix XXX). In general, a dicyclic population pattern was exhibited and the highest incidence occurred between January and March. The highest count for a given month and

TABLE VI

FREQUENCY OF COLLECTION OF CHRYSOPHYTA AND CHLOROPHYTA

CHRYSOPHYTA	Number of months Collected
Botryococcus braunii Kuetzig	2
Cymatopleura sp.	13
Dinobryon sertularia (Ehrenberg)	27
Fragilaria sp.	1
Gomphonema sp.	4
Gyrosigma sp.	1
Navicula sp.	12
Rhopalodia sp.	6
Synedra sp.	3
CHLOROPHYTA	
Ankistrodesmus sp.	7
Closterium sp.	21
Cosmarium sp.	16
Docidium sp.	15
Euastrum sp.	1
Kirchneriella sp.	1
Micrasterias sp.	2
Pediastrum boryanum (Turpin)	36
Pediastrum simplex (Myen)	33
Scenedesmus sp.	13

over the entire period was in January. The highest annual count was in 1952.

Dinobryon sertularia was not included in total plankton counts because of its abundance. My count was of individuals rather than colonies. When it was present it usually far exceeded other organisms in number (Fig. 4). This agrees with Prescott (1951) who related that D. sertularia may be the most conspicuous element in phytoplankton.

The higher numbers of D. sertularia coincide with higher alkalinity values. This impoundment, limited in size, fluctuated somewhat in alkalinity. These fluctuations were due probably to removal of carbon dioxide from the water by Chara (Fassett, 1940), water level variation resulting from seepage and evaporation, and dilution caused by rainfall. D. sertularia was not collected when lower alkalinity values occurred which agrees with Prescott (1951).

Navicula sp. was the only species of Chrysophyta other than D. sertularia that was collected in as much as 10 percent of the collecting time. Synedra sp. (Fig. 4) was found abundantly in one collection but appeared in a total of just three months. There was no apparent reason for this pulse.

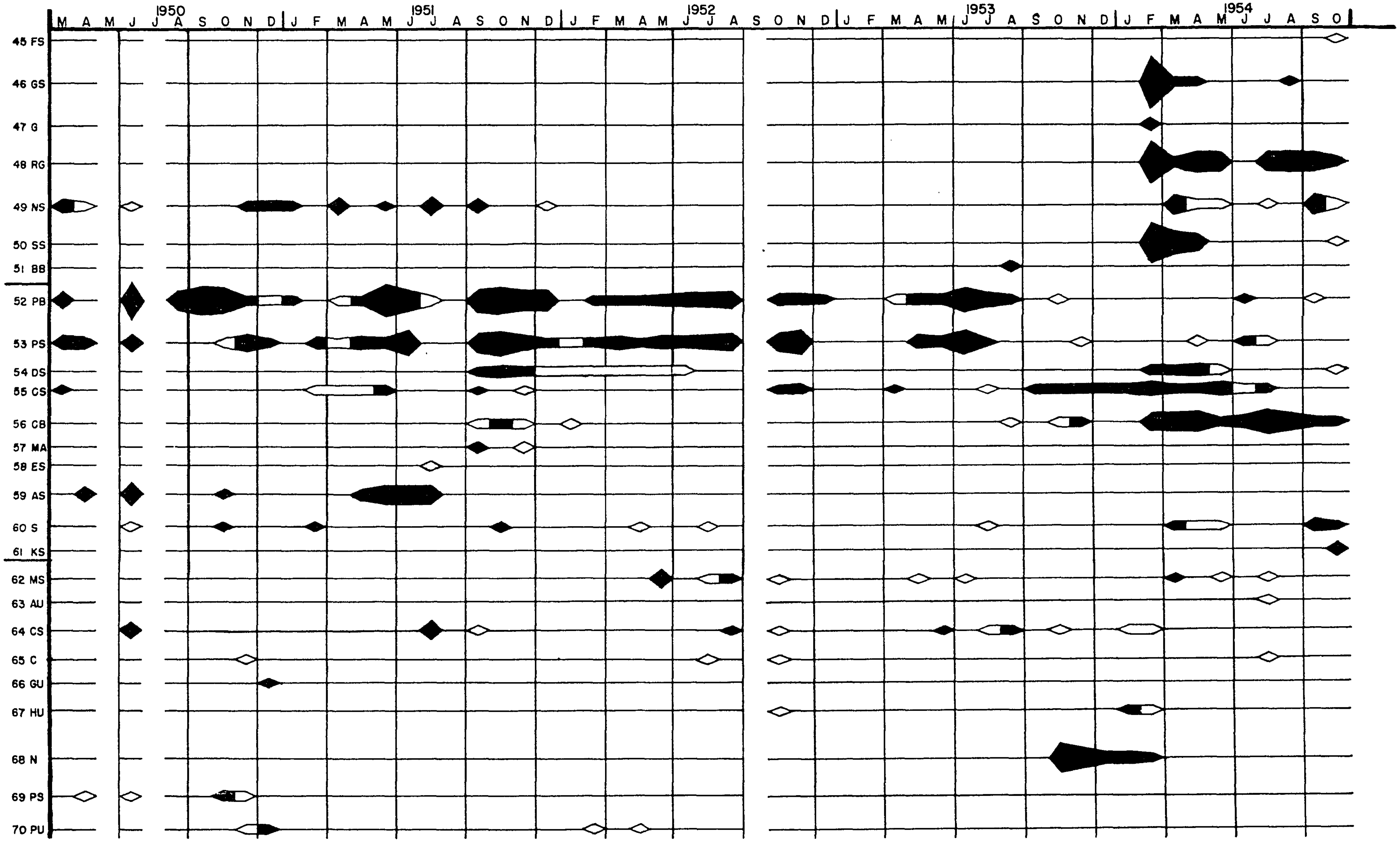
All Chrysophyta collected except B. braunii and D. sertularia belong to Bacillariophyceae. Diatoms are widely distributed through fresh and salt water (Fuller, 1935). The relative abundance of some species has been useful in characterizing the type of water and degree of pollution (Patrick, 1959). The frequency and abundance of the species which I collected were not sufficient to associate with specific characteristics of the environment.

CHLOROPHYTA

Ten species of Chlorophyta were collected. Only two, *Pediastrum boryanum* (Turpin) and *Pediastrum simplex* (Myen) were found in more than 50 percent of the collecting time (Fig. 5; Table VI).

Pediastrum boryanum was present in a total of 68 percent of the collecting time. It first appeared in March, 1950 and was collected consistently until October, 1953. It appeared only twice thereafter (Fig. 5; Appendix XXXI). The highest averages per liter occurred between May and October inclusive. The highest average for a given month was in June, 1950. On an annual basis, the highest average was in 1950. A dicyclic population pattern was exhibited in 1950 and 1951 but after that recovery was not in sufficient quantities to establish any particular pattern.

FIG. 5--DIAGRAM SHOWING THE NUMERICAL RESULTS FOR NET PLANKTON OF THE RENSHAW IMPOUNDMENT......1950-1954.



45. FS-Fragilaria sp.
46. GS-Gomphonema sp.
47. G -Gyrosigma sp.
48. RG-Rhopalodia sp.
49. NS-Navicula sp.
50. SS-Synedra sp.
51. BB-Botyrococcus braunii
52. PB-Pediastrum boryanum
53. PS-Pediastrum simplex

54. DS-Docidium sp.
55. CS-Closterium sp.
56. CB-Cosmarium sp.
57. MA-Micrasterias sp.
58. ES-Euastrum sp.
59. AS-Ankistrodesmus sp.
60. SS-Scenedesmus sp.
61. KS-Kirchneriella sp.
62. MS-Merismopedia sp.

63. AU-Annelida
64. CS-Chaoborus sp.
65. C -Chironomus sp.
66. GU-Gastrotricha
67. HU-Hydracarina
68. N -Nematoda
69. PS-Paramecium sp.
70. PU-Plumatella (statoblast)

45-51 Chrysophyta
52-61 Chlorophyta
62 Cyanophyta
63-70 Miscellaneous

Radius > 1

Radius < 1

Pediastrum simplex was collected in a total of 62 percent of the collecting time (Fig. 5; Appendix XXXII). It appeared first in March of 1950 but was collected more consistently in 1951 and 1952 than in other years. The highest average per liter for a given month was in November, 1952. On an annual basis, the averages were essentially the same for 1951 and 1952; those for the other years were considerably lower.

CYANOPHYTA

Only one species of Cyanophyta was collected. Merismopedia sp. was recovered in eight different months but in very small quantities (Fig. 4).

MISCELLANEOUS

Eight organisms collected were listed as miscellaneous (Fig. 5; Table VII). Chaoborus sp. appeared in 12 different months and averaged between 15 and 21 per liter per month in three months but less than 5 per liter in other months. It was never recovered later than October but did appear as early as January (Fig. 5).

Larval nematodes of the miscellaneous group were collected in just five months. This organism averaged 121

TABLE VII

FREQUENCY OF COLLECTION OF MISCELLANEOUS ORGANISMS

Organism	Number of Months Collected
Annelida	1
Chaoborus sp.	12
Chironomus sp.	4
Gastrotricha	1
Hydracarina	3
Nematoda	5
Paramecium sp.	4
Plumatella sp. (statoblast)	4

CHAPTER VI

DISCUSSION

The overall population community development in this investigation presents a pattern with its highest peak during the first year, 1950. This peak was followed by a pronounced drop in 1951. As the lake matured through the following three years, the population gradually increased. Since this investigation involved a previously unoccupied environment, it was possible to study the community as it developed. During the early part of 1950, the "environmental resistance" (Chapman, 1928) toward the various species was very low. This permitted each to reproduce without the degree of intraspecies and interspecies competition that would normally be found in a well established community. The sharp decline in 1951 may well be the result of environmental resistance becoming effective. The gradual increase in population over the next years represents an adjustment toward equilibration or to some change in the ecology of the watershed.

The number of genera collected closely approximates the number of species. This observation coincides with that of Elton (1946) in his study of closely related species in 55 animal communities. I found four genera, Daphnia, Euglena, Pediastrum, and Phacus, each represented by two species and one, Brachionus, by four. In each case, one species of a genus occupied a dominant position. According to Frank (1957) and dating back to Darwin (1859), taxonomic groups should have adaptive significance and thus, two species of the same genus should not be found in the same habitat. However, closely related species may exist in the same general ecological locale unless requirements are so similar that one is unable to withstand resulting competition.

In general, the population components observed in this study parallel closely those recorded by Jones (1939), Harris and Silvey (1940), Patterson (1941), and Cheatum et al. (1942), who worked in this area, and Pennak (1949), who worked in Colorado. Their investigations were all on well-established or aged communities. My study accounts for development of the community from its beginning through the first five years. Qualitatively, the population remained appreciably the same even through the drop in water level in the third year from approximately 20 feet to 5 feet and through the subsequent gradual rise to normal. Also, the chemical qualities of the water did not appear to effect noticeable reactions on the part of the population components. This is in agreement with Hutchinson (1944).

The dominant species of the present investigation, as observed in most lakes (Tressler, 1939), exhibited a spring and fall maximum. These maxima varied from year to year as to the time of appearance. Birge and Juday (1922) in their work on Lake Mendota, as well as more recent workers, have observed these same conditions.

The general population pattern of the current study does not coincide with that of Lake Decatur as reported by Eddy (1929). Eddy observed development year after year to be a steady progression toward a stable community. New species appeared each year and tended to increase in number as the lake grew older but no species really disappeared. In the current study, only a limited number of new species occurred after the first year and only one, Tropocyclops prasinus, exhibited a consistent pattern. However, population patterns of lakes in different latitudes may be expected to develop differently. The biota of a given lake depends upon a combination of factors such as physical, chemical and climatological conditions (Rawson, 1939; Prescott, 1939). The variation of those factors affords individuality to the body of water and this determines the aquatic fauna and flora. Numerous interacting factors of an aquatic environment produce a variety of habitat types (Prescott, 1939; Allee *et al.*, 1949). Continued metabolism of the environment results in successive changes in limiting factors and thus controls or affects variation in the population from time to time (Tressler, 1939).

The impoundment which I investigated derived some of the species in its initial population from a small spring-fed stream of very limited capacity whose source was a few hundred yards from the main basin. Stocking the impoundment with fish from a hatchery probably introduced additional plankters. Distribution of both land and aquatic organisms is regulated by factors associated with chemical conditions, nutrients, physics, geology, temperature, light, currents, and depth of water (Prescott, 1951). The most widely distributed organisms are those with a great range of tolerance for many factors, euroky, combined with a high degree of vagility (Allee *et al.*, 1949; Hesse *et al.*, 1949). Low vagility in combination with barriers to distribution is normally associated with stenotopy of a species. Those species usually possess a high degree of specialization and lack adaptability. The facility with which some animals are transplanted may contribute to their wide or narrow range. Organisms living in vegetation and temporary bodies of water that may be transplanted while in a dormant stage such as eggs, seeds, statoblasts, cysts, and spores are frequently world-wide in distribution (Hesse _et al._, 1949). New impoundments frequently resemble ponds of similar size cut off from streams (Eddy, 1929). When the basic necessities for subsistence of organisms are present, the appearance and establishment of the community depends upon the capacity of representative organisms to overcome the respective barriers. Passive transfer by wind, birds, and various other animals is an important factor in this distribution.

The majority of predominants collected during this study were cosmopolitan forms of wide distribution. This indicates that this body of water possesses qualities similar to those in other geographic regions and the representative organisms have a high degree of vagility as well as a wide tolerance range for conditions present. The source of each type of population, like that of temperate or tropical lakes, would be difficult to establish.

CHAPTER VII

SUMMARY

1. A new impoundment in Wise County, Texas was investigated in an attempt to determine population patterns in the establishment of the plankton community. Plankton samples were collected on a biweekly basis over a fifty-seven-month period dating from the time construction of the impoundment was completed. Average temperature for the state as a whole was above normal throughout the investigation and rainfall was below normal.

2. A total of 69 species was collected but only 45 to 55 were taken in any one year; the range of species collected was 8 to 31 in a single month. As the impoundment matured, there was a tendency toward a consistent distribution of species from month to month.

3. Only four species appeared in collections of 90 percent of the months in which collections were made. Six species were taken in 70 to 90 percent of the months and 25 species in less than 10 percent of the months in which collections were made.

4. Of the 69 species, 45 percent were collected during each of the five years and 21 percent only in a single year. Of the species taken during the last year of the study, 66 percent were present during each year. This observation indicates that relatively permanent species appear and establish themselves early in the history of an impoundment in this locality.

5. Forty-five percent of the species appeared in all seasons of the year; 26 percent were present in three seasons and 29 percent in one or two seasons. Some species disappeared from the collections for a year or more then reappeared.

6. Only 16 percent of the species were collected in sufficient quantities to be designated as predominants (highest average number per liter per month). *Bosmina longirostris*, *Brachionus angularis*, *Ceratium hirundinella*, and *Keratella cochlearis* were the leading organisms in this category.

7. The number of genera closely approximated the number of species. When two or more species of the same genus occurred, one species consistently occupied the predominant position. Usually, not more than three organisms

of a major division (Chapter V) appeared in appreciable numbers. Rotifera species were found in a greater number than any other major group.

8. Dominant species usually exhibited dicyclic population patterns. The peaks varied as to time of appearance and abundance of individuals involved.

9. The overall population development presents a pattern with its highest peak during the first year. This peak was followed by a pronounced decline and then a gradual rise through the next three years.

10. The plankton community components of this impoundment parallel closely those of older lakes in the same general area and in neighboring states.

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APPENDIX I

SPECIES INCIDENCE, TOTAL MONTHS AND YEARS COLLECTED

Organism	Total Months Collected	Years Collected 1950	1951	1952	1953	1954
Ceratium hirundinella (O.F.M.)	53	X	X	X	X	X
Mesocyclops edax (Forbes)	53	X	X	X	X	X
Keratella cochlearis (Gosse)	52	X	X	X	X	X
Nauplius	52	X	X	X	X	X
Bosmina longirostris (O.F.M.)	50	X	X	X	X	X
Daphnia longispina (O.F.M.)	47	X	X	X	X	X
Peridinium willei (Huitfeld-Kaas)	47	X	X	X	X	X
Difflugia cratera (Leidy)	42	X	X	X	X	X
Trichocerca longiseta (Schrank)	39	X	X	X	X	X
Brachionus angularis (Gosse)	38	X	X	X	X	X
Daphnia pulex (deGeer)	37	X	X	X	X	X
Pediastrum boryanum (Turpin)	36	X	X	X	X	X
Tropocyclops prasinus (Fischer)	34	0	X	X	X	X
Phacus longicauda (Ehrenberg)	33	X	X	X	X	X
Pediastrum simplex (Myen)	33	X	X	X	X	X
Ostracoda	28	X	X	X	X	X
Euglena tripteris (DuJardin)	29	X	X	X	X	X
Dinobryon sertularia (Ehrenberg)	27	X	X	X	X	X

APPENDIX I -- Species Incidence continued:

Organism	Total Months Collected	Years Collected 1950	1951	1952	1953	1954
Ceriodaphnia lacustris (Birge)	26	X	X	X	X	X
Phacus pleuronectes (Mueller)	25	X	X	X	X	X
Polyarthra trigla (Ehrenberg)	23	X	0	X	X	X
Lecane luna (Müller)	22	X	X	X	X	X
Closterium sp.	21	X	X	X	X	X
Lepadella sp.	21	0	0	X	X	X
Trochosphaera solstitialis (Thorpe)	19	X	X	X	X	X
Platyias patulus (Müller)	18	X	X	X	X	X
Chydorus sphaericus (O.F.M.)	18	X	X	X	X	X
Cosmarium sp.	16	X	X	X	X	X
Asplanchna sp.	14	X	X	X	X	X
Docidium sp.	15	0	X	X	0	X
Monostyla lunaris (Ehrenberg)	14	X	X	X	X	X
Scenedesmus sp.	13	X	X	X	X	X
Cymatopleura sp.	13	X	X	X	X	X
Synchaeta sp.	12	X	X	X	X	X
Navicula sp.	12	X	X	X	X	X
Chaoborus sp.	12	X	X	X	X	X
Rotaria sp.	11	0	0	0	X	X
Filinia longiseta (Ehrenberg)	10	X	X	X	X	0

APPENDIX I -- Species Incidence continued:

Organism	Total Months Collected	Years Collected 1950	1951	1952	1953	1954
Cephalodella sp.	9	X	X	X	X	0
Merismopedia sp.	8	0	0	X	X	X
Euglena acus Ehrenberg	7	0	0	X	X	X
Ankistrodesmus sp.	7	X	X	0	0	0
Rhopalodia sp.	6	0	0	X	X	0
Brachionus quadridentata (Hermann)	6	0	0	X	X	0
Arcella vulgaris (Ehrenberg)	6	X	0	0	X	X
Brachionus havanaensis (Rousslet)	5	X	0	0	X	X
Pleuroxus denticulatus (Birge)	5	X	X	X	0	X
Nematoda (larvae)	5	X	X	0	X	X
Diaphanosoma brachyurum (Leiven)	4	X	X	X	0	0
Platyias quadricornis (Ehrenberg)	4	0	0	0	X	0
Chironomus sp.	4	X	X	X	X	0
Gomphonema sp.	4	0	0	0	0	X
Paramecium sp.	4	X	0	0	0	X
Plumatella sp. (statoblast)	4	X	0	X	0	0
Centropyxis aculeata (Ehrenberg)	4	X	X	X	0	X
Synedra sp.	3	0	0	0	0	X
Hydracarina	3	0	0	X	0	X
Alona sp.	3	0	0	0	X	X

APPENDIX I -- Species Incidence continued:

Organisms	Total Months Collected	1950	1951	1952	1953	1954
Hexarthra mira (Hudson)	2	0	0	X	0	0
Micrasterias sp.	2	X	X	0	0	0
Botryococcus braunii Kuetzing	2	0	0	0	X	0
Brachionus calyciflorus (Pallas)	1	0	X	0	0	0
Kellicottia longispina (Kellicott)	1	0	0	X	0	0
Gyrosigma sp.	1	0	0	0	0	X
Fragilaria sp.	1	0	0	0	0	X
Euastrum sp.	1	0	X	0	0	0
Gastrochica	1	0	0	0	0	X
Kirchneriella sp.	1	0	0	0	0	X
Annelida	1	0	0	0	0	X
Unidentified rotifer	1	0	X	X	0	X

APPENDIX II

SEASONAL DISTRIBUTION OF PLANKTON PREDOMINANTS

A-Phytoplankton

	Winter	Spring	Summer	Fall
Ceratium hirundinella (O.F.M.)		X	X	X
Peridinium willei (Huitfeld-Kaas)	X	X	X	X
Phacus pleuronectes (Mueller)			X	

B-Zooplankton

	Winter	Spring	Summer	Fall
Asplanchna sp.		X		
Bosmina longirostris (O.F.M.)		X	X	
Brachionus angularis (Gosse)	X	X	X	
Brachionus havanaensis (Gosse)		X		
Daphnia longispina (O.F.M.)	X	X		
Difflugia cratera (Leidy)	X	X	X	X
Keratella cochlearis (Gosse)	X	X	X	X
Mesocyclops edax (Forbes)	X		X	
Copepoda nauplii	X	X	X	
Synchaeta sp.	X			

APPENDIX III

AVERAGE NUMBER PER LITER PER MONTH OF

CHYDORUS SPHAERICUS

	1950	1951	1952	1953	1954	Total
Jan.	*	7	25	0	0	32
Feb.	*	0	1	0	13	14
March	0	0	2	0	0	2
April	93	1	4	0	40	138
May	*	0	2	0	2	4
June	2	0	0	11	0	13
July	*	0	0	0	0	0
Aug.	0	0	0	0	0	0
Sept.	0	0	*	0	0	0
Oct.	0	2	0	0	0	2
Nov.	5	0	0	0	*	5
Dec.	12	8	10	0	*	30
Total	112	18	44	11	55	
Average	14	2	3	1	6	

* No collections made.

APPENDIX IV

AVERAGE NUMBER PER LITER PER MONTH OF

CERIODAPHNIA LACUSTRIS

	1950	1951	1952	1953	1954	Total
Jan.	*	0	0	0	0	0
Feb.	*	0	0	0	0	0
March	11	0	0	0	0	11
April	2	0	0	28	1	31
May	*	0	19	36	0	75
June	1	54	2	225	0	282
July	*	32	0	40	40	112
Aug.	0	11	0	12	0	23
Sept.	67	14	*	65	37	183
Oct.	7	48	104	92	11	262
Nov.	0	4	7	0	*	11
Dec.	0	0	0	0	*	0
Total	88	163	132	518	89	977
Average	11	12	12	43	9	

* No collections made.

APPENDIX V

AVERAGE NUMBER PER LITER PER MONTH OF

BOSMINA LONGIROSTRIS

	1950	1951	1952	1953	1954	Total
Jan.	*	98	79	170	7	354
Feb.	*	277	178	1038	20	1513
March	186	60	30	1157	47	1480
April	0	169	130	6731	65	7095
May	*	70	19	14	17	120
June	1	4	4	24	33	66
July	*	5	12	0	147	164
Aug.	21	3	30	2	413	469
Sept.	235	6	*	0	356	597
Oct.	7	58	343	1	47	456
Nov.	23	81	307	1	*	412
Dec.	26	19	459	5	*	509
Total	499	850	1591	9143	1152	
Average	62	74	115	762	116	

* No collections made.

APPENDIX VI

AVERAGE NUMBER PER LITER PER MONTH OF

DAPHNIA LONGISPINA

	1950	1951	1952	1953	1954	Total
Jan.	*	16	2	5	86	109
Feb.	*	0	15	0	77	92
March	5	4	16	6	26	57
April	11	10	18	12	69	120
May	*	41	9	0	18	68
June	0	68	51	7	42	168
July	*	17	31	2	1	51
Aug.	0	7	8	4	0	19
Sept.	28	106	*	47	9	190
Oct.	25	11	25	51	20	132
Nov.	23	51	39	25	*	138
Dec.	35	4	9	42	*	90
Total	127	335	223	201	348	
Average	16	28	21	17	35	

* No collections made.

APPENDIX VII

AVERAGE NUMBER PER LITER PER MONTH OF

DAPHNIA PULEX

	1950	1951	1952	1953	1954	Total
Jan.	*	12	9	0	40	61
Feb.	*	74	17	0	31	122
March	0	42	35	0	28	105
April	0	23	8	18	54	103
May	*	20	2	4	5	31
June	0	0	0	52	0	52
July	*	0	3	1	4	8
Aug.	0	4	0	0	0	4
Sept.	5	34	*	8	0	47
Oct.	31	30	39	39	0	139
Nov.	24	19	4	54	*	101
Dec.	15	11	16	91	*	133
Total	75	269	133	267	162	
Average	9	22	12	22	16	

* No collections made.

APPENDIX VIII

AVERAGE NUMBER PER LITER PER MONTH OF

MESOCYCLOPS EDAX

	1950	1951	1952	1953	1954	Total
Jan.	*	18	69	7	72	166
Feb.	*	5	31	18	8	62
March	78	14	12	114	7	225
April	196	36	54	578	36	834
May	*	247	165	53	26	490
June	111	113	168	70	67	529
July	*	239	176	50	27	492
Aug.	49	133	62	137	5	386
Sept.	233	125	*	40	378	776
Oct.	63	58	123	34	426	704
Nov.	45	219	238	7	*	509
Dec.	63	110	32	2	*	207
Total	838	1317	1130	1110	1052	
Average	105	110	103	92	105	

* No collections made.

APPENDIX IX

AVERAGE NUMBER PER LITER PER MONTH OF

<u>TROPOCYCLOPS PRASINUS</u>

	1950	1951	1952	1953	1954	Total
Jan.	*	0	7	0	7	14
Feb.	*	0	39	0	5	44
March	0	0	3	7	0	10
April	0	0	32	191	5	228
May	*	0	105	32	19	156
June	0	0	44	67	49	160
July	*	0	41	29	23	94
Aug.	0	0	29	19	28	76
Sept.	0	56	*	56	212	324
Oct.	0	167	61	153	178	559
Nov.	0	190	256	35	*	481
Dec.	0	28	54	35	*	117
Total	0	441	672	624	526	
Average	0	37	61	52	53	

* No collections made.

APPENDIX X

AVERAGE NUMBER PER LITER PER MONTH OF NAUPLIUS

	1950	1951	1952	1953	1954	Total
Jan.	*	7	21	5	5	38
Feb.	*	7	96	7	21	131
March	6	30	306	551	84	977
April	72	70	275	266	183	866
May	*	256	1132	172	116	1676
June	63	133	792	416	433	1837
July	*	238	441	85	105	869
Aug.	0	114	487	509	383	1493
Sept.	441	382	*	312	467	1602
Oct.	31	465	183	217	1291	2187
Nov.	21	786	319	99	*	1225
Dec.	24	186	156	7	*	373
Total	658	2674	4208	2646	3088	
Average	82	223	382	240	327	

* No collections made.

APPENDIX XI

AVERAGE NUMBER PER LITER PER MONTH OF

KERATELLA COCHLEARIS

	1950	1951	1952	1953	1954	Total
Jan.	*	73	72	415	560	1120
Feb.	*	19	7	399	65	490
March	23	0	11	179	12	225
April	16142	304	11	17	34	16508
May	*	874	106	207	908	2095
June	91	33	394	1255	272	2045
July	*	27	694	51	107	879
Aug.	7	6	1366	30	375	1785
Sept.	147	9	*	92	7	256
Oct.	89	129	264	686	135	1303
Nov.	46	650	3878	405	*	4979
Dec.	34	557	293	938	*	1822
Total	16652	2681	7096	4675	2476	
Average	2072	1890	636	389	328	

* No collections made.

APPENDIX XII

AVERAGE NUMBER PER LITER PER MONTH OF

TRICHOCERCA LONGISETA

	1950	1951	1952	1953	1954	Total
Jan.	*	*	151	9	19	179
Feb.	*	*	92	4	21	117
March	*	*	25	42	0	67
April	*	*	12	5	4	21
May	*	*	7	4	6	17
June	*	12	30	6	16	64
July	*	6	45	4	15	70
Aug.	*	*	26	14	35	75
Sept.	4	16	*	4	5	29
Oct.	*	1	19	1	22	43
Nov.	2	4	23	7	*	36
Dec.	*	3	44	5	*	52
Total	6	42	474	105	143	
Average	1	3	42	9	15	

* No collections made.

APPENDIX XIII

AVERAGE NUMBER PER LITER PER MONTH OF

BRACHIONUS ANGULARIS

	1950	1951	1952	1953	1954	Total
Jan.	*	0	462	298	29	809
Feb.	*	0	499	448	0	947
March	0	0	322	994	0	1316
April	5	0	417	237	1	660
May	*	822	72	141	24	1059
June	0	171	56	382	11	620
July	*	51	63	159	58	331
Aug.	0	3	10	5	64	82
Sept.	0	32	*	4	65	101
Oct.	0	14	12	2	378	406
Nov.	0	75	221	0	*	296
Dec.	0	379	1376	0	*	1755
Total	5	1547	3510	2670	650	
Average	.5	129	323	242	117	

* No Collections made.

APPENDIX XIV

AVERAGE NUMBER PER LITER PER MONTH OF

POLYARTHRA TRIGLA

	1950	1951	1952	1953	1954	Total
Jan.	*	0	0	0	0	0
Feb.	*	0	8	0	13	21
March	9	0	75	0	7	91
April	0	0	146	0	14	160
May	*	0	96	0	39	135
June	9	0	15	0	27	51
July	*	0	49	6	174	229
Aug.	0	0	55	30	125	210
Sept.	0	0	*	0	2	2
Oct.	0	0	0	0	50	50
Nov.	0	0	9	9	*	18
Dec.	0	0	0	7	*	7
Total	18	0	453	52	451	
Average						

* No collections made.

APPENDIX XV

AVERAGE NUMBER PER LITER PER MONTH OF

LECANE LUNA

	1950	1951	1952	1953	1954	Total
Jan.	*	0	0	0	0	0
Feb.	*	0	0	0	1	1
March	0	0	0	0	7	7
April	0	0	0	0	1	1
May	*	0	5	7	0	12
June	1	0	4	1	0	6
July	*	3	1	0	1	5
Aug.	0	3	0	2	2	7
Sept.	4	4	*	0	2	10
Oct.	0	1	2	0	1	4
Nov.	0	5	5	0	*	10
Dec.	0	0	0	0	*	0
Total	5	16	17	10	15	
Average	0	0	0	0	0	

* No collections made.

APPENDIX XVI

AVERAGE NUMBER PER LITER PER MONTH OF

LEPADELLA SP.

	1950	1951	1952	1953	1954	Total
Jan.	*	0	12	7	0	19
Feb.	*	0	7	21	3	31
March	0	0	6	5	0	11
April	0	0	3	1	2	6
May	*	0	5	0	0	5
June	0	0	9	2	0	11
July	*	0	3	0	2	5
Aug.	0	0	0	0	0	0
Sept.	0	0	*	0	0	*
Oct.	0	0	2	7	0	9
Nov.	0	0	11	1	*	12
Dec.	0	0	10	2	*	12
Total	0	0	68	46	7	
Average	0	0	6	2	0	

* No collections made.

APPENDIX XVII

AVERAGE NUMBER PER LITER PER MONTH OF

TROCHOSPHAERA SOLSTITIALIS

	1950	1951	1952	1953	1954	Total
Jan.	*	0	0	0	0	0
Feb.	*	0	2	7	0	9
March	0	0	7	6	0	13
April	7	0	9	11	0	27
May	4	18	9	1	0	32
June	8	0	0	0	0	8
July	*	6	0	0	0	6
Aug.	7	0	0	0	5	12
Sept.	0	0	*	0	7	7
Oct.	0	0	1	0	1	2
Nov.	0	0	4	0	*	3
Dec.	0	0	0	0	*	0
Total	26	24	32	25	13	
Average	0	0	0	0	0	

* No collections made.

APPENDIX XVIII

AVERAGE NUMBER PER LITER PER MONTH OF

PLATYIAS PATULUS

	1950	1951	1952	1953	1954	Total
Jan.	*	0	0	0	0	0
Feb.	*	0	0	0	0	0
March	2	0	0	0	0	2
April	0	0	0	0	0	0
May	*	12	84	64	7	167
June	0	63	0	0	6	69
July	*	5	1	1	13	20
Aug.	0	0	0	5	0	5
Sept.	0	1	*	0	2	3
Oct.	10	4	0	0	8	22
Nov.	0	0	4	0	*	4
Dec.	0	0	0	0	*	0
Total	12	85	89	70	36	
Average	0	0	0	0	0	

* No collections made.

APPENDIX XIX

AVERAGE NUMBER PER LITER PER MONTH OF

ASPLANCHNA SP.

	1950	1951	1952	1953	1954	Total
Jan.	*	0	0	0	7	7
Feb.	*	25	0	0	0	25
March	0	40	0	9	0	49
April	19	0	0	0	0	19
May	*	0	2	0	0	2
June	2	0	0	0	2	4
July	*	4	0	0	0	4
Aug.	0	0	0	0	0	0
Sept.	0	2	*	0	0	2
Oct.	0	0	2	0	0	2
Nov.	0	0	7	0	*	7
Dec.	2	24	0	0	*	26
Total	23	95	11	9	9	
Average	0	0	0	0	0	

* No collections made.

APPENDIX XX

AVERAGE NUMBER PER LITER PER MONTH OF

FILINIA LONGISETA

	1950	1951	1952	1953	1954	Total
Jan.	*	0	0	0	0	0
Feb.	*	0	0	0	0	0
March	0	0	0	0	0	0
April	411	2	1	0	0	411
May	*	0	2	0	0	2
June	0	0	0	0	0	0
July	*	0	0	0	0	0
Aug.	0	0	160	19	0	179
Sept.	0	0	*	1	0	1
Oct.	0	0	0	0	0	0
Nov.	1	0	0	0	*	1
Dec.	1	0	0	0	*	1
Total	413	2	163	20	0	
Average	52	0.2	12	.2	0	

* No collections made.

APPENDIX XXI

AVERAGE NUMBER PER LITER PER MONTH OF

MONOSTYLA LUNARIS

	1950	1951	1952	1953	1954	Total
Jan.	*	0	3	0	2	5
Feb.	*	0	0	0	0	0
March	2	0	0	0	0	2
April	0	4	0	0	0	4
May	*	0	0	0	0	0
June	1	0	1	0	0	2
July	*	0	1	0	5	6
Aug.	0	0	0	0	0	0
Sept.	0	0	*	0	0	0
Oct.	0	0	0	0	30	30
Nov.	0	0	0	0	*	0
Dec.	0	6	0	0	*	6
Total	3	10	5	0	37	
Average	0	0	0	0	0	

* No collections made.

APPENDIX XXII

AVERAGE NUMBER PER LITER PER MONTH OF

ROTARIA SP.

	1950	1951	1952	1953	1954	Total
Jan.	*	0	0	0	9	9
Feb.	*	0	0	4	3	7
March	0	0	0	0	5	5
April	0	0	0	0	1	1
May	*	0	0	0	17	17
June	0	0	1	0	1	2
July	*	0	0	0	2	2
Aug.	0	0	0	0	0	0
Sept.	0	2	*	0	0	2
Oct.	0	0	0	0	4	4
Nov.	0	0	0	0	*	0
Dec.	0	0	0	0	*	0
Total	0	2	1	4	42	
Average	0	0	0	0	4	

* No collections made.

APPENDIX XXIII

AVERAGE NUMBER PER LITER PER MONTH OF

<u>SYNCHAETA</u> SP.

	1950	1951	1952	1953	1954	Total
Jan.	*	0	19	0	54	73
Feb.	*	0	3	14	75	92
March	0	0	5	0	173	178
April	0	32	0	0	50	82
May	*	0	0	0	0	0
June	1	0	0	0	21	22
July	*	0	0	0	0	0
Aug.	0	0	0	22	0	22
Sept.	0	0	*	0	0	0
Oct.	0	0	0	0	0	0
Nov.	0	0	0	0	*	0
Dec.	0	0	0	0	*	0
Total	1	32	27	36	373	
Average	0	0	0	0	0	

* No collections made.

APPENDIX XXIV

AVERAGE NUMBER PER LITER PER MONTH OF

DIFFLUGIA CRATERA

	1950	1951	1952	1953	1954	Total
Jan.	*	4	1202	70	86	1362
Feb.	*	0	32	238	4	274
March	0	7	123	28	101	259
April	19	51	1810	117	161	1250
May	*	222	224	567	12	1025
June	0	0	18	8	0	26
July	*	0	89	5	0	94
Aug.	14	6	27	0	51	98
Sept.	418	4	*	0	30	452
Oct.	11	101	940	0	83	1135
Nov.	1	1207	1467	13	*	2688
Dec.	0	517	311	54	*	882
Total	463	2119	6243	1100	528	
Average	58	117	549	92	53	

* No collections made.

APPENDIX XXV

AVERAGE NUMBER PER LITER PER MONTH OF

EUGLENA TRIPTERIS

	1950	1951	1952	1953	1954	Total
Jan.	*	0	0	0	0	0
Feb.	*	0	0	0	0	0
March	9	0	2	53	0	64
April	0	0	0	100	27	127
May	*	4	5	46	54	109
June	4	0	16	540	5	565
July	*	2	133	188	1	324
Aug.	*	0	32	0	0	32
Sept.	582	0	*	11	5	598
Oct.	18	0	25	36	14	93
Nov.	1	0	46	1	*	48
Dec.	0	0	5	0	*	5
Total	614	6	264	926	106	
Average	77	.5	24	77	10	

* No collections made.

APPENDIX XXVI

AVERAGE NUMBER PER LITER PER MONTH OF

<u>PHACUS LONGICAUDA</u>

	1950	1951	1952	1953	1954	Total
Jan.	*	0	0	0	0	0
Feb.	*	4	4	0	0	8
March	9	0	8	14	0	32
April	0	0	12	15	39	66
May	*	1	14	11	81	107
June	0	0	35	28	14	77
July	*	0	98	22	2	122
Aug.	0	0	24	2	5	31
Sept.	18	4	*	11	2	35
Oct.	0	2	26	8	12	48
Nov.	0	2	126	1	*	129
Dec.	0	1	*	0	*	1
Total	27	14	347	112	155	
Average	3	1	31	9	15	

* No collections made.

APPENDIX XXVII

AVERAGE NUMBER PER LITER PER MONTH OF

PHACUS PLEURONECTES

	1950	1951	1952	1953	1954	Total
Jan.	*	0	0	0	0	0
Feb.	*	0	0	0	0	0
March	0	0	9	0	0	9
April	0	0	4	8	3	15
May	*	8	84	4	75	171
June	0	0	370	12	40	422
July	*	0	110	1410	9	1529
Aug.	0	0	9	19	47	75
Sept.	35	29	*	6	0	70
Oct.	7	48	15	30	28	158
Nov.	0	0	0	0	*	0
Dec.	0	0	0	0	*	0
Total	42	85	601	1489	202	
Average	5	7	55	124	20	

* No collections made.

APPENDIX XXVIII

AVERAGE NUMBER PER LITER PER MONTH OF

CERTIUM HIRUNDINELLA

	1950	1951	1952	1953	1954	Total
Jan.	*	7	129	9	12	157
Feb.	*	11	28	11	64	114
March	4	51	19	33	623	730
April	5	461	86	1481	4381	6414
May	*	4215	4895	1334	13526	23970
June	2937	465	6196	105	16690	26393
July	*	238	11	938	1003	2190
Aug.	21	20	8	14	2704	2767
Sept.	4	2	*	385	4257	4648
Oct.	771	48	1025	6099	3033	10976
Nov.	262	159	3248	2800	*	6470
Dec.	78	134	113	44	*	369
Total	4083	5694	15758	13253	46293	
Average	510	484	1432	1021	4629	

* No collections made.

APPENDIX XXIX

AVERAGE NUMBER PER LITER PER MONTH OF

PERIDINIUM WILLEI

	1950	1951	1952	1953	1954	Total
Jan.	*	128	117	0	5	250
Feb.	*	26	250	0	32	308
March	0	420	393	256	628	1697
April	0	565	582	508	2488	4143
May	*	1268	2457	1519	5643	10887
June	0	79	6267	366	3350	10062
July	*	171	5899	631	4653	11354
Aug.	0	23	3009	35	5129	8196
Sept.	81189	407	*	7350	48638	137584
Oct.	11203	2157	2107	157396	24874	197733
Nov.	2836	428	177	1504	*	4945
Dec.	373	74	9	14	*	470
Total	95609	5746	21267	169580	73057	
Average	11950	479	1725	14132	9543	

* No collections made.

APPENDIX XXX

AVERAGE NUMBER PER LITER PER MONTH OF

DINOBRYON SERTULARIA

	1950	1951	1952	1953	1954	Total
Jan.	*	2182656	50202299	0	96402	7299296
Feb.	*	40015	1061	0	576282	617358
March	0	6972	0	310346	2139003	2456321
April	441078	49640	0	829619	403488	1311337
May	*	38045	0	0	862040	900086
June	0	0	14627	264193	95188	374008
July	*	0	0	0	0	0
Aug.	0	0	0	*	0	0
Sept.	1643297	0	*	0	0	1643297
Oct.	527475	0	0	326489	0	853946
Nov.	879720	273510	1148167	0	*	2301397
Dec.	1216225	804543	0	397425	*	2418193
Total	6148872	3395380	6184093	2119072	4172404	
Average	588474	282948	4280513	165370	417240	

* No collections made.

APPENDIX XXXI

AVERAGE NUMBER PER LITER PER MONTH OF

PEDIASTRUM BORYANUM

	1950	1951	1952	1953	1954	Total
Jan.	*	4	0	0	0	4
Feb.	*	0	4	0	0	4
March	28	2	4	2	0	36
April	0	1	4	7	0	12
May	*	146	5	7	0	158
June	263	51	6	77	4	401
July	*	1	18	18	0	37
Aug.	35	0	12	3	0	50
Sept.	98	50	*	0	3	151
Oct.	85	96	23	1	0	205
Nov.	4	41	7	0	*	52
Dec.	2	41	3	0	*	45
Total	515	433	86	115	37	
Average	64	36	8	10	4	

* No collections made.

APPENDIX XXXII

AVERAGE NUMBER PER LITER PER MONTH OF

PEDIASTRUM SIMPLEX

	1950	1951	1952	1953	1954	Total
Jan.	*	0	2	0	0	2
Feb.	*	11	5	0	0	16
March	14	2	12	0	0	28
April	7	11	5	12	1	36
May	*	8	9	7	0	24
June	23	58	8	59	4	152
July	*	0	16	7	1	25
Aug.	0	0	27	0	0	27
Sept.	0	33	*	0	0	33
Oct.	3	54	27	0	0	84
Nov.	23	20	67	1	*	111
Dec.	4	5	0	0	*	9
Total	74	202	178	87	6	
Average	9	17	16	7	1	

* No collections made.